A Conceptual Model of Design-Build

by

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Abstract

Design-build is a project delivery method with roots in the ancient concept of the “master builder” where responsibility for both design and construction reside in one person. Despite the dominance of design-bid-build in more recent years a reemergence of design-build was anticipated with early projections indicating it would begin to dominate over design-bid-build. While there has been steady growth in the use of design-build it has not met initial expectations which seems in part due to the lack of conceptual knowledge about the method.

Through a process of triangulation involving the Delphi technique, Grounded Theory and Case Study analysis this research develops a conceptual model of design-build. Delphi data identifying critical factors of design-build is inductively coded into seven categories that are enfolded into the twelve defining characteristics of “relational contracts,” the central theme upon which the model is built. Literature used to define and ground each characteristic factor is synthesized into a conceptual framework then illustrated and applied in the context of design-build with Case studies and Delphi data. The value of the conceptual model is then highlighted through application to current design-build procedures. The conceptual model provides practitioners a perspective to better understand their past projects and a tool to tailor design-build to their current projects.

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Table of Contents

Abstract 2

Acknowledgments 3

List of Tables 16

List of Figures 17

Chapter 1 Introduction 18

1.1 Background 18

1.2 Problem Statement 19

1.3 Research Question 23

1.4 Objectives 24

1.5 Development Plan 24

Chapter 2 Literature Review 27

2.1 Introduction 27

2.2 Design-Build 27

2.2.1 Background 27

2.2.1.1 History 28

2.2.1.1.1 Emergence of Design-Bid-Build 29

2.2.1.1.2 Reemergence of Design-Build 31

2.2.1.2 Challenges for Design-Build 32

2.2.2 State-of-the-Practice Review 35

2.2.2.1 CDOT Design-Build Manual 35

2.2.2.2 GDOT Design-Build Manual 37

2.2.2.3 MnDOT Design-Build Manual 39

2.2.2.4 WSDOT Design-Build Manual....41
2.2.2.5 NCHRP Design-Build Procurement Guidebook....43
2.2.2.6 NCHRP ATCs Guidebook....45
2.2.2.7 NCHRP Design-Build Post-Award Contract Administration Guidebook....46
2.3 Relational Contracts....48
2.3.1 Boundaries....49
2.3.2 Actors....53
2.3.3 Planning....55
2.3.4 Time....57
2.4 Summary....58
Chapter 3 Research Methodology....59
3.1 Triangulation....59
3.2 Delphi....62
3.3 Grounded Theory....64
3.3.1 Open coding....66
3.3.2 Axial coding....66
3.3.3 Selective coding....68
3.3.4 Theory refinement....69
3.3.5 Theory validation....69
3.4 Case Study....69
3.5 Stepwise Research Process....71
3.5.1 Collecting the data....73

3.5.2 Discovering the categories 75
3.5.3 Discovering the central category 75
3.5.4 Developing the theory 76
3.5.5 Refining the theory 76
3.5.6 Validating the theory 77
3.5.7 Applying the theory 78
3.6 Summary 79
Chapter 4 Data Collection and Selective Coding 80
4.1 Introduction 80
4.2 Data Collection 80
4.2.1 Delphi 81
4.2.2 Case Studies 82
4.2.3 Case Study Project Summaries 84
4.2.3.1 I-15 Corridor Reconstruction 84
4.2.3.2 Knightdale Connector 85
4.2.3.3 St. George Island Bridge 85
4.2.3.4 I-77 Reconstruction 86
4.2.3.5 I-85 Reconstruction 87
4.2.3.6 I-10 Blackwater Bridge Replacement 88
4.2.3.7 I-4 Reconstruction 88
4.2.4 Data Collection Summary 89
4.3 Open/Axial Coding 90
4.4 Delphi Categories 91

4.4.1 The Right Team 91
4.4.2 Stakeholders 92
4.4.3 Expectations 95
4.4.4 Shared Understanding of Scope 96
4.4.5 Reliance on Something 102
4.4.6 Reliance on Someone 104
4.4.7 Power 105
4.4.8 Summary 108
4.5 Selective Coding: Central Category 109
4.6 Contractual Spectrum 116
4.7 Summary 126
Chapter 5 Theory Refinement and Validation Using Triangulation 127
5.1 Introduction 127
5.2 Boundaries 128
5.2.1 Overall Relation Type 128
5.2.1.1 MacNeil 128
5.2.1.2 Delphi Panel 129
5.2.1.3 Literature 130
5.2.1.3.1 Organizational Boundaries 131
5.2.1.3.2 Boundary Objects & Boundary Spanners 131
5.2.1.3.3 Discrete Transaction 134
5.2.1.3.4 Relational Contract 135

5.2.1.4 Classifying Overall Relation Type in Construction Practices and Trends……..……..137
5.2.1.5 Conceptual Framework.....139
5.2.1.6 Case Study Illustrations 140
5.2.1.7 Delphi Application.....142
5.2.1.8 Summary.....143
5.2.2 Sources of Contractual Solidarity 144
5.2.2.1 MacNeil.....144
5.2.2.2 Delphi Panel.....145
5.2.2.3 Literature.....146
5.2.2.3.1 External contractual solidarity 147
5.2.2.3.2 Internal social solidarity.....148
5.2.2.4 Classifying Sources in Construction Practices and Trends.....149
5.2.2.5 Conceptual Framework.....151
5.2.2.6 Case Study Illustrations 152
5.2.2.7 Delphi Application.....154
5.2.2.8 Summary.....155
5.3 Actors.....155
5.3.1 Power, Hierarchy, and Command.....156
5.3.1.1 MacNeil.....156
5.3.1.2 Delphi Panel.....157
5.3.1.3 Literature.....159

5.3.1.4 Classifying Power, Hierarchy, and Command in Current Construction Practices and Trends……...160
5.3.1.5 Conceptual Framework.....162
5.3.1.6 Case Study Illustrations 163
5.3.1.7 Delphi Application.....165
5.3.1.8 Summary.....169
5.3.2 Numbers.....169
5.3.2.1 MacNeil.....169
5.3.2.2 Delphi Panel.....171
5.3.2.3 Literature.....173
5.3.2.4 Classifying Numbers in Current Construction Practices and Trends……..178
5.3.2.5 Conceptual Framework.....180
5.3.2.6 Case Study Illustrations 182
5.3.2.7 Delphi Application.....184
5.3.2.8 Summary.....186
5.3.3 Attitudes.....186
5.3.3.1 MacNeil.....186
5.3.3.2 Delphi Panel.....189
5.3.3.3 Literature.....192
5.3.3.3.1 Awareness of Conflict of Interest 192
5.3.3.3.2 Unity 194
5.3.3.3.3 Time 199

5.3.3.3.3.1 Relational time 199
5.3.3.3.3.1.1 Horizontal time……...199
5.3.3.3.3.1.2 Vertical time……201
5.3.3.3.3.2 Temporal ordering 203
5.3.3.3.3.3 Accessibility.....204
5.3.3.3.3.4 Production.....204
5.3.3.3.4 Trouble.....205
5.3.3.4 Classifying Attitudes in Construction Practices and Trends.....208
5.3.3.5 Conceptual Framework.....218
5.3.3.6 Case Study Illustrations 224
5.3.3.7 Delphi Application.....227
5.3.3.8 Summary.....229
5.4 Time 230
5.4.1 Commencement, Duration and Termination.....230
5.4.1.1 MacNeil.....230
5.4.1.2 Delphi Panel.....231
5.4.1.3 Literature.....232
5.4.1.4 Classifying Commencement, Duration and Termination in Current Construction Practices and Trends 234
5.4.1.5 Conceptual Framework.....237
5.4.1.6 Case Study Illustrations 238
5.4.1.7 Delphi Application.....239
5.4.1.8 Summary.....241

5.4.2 Transferability....242
5.4.2.1 MacNeil....242
5.4.2.2 Delphi Panel....243
5.4.2.3 Literature....245
5.4.2.4 Classifying Transferability in Current Construction Practices and Trends....252
5.4.2.5 Conceptual Framework....255
5.4.2.6 Case Study Illustrations....258
5.4.2.7 Delphi Application....260
5.4.2.8 Summary....263
5.5 Planning....264
5.5.1 Planning....264
5.5.1.1 MacNeil....264
5.5.1.2 Delphi Panel....266
5.5.1.3 Literature....268
5.5.1.3.1 Presentiating....269
5.5.1.3.2 Futuring....269
5.5.1.4 Classifying Planning in Current Construction Practices and Trends....271
5.5.1.5 Conceptual Framework....274
5.5.1.6 Case Study Illustrations....275
5.5.1.7 Delphi Application....279
5.5.1.8 Summary....281

5.5.2 Future Cooperation 282
5.5.2.1 MacNeil.....282
5.5.2.2 Delphi Panel.....282
5.5.2.3 Literature.....284
5.5.2.4 Classifying Future Cooperation in Current Construction Practices and Trends……286
5.5.2.5 Conceptual Framework.....288
5.5.2.6 Case Study Illustrations 288
5.5.2.7 Delphi Application.....289
5.5.2.8 Summary.....291
5.5.3 Measurement and Specificity.....291
5.5.3.1 MacNeil.....291
5.5.3.2 Delphi Panel.....292
5.5.3.3 Literature.....293
5.5.3.4 Classifying Measurement and Specificity in Current Construction Practices and Trends.....295
5.5.3.5 Conceptual Framework.....296
5.5.3.6 Case Study Illustrations 298
5.5.3.7 Delphi Application.....300
5.5.3.8 Summary.....302
5.5.4 Obligations.....302
5.5.4.1 MacNeil.....302
5.5.4.2 Delphi Panel.....303

5.5.4.3 Literature.....305
5.5.4.4 Classifying Obligations in Current Construction Practices and Trends.....310
5.5.4.5 Conceptual Framework.....313
5.5.4.6 Case Study Illustrations.....315
5.5.4.7 Delphi Application.....320
5.5.4.8 Summary.....323
5.5.5 Sharing and Dividing Benefits and Burdens.....324
5.5.5.1 MacNeil.....324
5.5.5.2 Delphi Panel.....325
5.5.5.3 Literature.....326
5.5.5.3.1 Bargains.....327
5.5.5.3.2 Boundaries.....327
5.5.5.3.3 Risk.....328
5.5.5.3.4 Externalities.....329
5.5.5.4 Classifying Benefits and Burdens in Current Construction Practices and Trends.....329
5.5.5.5 Conceptual Framework.....333
5.5.5.6 Case Study Illustrations.....336
5.5.5.6.1 Divided bargain.....336
5.5.5.6.2 Shared bargain.....339
5.5.5.6.3 Allocated bargain.....341
5.5.5.6.4 Traded bargain.....342

5.5.5.7 Delphi Application 345
5.5.5.8 Summary 347
5.6 Chapter Summary 347
Chapter 6 Conceptual Model Applications 353
6.1 Introduction 353
6.2 Development Plan 355
6.3 Co-location 356
6.3.1 Literature 356
6.3.2 Reasons for using co-location 357
6.3.3 Analyzing the procedure using the conceptual model 358
6.3.4 Evaluating the procedure using the conceptual model 364
6.3.5 Creating new aspects of the procedure 369
6.3.6 Summary 371
6.4 Alternative Technical Concepts (ATCs) 371
6.4.1 Literature 372
6.4.2 Reasons for using ATCs 373
6.4.3 Analyzing the procedure using the conceptual model 374
6.4.4 Evaluating the procedure using the conceptual model 377
6.4.5 Creating new aspects of the procedure 381
6.4.6 Summary 384
6.5 Over-the-Shoulder Design Review 385
6.5.1 Literature 385
6.5.2 Reasons for using over-the-shoulder resign review 386

6.5.3 Analyzing the procedure using the conceptual model 387
6.5.4 Evaluating the procedure using the conceptual model 399
6.5.5 Creating new aspects of the procedure 408
6.5.6 Summary 410
6.6 Summary 411
Chapter 7 Summary and Conclusions 414
7.1 Summary 414
7.2 Conclusions 458
7.3 Suggestions for Future Research 459
References 462
Appendix 486
A. The Delphi Method 486
B. Case Studies 501
C. Theory Refinement and Validation Using Triangulation 560
D. Conceptual Model Applications 570

List of Tables

Table 4.1 MacNeil's Enumerated Relational Contract Characteristics with Definitions 112

Table 4.2 Initial Match of Delphi Categories and Relational Contract Characteristics.....112

Table 4.3 In-depth Analysis and Match of Delphi Categories and Relational Contract Characteristics.....113

List of Figures

Figure 1.1 Estimated Market Share for Delivery Methods on Non-Residential Construction.....20

Figure 1.2 Actual Market Share for Delivery Methods on Non-Residential Construction 20

Figure 3.1 Inductive and Deductive Reasoning in Grounded Theory 65

Figure 3.2 Axial Coding Paradigm Using a Cognitive Behavior Framework.....67

Figure 3.3 Grounded Theory using Triangulation 72

Figure 4.1 Interaction Possibility Space Model.....121

Figure 5.1 Traditional Relationship with Impermeable Boundaries.....135

Figure 5.2 Relationship with Permeable Boundaries.....136

Chapter 1

Introduction

1.1 Background

Design-build is a project delivery method with a single contract between the project owner and an entity providing both project design and construction. This method is not new, having its roots in the ancient concept of the "master builder," where responsibility for design and construction resides in one person. Some of history's most extraordinary engineering feats were built in this manner, including Giza's pyramids, China's Great Wall, India's Taj Mahal, and, more recently, the Panama Canal (Tenah 2001, Alarcón et al. 2011).

Irrespective of these notable uses of the method, the U.S. government stepped away from design-build mainly due to the disastrous performance of a few high-visibility projects in Washington, D.C., early in the nation's history. Both the U.S. Treasury and the Patent Office Buildings commissioned in 1836 used the design-build method resulting in three noted deficiencies according to Evans (1997): (1) significant cost overruns occurring during construction, (2) the owner's lack of awareness of critical issues due to limited involvement and oversight during the process, and (3) a completed building ill-suited for its intended use. Based on these experiences, the U.S. government abandoned its design-build practices in favor of a sequential performance method of completed plans and approved cost estimates before soliciting competitive bids for construction contracts. This sequential design-bid-build approach has been the predominant delivery method for U.S. public works for over a century.

Although this process provides a complete design and an established cost before commencing construction, there are downsides to this approach. For example, the linear sequencing of project activities results in long project timeframes. Also, unforeseen but

sometimes necessary construction changes contribute to the potential for significant cost overruns. Additionally, rather than a hierarchical organizational structure, a contract between project participants increases the likelihood of adversarial self-dealing relationships (Tenah 2001).

Recently, the industry has been experiencing a reemergence of design-build due partly to the owners' desires for accelerated project deliveries coupled with removing impediments to its use in existing public procurement laws (Halsey and Quatman 2014). Other benefits encouraging its use are the potential for lower resulting project costs, a more collaborative process facilitating innovative solutions, and better communication between the parties leading to fewer disputes and faster solutions when problems arise (Beard et al. 2001).

The renewed interest in design-build and its more frequent implementation led to the belief that design-build would again be the dominant project delivery mode. Figure 1.1, which first appeared in print in Metcalf-Kupres (2001) and later in other literature (e.g., McClain 2007, Solomon 2008, Kubba 2010), indicates expectations that design-build usage would increase while design-bid-build would fade, with breakeven occurring by 2005. However, design-build has not met these early expectations. Figure 1.2 appears in a report (Duggan and Patel 2015) commissioned by the Design-Build Institute of America comparing actual use from 2005 to 2014. It depicts that design-build growth in recent years is more modest, while design-bid-build continues as the most common project delivery method. A hypothesized reason for this unmet expectation is the lack of conceptual knowledge about design-build.

1.2 Problem Statement

Despite design-build use in the past and its recent resurgence, a problem for design-build is the lack of a conceptual knowledge base.

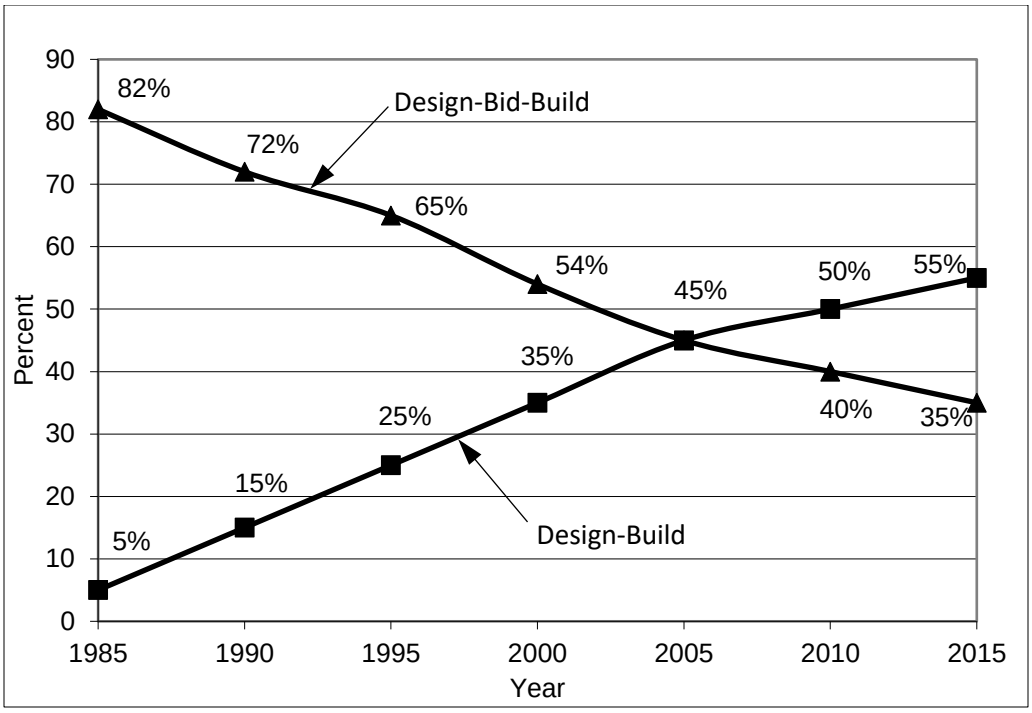

Fig. 1.1 Estimated Market Share for Delivery Methods on Non-Residential Construction (Metcalf-Kupres 2001)

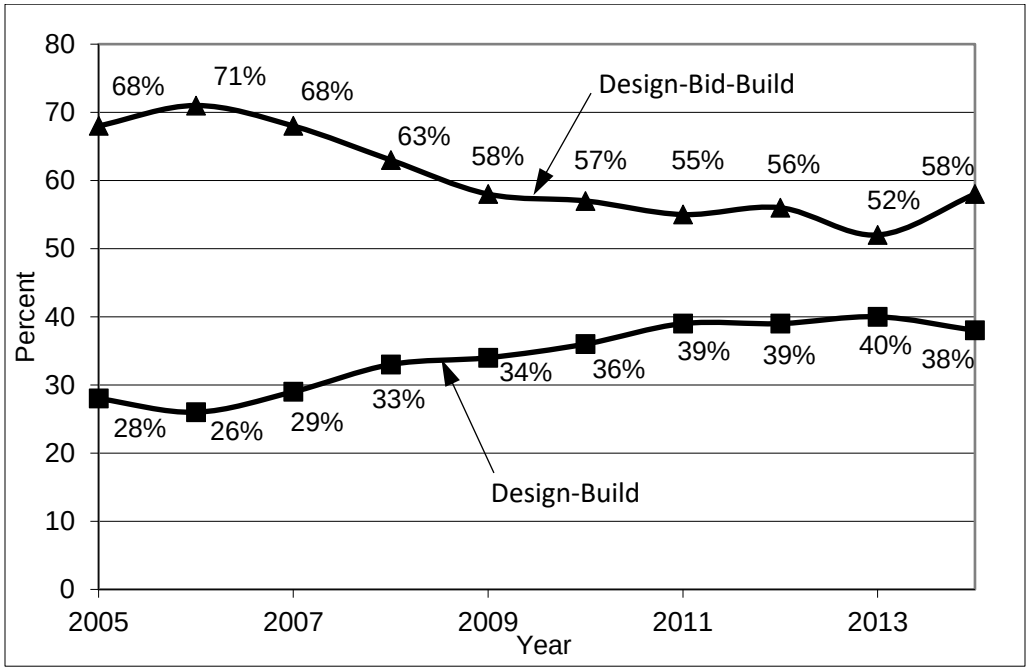

Fig. 1.2 Actual Market Share for Delivery Methods on Non-Residential Construction (Duggan and Patel 2015)

Bloom's Revised Taxonomy (Anderson et al. 2001), built on Bloom's original Taxonomy (Bloom et al. 1986), identifies conceptual knowledge as one of four knowledge types: factual, procedural, conceptual, and metacognitive. Three of those—factual, procedural, and conceptual—are pertinent here, being foundational for any mature subject field. Factual knowledge refers to the terms and specific details about the subject and is essential to facilitating communication. Procedural knowledge relates to the skills and processes necessary for implementation within the subject field, reflecting how to accomplish things. And conceptual knowledge establishes a theoretical structure of the subject field by organizing various elements into a collective whole.

Conceptual knowledge is lacking for design-build despite its importance to the subject field. As many practitioners know, the industry has faced design-build issues partly because of the deficiency in knowledge needed for individuals to implement their projects and organize their experiences. This deficiency has led some practitioners to indicate a need for additional training. Others use ill-adapted routines embedded in the knowledge base of different but familiar project delivery methods. Numerous professionals express the need to "retool." These concerns reflect symptoms associated with lacking a theoretical framework for the design-build process.

First, there is recognition of the need for training. Bernstein (2014) found that a significant obstacle in implementing design-build is the lack of owner familiarity with the process. He states that when individuals embark on something new, they must understand their roles and responsibilities and have a fundamental understanding of the process. Ling and Poh (2008) suggest that this lack of familiarity and knowledge contributes to the potential for problems experienced throughout the project phases.

Second, reverting to prior knowledge or experience in dealing with new challenges is problematic when it leads to a poorly aligned approach. This maladaptation is known as "structural inertia" (Hannan and Freeman 1984) or "historical inertia" (Elvin 2007). Many practitioners implementing design-build have worked in an industry dominated by design-bid-build. Jeffrey Beard, a past president of the Design-Build Institute of America, states in Elvin (2007) that change is difficult and identifies "historical inertia" as the highest hurdle for design-build. Eraut (1985) points out that projects often require efficient and immediate action. In these "hot action" situations, some are misapplying the principles of design-bid-build in the absence of fundamental knowledge about design-build.

Third, and finally, is the need to deconstruct routines. Molenaar and Saller (2003) identify learning modules for additional training in design-build. These listed modules gravitate toward procedural skills, such as cost estimating, which, when implemented, are not vastly different than when used in traditional design-bid-build. However, what is notably different is the underlying conceptual knowledge that supports these procedural skills when routinely applied in practice. This lack of conceptual knowledge contravenes Bloom's original Taxonomy (Bloom et al. 1986), where "skills + knowledge = abilities." In this formulation, the skills necessary to properly implement design-build links to the conceptual knowledge base specific to design-build. This linking will result in new routines grounded in this conceptual design-build knowledge. Beard et al. (2001) reflect this in their comment that design-build is a concept, not simply a method.

The importance of efficiency and immediate action may leave some wondering why such a high level of knowledge is even relevant. There are two reasons, one general and one specific.

First, conceptual knowledge provides practitioners with the theory and understanding of why things work, e.g., why specific processes are followed and choices made. Hirsch (1996) illustrates this by contrasting how a novice and expert solve a simple physics problem. The novice identifies an applicable formula and extracts the necessary information from the problem statement to use in the formula. The expert analyzes the situation and makes critical observations before applying any equations. For the novice, the solution is wrong, not because the equation or the math is wrong, but because the novice does not know enough about real-world physics to connect the formula to the problem. For the expert, the structure of the answer is solved based on multiple cues and relevant knowledge before any formulas are applied.

Second, and more specifically, conceptual knowledge provides practitioners with a way of organizing their experiences. Eraut (1985) points out that practitioners use their experience to deal with future endeavors. Conceptual knowledge generalizes that experience, allowing practitioners to tailor their approach to the specific needs of each project.

1.3 Research Question

This study begins by shifting participants' perspectives by providing foundational knowledge about the design-build process. The research answers the question: "What are the key characteristics of design-build that, when linked together, form its conceptual knowledge base?"

This research is limited to public agencies' transportation projects. However, it is believed the characteristics of design-build found here will have a broader application across other sectors, although it is validated only for this industry sector.

1.4 Objectives

This research develops a core conceptual knowledge base for design-build. There were two principal objectives:

- Provide a general perspective on how to view design-build as differing from design-bid-build, and
- Provide a focused perspective on characteristics of the design-build process, which allows it to be modified to accommodate specific project needs.

These objectives will be accomplished through the sequencing of four sub-objectives:

- Identify and define the essential characteristics of design-build,
- Illustrate these characteristics with case studies of public agency transportation projects,
- Validate these employing Delphi data collected during this research effort that identifies practitioners' design-build concerns, and
- Demonstrate the application, current relevance, and framework of the developed conceptual knowledge to understand current design-build procedures more fully.

1.5 Development Plan

This section briefly describes the organization and content of the following chapters in this work.

Chapter 2 provides a literature review in two parts. The first part offers foundational design-build literature and state-of-the-practice guidebook procedures. The second provides relational contracts literature to aid the reader in more clearly understanding the research findings.

Chapter 3 lays out the research methodology describing how this research utilized Triangulation, Delphi, Grounded Theory, and Case Studies in concert. A sequential triangulation process that combines theory building with theory testing begins with the Delphi method that provides an empirical dataset on Design-Build that is inductively coded using Grounded Theory to build the theory. Grounded theory continues to be used along with the Case Study dataset to refine the developed theory that is then validated using the original Delphi data. The built and tested theory will then be applied to current Design-Build procedures.

Chapters 4 and 5 discuss the research results. Chapter 4 discusses the Delphi results, which are at the genesis of this effort. Interviews of leading design-build professionals are distilled into seven categories of collective concerns.

Chapter 5 provides the Grounded Theory results. Built on the Delphi seven categories, Grounded Theory expanded this list to twelve characteristics for design-build. Each of these characteristics is triangulated, beginning with reflections of each characteristic captured in the Delphi data, then described and expanded using pertinent literature, refined into a design-build framework, and illustrated using case study project examples. Finally, the characteristics are validated through application back to the original Delphi data.

Chapter 6 is the application of research findings. Three current design-build procedures identified in state DOT and NCHRP guidebooks are analyzed, evaluated, and modified to demonstrate the conceptual model's contemporary relevance and ability to provide an understanding of procedures at a foundational level.

Chapter 7 is the Summary and Conclusions, where the research is summarized and conclusions offered. Suggestions for future research are provided in the chapter as well.

There are five Appendices. The first is a list of references. The second appendix is a description of the Delphi process used in the research and summaries of the data. The third is detailed descriptions of the case study projects. The fourth is supplemental literature for the grounded theory. The fifth is worksheets used to apply the conceptual model to current procedures.

Chapter 2

Literature Review

2.1 Introduction

Typically, an extensive literature review is conducted initially to provide the necessary background on which the theory of the current effort is structured. However, in keeping with the Grounded Theory methodology, the theory-building literature is reviewed later to avoid preconceptions that hinder critical thinking and discovery while relying only on the original data in developing theory (Bitsch 2005). After theory development, this type of literature review will be performed to provide confirmation and theory refinement.

There are two literature review sections within this chapter. The first focuses on general design-build knowledge and state-of-the-practice procedures documented in various state DOT manuals and NCHRP guidebooks. The second provides a review of "relational contracts" conducted in an out-of-sequence research order to provide a background to this subject while accomplishing four relevant objectives: (1) provides current relational contract theory applications in construction, (2) offers confirmation of research findings, (3) documents parallel theoretical connection made by other researchers, and (4) allows the present work to be viewed in the context of these other works.

2.2 Design-Build

This section reviews general knowledge about the design-build project delivery method, summarizes its history, discusses its challenges, and describes other delivery method variants that facilitate greater cooperation among project participants.

2.2.1 Background

Design-build is a method combining the art of design with the craft of construction within an iterative, collaborative process (Elvin 1998). Elvin notes in a traditional design-bid-build

process, the architect incorporates design knowledge into the plans and specifications and then delivers it “over the wall” to the contractor. The contractor then continuously builds towards the result portrayed in the furnished plans and specifications. Thus, design-bid-build is a process of conforming to the plans and specifications during construction of what was laid out by the architect during design.

Alternatively, design-build is a transformation process where the team fine-tunes the design during construction while continuously improving the project results. Design-build recognizes the value of each discipline’s specialization while providing a means of overcoming fragmentation and adversity. It seeks to take advantage of each participant’s expertise while dismantling the “over the wall” paradigm.

2.2.1.1 History

The design-build method is not new. It was the dominant method in ancient times when there was no distinct partition between design and construction. A single individual, the “master builder,” is held responsible for both design and construction. He provided a seamless service with the complete range of knowledge needed to carry each project stage from conception to operation. Necessary communication and integration of information and expertise were automatic because a single individual was responsible for the project and all related decisions.

The National Society of Professional Engineers (1995) indicates that those who built ancient civilizations’ landmarks utilized processes like design-build. Some of the incredible engineering feats, such as the Pyramids, Great Wall of China, and Taj Mahal, were essentially design-build jobs (McManamy et al. 1994). Beard et al. (2001) indicate master builders designed and directed the construction of temples and other public buildings of past civilizations, including the Gothic Royal Abbey Church of Saint-Denis outside Paris and the Florence

Cathedral in Italy. Songer and Molenaar (1996) note that ancient Greece's magnificent temples, public buildings, and civil works were designed and built by master builders. Enduring structures such as the Parthenon and Theater of Dionysis are noted by many as testaments to the master-builder process. Also, much of the early United States public infrastructure was built using the design-build method, as pointed out by the National Society of Professional Engineers (1995).

2.2.1.1.1 Emergence of Design-Bid-Build

Design-build was the dominant project delivery method until design-bid-build began offering owners a sequential design, bid, and then build approach. Since then, most public works projects have been delivered using this method. It is suggested that four primary factors led to the development and adoption of the traditional design-bid-build delivery system: the Renaissance, the Industrial Revolution, legal changes, and corruption/efficiency concerns.

Renaissance

Songer and Molenaar (1996), Natkin (1994), and Coble and Blatter (1999) indicate during the Renaissance, master builders began to be replaced by the distinct professions of architecture and construction. Continuous changes in technology and increasing project complexity led to the functional need for specialization of design and construction. The specialties' services and interactions were meager, particularly during the design phase. Design and construction entities only shared information at the end of the design process with little opportunity to contribute their specific knowledge to the other.

The Industrial Revolution

The Industrial Revolution began in Great Britain during the last half of the 18th century and spread throughout Europe and to the United States during the 19th century, and had a notable effect on the organization of design and construction (Beard et al. 2001). Walker (1996) notes

the Industrial Revolution created an enormous surge in construction industry demand. New engineering and construction techniques and more complex building materials developed because of the increasing need for housing, buildings, and improved transportation (Beard et al. 2001). All these factors contributed to greater specialization and expertise among the disciplines. During this period, the engineer emerged, further delineating the architect and builder as distinct specialists.

Legal changes

Another factor contributing to the emergence of design-bid-build was legal changes. Songer and Molenaar (1996) suggest the separation of design and construction evolved from functional to legal during the 1800s as statutory and case law developed. The courts decided that instead of the strict liability that contractors faced, architects were liable only in cases of design negligence. As a result, the design-bid-build method became more widely utilized.

Corruption and Efficiency Concerns

The Building Futures Council (1995) indicates design-bid-build was first used during the 18th century but became institutionalized during the 19th and 20th centuries. The separation of design and construction was primarily established to thwart corruption that existed during the late 1800s to early 1900s.

Baxter (1991) notes the traditional method of public construction has the government buying design and construction services from private individuals and firms through private contracts. These contracts proved lucrative, and scandals routinely surfaced of officials benefiting individually by awarding these public contracts. Federal and state legislatures countered this corruption by developing a regulatory system for public procurement with three primary objectives (Baxter 1991): (1) honesty, to prevent collusion in the award of contracts;

(2) equity, to place all businesses on the same footing; and (3) economy, to secure products and services at the lowest price.

Evans (1997) attributes the impetus toward design-bid-build for government construction in the United States to two problem-plagued projects—the Treasury Department Building and the Patent Office Building. An Act of Congress on July 4, 1836, commissioned the Treasury Department building after a fire destroyed the previous structure. No plan or estimate for the building was made by those charged with the work before commencing construction. Project execution proved grossly negligent, lacking due economy with the resulting structure expensive and ill-suited for its intended use, needing to be enlarged shortly after completion.

Congress also commissioned the Patent Office building on July 4, 1836 (Evans 1997). While the building design met the intended purpose, officials criticized the builders for their wastefulness. The uncontrolled cost overruns attributable to the Executive Branch administration of the building effort indicated an erosion of governmental checks and balances, signifying reform was necessary.

Congress decided it was essential to regulate the building process to prevent these abuses of the Executive Branch that had become common. Subsequently, Congress passed legislation stipulating that the Executive Branch would present a complete plan of the project and an accurate estimate of cost for congressional approval before contract award and construction, leading to the design-bid-build process.

2.2.1.1.2 Reemergence of Design-Build

Design-bid-build was used almost exclusively until the middle-to-late 1900s when owners became dissatisfied with its results and sought alternatives. Tenah (2001) explains in the early 1970s that inadequate quality control, costly budget overruns, excessive delays, and other

complexities led owners to desire improving project delivery. Owners began to demand higher quality, innovative and cost-effective designs, faster schedules, less risk, and less litigation. These experiences and demands facilitated the reemergence of the design-build project delivery method.

2.2.1.2 Challenges for Design-Build

The emergence and popularity of design-bid-build in recent history led most laws, regulations, procurement procedures, and customs to evolve around this delivery method. As a result, owners and practitioners faced specific challenges when using design-build.

One challenge is industry perception (Beard et al. 2001). Design-bid-build delivery has dominated the industry. The fear of change by traditional owners and practitioners, i.e., "historical inertia," has been a cultural barrier for design-build in both public and private industry sectors. Design-bid-build is believed to provide the lowest price; it is well understood and relatively easy for public procurement officials to administer. Most of all, public sector participants in construction organize under a system of implicit rules of practice based on historical patterns of differentiated functional activities and linearly sequenced work segments. Design-bid-build has been used for decades and is a consistent part of doing business for public entities and contractors. As a result, participants have the procedures, experience, and abilities to use it effectively. This method is also strongly supported by regulations with the involved parties experienced in any legal issue that might arise.

Another challenge is legal barriers (Beard et al. 2001). Most public procurement laws were enacted to provide a framework for purchasing goods from the private sector. This framework intends to allow all competitors an equal opportunity to submit offers or bids to the buyer; however, this created inflexible procurement laws that either did not allow purchasing of

integrated services or precluded using anything other than low-bid procurement. As owners began to demand more from their providers of goods and services, it became apparent that the "low first cost" is not always the best indicator of project performance. Changes in procurement laws allowing consideration of past performance and including objective and subjective factors permitting owners to determine a "best-value solution" reflect a philosophical shift in procurement policy. Such changes have occurred at both the federal and state levels (Loulakis 2003).

The owners' desire to have more participant interaction and a more cooperative environment has shown itself as they embrace alternative project delivery methods that lead to more communication and knowledge sharing. Below, the author addresses four of the most common collaborative options: partnering, construction manager at-risk, design-build-operate-maintain, and the firm.

Partnering

Partnering facilitates teamwork across contractual and organizational boundaries (Chan et al. 2009), establishing a means for participants to resolve conflicts, expedite decision-making and increase organization competence in achieving project goals (Crowley and Karim 1995). Although like design-bid-build with separate design and construction contracts, there is an effort to remove the adversarial nature often existing during construction by having the parties agree to cooperate.

Construction Manager-at-Risk

Construction manager at-risk is a project delivery method, like design-bid-build where the owner contracts separately with a designer and contractor; however, with this approach, a contractor usually has significant input during the design process (Konchar and Sanvido 1998).

Like design-bid-build, the owner contracts with a designer to provide a complete design and selects a contractor to build per plans and specifications (Konchar and Sanvido 1998). Unlike design-bid-build, construction manager at-risk brings a contractor into the design process where construction input can positively impact the design effort (Touran et al. 2009).

Design-Build-Operate-Maintain

Beard et al. (2001) characterize the essential part of the design-build method as combining design and construction; however, the owner may incorporate additional services, such as operation and maintenance. These authors suggest combining extended services into one contract is a realistic approach to address owners' concerns about facility quality and long-term performance. Owners identify operation and maintenance activities as being the least integrated into facility lifecycle models but having the most significant impact on lifecycle costs and facility value. Design-build-operate-maintain incentivizes the service provider to incorporate quality measures to prevent technical failure or obsolescence during the contract term. Many additional service variations to design-build are possible such as design-build-operate-transfer (DBOT) and design-build-operate-own (DBOO), to name a couple (Beard et al. 2001, Touran et al. 2009).

The Firm

In many cases, design-build is carried out by either a contractor or designer who contracts out for supplemental project skills. Still, in some cases, a firm possesses in-house capabilities of both design and construction sufficient for project execution (Oyegoke et al. 2009). These authors suggest the firm is the purest form of integration of a design-build contract.

2.2.2 State-of-the-Practice Review

A state-of-the-practice review is provided of four state DOT design-build manuals along with several synthesis guides consolidating and segmenting current design-build policies into procurement, Alternative Technical Concepts (ATCs), and post-award contract administration. These manuals and guides describe current procedures and practices of design-build.

2.2.2.1 Colorado Department of Transportation (CDOT) Design-Build Manual

In an update to its first design-build procedural manual issued in 2006, CDOT (2016) organizes its most recent procedures and practices into seven key project areas: (1) Initial Project Development, Goal Setting and Project Delivery Method Selection, (2) Risk Management, (3) Project Organizational Structure and Design Development, (4) Procurement, (5) Evaluation of Statements of Qualifications and Proposals, (6) Structure and Content of the RFP, and (7) Implementation.

Initial Project Development, Goal Setting, and Project Delivery Method Selection is the first project area accomplished in the three named steps. Initial Project Development procedures and practices identify funding and schedule, define project scope, and preliminarily assess risks. Goals Setting with input from stakeholders describes the owners' project values, establishes factors in identifying best value proposers, facilitates unifying participants into collaborative teams, and filters individual interests while making project decisions when trouble is encountered. Project Delivery Method Selection involves considering five significant factors when selecting a project delivery method: delivery schedule, complexity and innovation, level of design, project cost, and project risks.

Risk Management is the second project area and involves a continual and iterative process of identifying, assessing, planning, allocating, and controlling risk. This process begins

with an initial assessment of risk during project development and continues through design development and project construction using risk register techniques.

Project Organizational Structure and Design Development is the third of seven project areas and is accomplished in two steps. Project Organizational Structure develops and defines the roles, responsibilities, and decision-making authority of the involved project agencies and stakeholders. Design Development begins by defining the basic configuration and fundamental project parameters, then advances to a preliminary design phase developing technical requirements and reference documents.

Procurement is the fourth project area, with most CDOT projects involving a two-phase selection process. The first phase consists of the Request for Qualifications (RFQs), Statements of Qualifications (SOQs), and short-listing qualified firms. The second phase involves the Request for Proposals (RFQ), Proposal Submission, and Selection.

Evaluation of Statements of Qualifications and Proposals is the fifth area with developing a project-specific evaluation plan for both the SOQs and proposals by customizing department templates.

Structure and Content of the RFP is the sixth area organizing the RFP in four Books (contract, technical requirements, applicable standards, and data and results), Contract Drawings, and Reference Documents. Departmental templates support this effort.

Implementation is the seventh area consisting of five main elements. (1) Project Organization transitions to a joint CDOT/Design-Builder team for project implementation. Key members of this team are identified, their responsibilities defined, and a hierarchical structure established. (2) Project Start-up is initiated with the Notice to Proceed and, for most projects, an initial partnering meeting and co-location of crucial participants. (3) The design-builder

accomplishes Design Development with the CDOT remaining involved through joint design task forces, over-the-shoulder reviews, formal design reviews, and design quality processes. (4) Construction involves quality monitoring performed by the CDOT or assigned to the design-builder with owner auditing. (5) The design-builder developed project Acceptance and Closeout, with the CDOT performing the final inspection.

2.2.2.2 Georgia Department of Transportation (GDOT) Design-Build Manual

The GDOT Design-Build Manual (GDOT 2018) outlines critical design-build procurement and delivery processes in four categories: (1) pre-advertisement; (2) advertisement; (3) evaluation, letting, and award; and (4) post-letting.

Pre-advertisement activities include project development, RFP review, schedule, and cost estimates, along with forums and workshops. Project development under the direction of the owner's designated project manager focuses on planning, project management, and third-party activities. Planning entails the preliminary design to establish project requirements and scope, determining such elements as right-of-way limits, potential environmental impacts/risks, and utility and permitting requirements. The plan details are kept to a minimum providing innovation opportunities and minimizing the owner's related risks. Project management activities consider the roles and responsibilities for schedule, quality, and cost management during design and construction. For specific complex projects, co-location is required for these activities. Third-party roles and responsibilities are considered for coordinating with entities such as utility and railroads. RFP templates are used to maintain consistency across GDOT design-build projects. An internal review of the RFP document is conducted with the reported findings used in revising the RFP. A preliminary project schedule and cost estimate are developed early in the RFP development process under the direction of the GDOT's designated project manager and

monitored and modified as necessary. GDOT periodically hosts industry forums and design-build workshops. GDOT forums engage industry groups and potential project team members before issuing the RFQ to discuss and receive feedback on the anticipated project scope, schedule, and risks. Design-build workshops focus more broadly on GDOT's design-build program, utility coordination, schedule development, and risk mitigation.

Advertisement activities involve advertising the project, assembling the Technical Review Committee, developing and advertising the RFQ, evaluating Statements of Qualifications (SOQs), and developing and advertising the RFP. GDOT begins these activities by releasing a Public Notice providing preliminary project information. During this period a three-to-five-member Technical Review Committee is assembled with project-related experience. This committee will select the design-builder, usually with a One-Phase Low Bid, Two-Phase Low Bid, or Best Value selection method. When using Two-Phase or Best Value methods, GDOT tailors the RFQ to the desired qualifications for the specific project; those responding will be evaluated by the Technical Review Committee, developing a shortlist of the most qualified. Selecting the successful candidate using the Best Value method is based on a ranked and weighted selection criteria focusing on project goals and risks developed by the Technical Review Committee with the assistance of key project participants, technical experts, and stakeholders. The criteria are incorporated into the RFP delivered to shortlisted proposers with details on processes for RFP questions, one-on-one meetings, and Alternative Technical Concepts, if used.

Evaluation, letting, and award activities include receiving, evaluating, and selecting from tendered proposals. Using a One- or Two-Phase Low Bid selection method, the Technical Review Committee considers the submitted technical proposal using pass/fail criteria, publicly

opening the separate price proposals, and announcing the apparent successful bid. Using the Best Value selection method, each Technical Review Committee member evaluates and scores the technical proposals using the pre-defined selection criteria, followed by a public reveal of technical scores and opening of price proposals. Best value calculations are performed, and the highest combined score is named the apparent successful proposer. A bid committee reviews the results determining if the project will be awarded.

Post-letting activities relate to the project's design, construction, and management. GDOT designates one department member as the point person and another to exercise final decision-making authority. The design-build team is responsible for completing the design, controlling and managing construction, and ensuring quality. GDOT recommends using gap analysis in assembling the right project design-build implementation team by identifying necessary skills, assessing internal organizational capabilities, identifying external sources of needed additional skills, and assigning project roles, responsibilities, and authority.

2.2.2.3 Minnesota Department of Transportation (MnDOT) Design-Build Manual

The MnDOT Design-Build Manual (MnDOT 2017) divides the Department's procedures for procuring design-build contracts into General Procurement, Pre-Advertisement, Advertisement, Evaluation and Letting, and Post-Letting activities.

General Procurement activities include identifying key project participants and their responsibilities, addressing organizational conflicts of interest, managing data release to the public, and specifying timesheet activity codes.

Pre-advertisement activities include project development, estimating, and team coordination. Project development encompasses four main tasks: (1) Planning of scope development, risk assessment, and project delivery method selection; (2) Preliminary

engineering of geometric layout, geotechnical investigation, and pavement design, among others; (3) Project Management, including cost, schedule, and quality management and co-location requirements, among others, and (4) Third-Party Agreements with municipal, utility and railroad.

Pre-advertisement activities include developing the engineer's estimate and updating it for revisions to planning, scoping, and preliminary design. Also among these activities is early team coordination allowing communication with prospective design-build teams before the RFQ release for potential constructability reviews, informational meetings, and draft RFP reviews.

Advertisement activities typically include developing the Request for Letters of Interest, forming the Technical Review Committee, advertising, releasing the RFQ, evaluating Statements of Qualifications, developing the RFP, and holding meetings for One-on-One discussions to include Alternative Technical Concept and Pre-Approved Elements.

Evaluation and Letting activities include receipt and evaluation of proposals and project letting. For low-bid selection, the Technical Review Committee evaluates the responsiveness of each proposal, publicly reads price proposals, and announces the apparent low bidder. For best value selection, the Technical Review Committee scores each technical proposal using predetermined criteria, announces these scores publicly, opens and reads price proposals, calculates the best value by dividing the price proposal by the technical score, and announces the apparent best value.

Post-letting activities include contract award, contract execution, and stipend payment. The results of the letting process are analyzed to determine the proposals are responsive and responsible. If so, the contract is awarded, executed, and the Notice to Proceed issued. Stipends are paid to unsuccessful proposers and debriefing meetings held.

2.2.2.4 Washington State Department of Transportation (WSDOT) Design-Build Manual

The WSDOT Design-Build Manual (WSDOT 2018) contains policies and recommended procedures for delivering design-build projects focusing on four major sets of activities: Pre-procurement, General Procurement, Contract Administration/Implementation, and Project Acceptance/Closeout.

Pre-procurement activities begin with initial project development that involves developing a baseline schedule, identifying funding sources, scoping the project, and performing an initial risk assessment. A Pre-procurement activity seeks to establish and communicate the values of WSDOT through project goals. These goals guide proposers to assemble their teams, develop proposals, and unify WSDOT and the design-build team. Project goals serve as the basis of the partnering charter and the lens filtering potential disputes. Also, during this period, WSDOT uses initial project information and a specified Guidance tool to select the best project delivery method. When the design-build delivery method is selected, the Department develops a Project Management Plan focusing on Initiating, Planning, Executing, Monitoring and Controlling, and Closeout. And because design-build typically involves a large project team and multiple agencies and stakeholders, a formal project development organizational structure is developed indicating roles, responsibilities, and decision-making authority.

Pre-procurement activities continue with preliminary engineering focusing on developing a Basic Configuration necessary to define fundamental project parameters and the contractual obligation of the design-build team. These activities include control and initial surveys, right-of-way plans, environmental studies and permits, hydraulic analysis, geotechnical and utility investigations, and required agreements. Preliminary engineering yields a conceptual design. WSDOT identifies necessary design procedures, documentation, and approvals with the

conceptual design. WSDOT expands its initial risk assessment using a five-step risk management process that will continue throughout the project of identifying, assessing and analyzing, mitigating and minimizing, assigning, and monitoring and managing project risks. The Department uses the information generated from these pre-procurement activities to tailor its RFP template into a project-specific RFP. The structure and content are outlined in the manual.

General Procurement activities are typically based on best value selection with a two-step procurement process. The Department prepares an RFQ identifying minimum design-build team qualifications during the first step. Interested design-build teams respond with SOQs evaluated by the evaluation team to develop a shortlist of the most qualified teams. During the second step, WSDOT sends RFPs to the short-listed teams. Those interested develop and submit separate technical and price proposals. If desired, the Department reserves the right to hold One-on-One and Alternative Technical Concepts meetings before the submission due date. The evaluation team then evaluates the technical proposals using predetermined criteria, opens the price proposals, and determines the best value.

Contract Administration/Implementation includes those startup activities necessary to transition the project to the design-build team involving awarding and executing the contract, issuing the Notice to Proceed, and co-locating the project team. During this phase, the design-build team is responsible for scheduling and holding all specified meetings, meeting stipulated milestones and satisfying the hold point requirements identified in the contract. The design-build team must also provide the agreed-upon submittals, a Quality Management Plan in which partnering is encouraged, and an Environmental Compliance Plan. Implementation activities also include design development by the design-build team with WSDOT expressing its intention to allow flexibility in design and construction if contract requirements are met. During construction,

the design-build team conducts inspections and testing with WSDOT conducting quality audits and issuing progress payments as the design-builder submits invoices.

Project Acceptance/Closeout activities include submitting the design-build team's final design and construction documents. Final acceptance occurs when WSDOT indicates all obligations of the contract are complete.

The guidance provided in the four design-build manuals referenced above is synthesized in three guidebooks from the National Cooperative Highway Research Program (NCHRP) addressing design-build procurement, ATCs, and post-award contract administration that are reviewed below.

2.2.2.5 NCHRP Design-Build Procurement Guidebook

NCHRP Design-Build Procurement Guidebook (AASHTO 2008) was developed as an NCHRP research project commissioned by the AASHTO Joint Task Force on Design-Build to assist state highway agencies in preparing the RFQ and RFP and selecting the design-builder. The Guidebook incorporated best practices from the state highway agencies and other public agencies in identifying four critical design-build procurement steps: (1) Define project goals, (2) Allocate risks appropriately, (3) Plan evaluation, and (4) Draft contract documents. While the authors refer to these as steps, in keeping with Bloom's Revised Taxonomy (Anderson et al. 2001), they can also be referred to as procedures.

Defining project goals is done during initial planning with selecting the project delivery method. Goals are identified on the project's unique needs, ranked with the expectation of necessary tradeoffs, and communicated to internal and external stakeholders. These goals provide needed focus in selecting and communicating the choice of design-build delivery, aiding in risk allocation decisions, drafting and communicating the owner's desires in the RFP, guiding

proposal development to accommodate owner needs and then allowing distinguishing between those submitted, and administering the contract during design and construction.

Allocating risks appropriately in the contract is a significant procurement undertaking. A risk allocation matrix is suggested in identifying significant potential risks and determining the party best able to handle them; sharing risks should only occur in extreme situations to avoid confusion and disputes. If unable to assign risk, it should be broken down into greater detail for more appropriate allocation.

Plan evaluation includes establishing evaluation criteria and assembling an evaluation panel. Evaluation criteria are typically based on the project goals, reflect project requirements, and fall into the technical, organizational, schedule, and price categories. Each criterion has an associated standard in measuring the proposed work and a weighting relative to other categories. A scoring method is used in determining the collective best value. A panel of experts is assembled and trained on the project and the evaluation criteria.

The draft contract, including the RFQ, RFP, and other documents, is developed in a continuing process completed only after the three earlier procedures are finalized. Critical elements of the RFQ suggested in the guidebook include a Project Description and Mandatory Requirements sufficient in communicating the owner's goals and project requirements. The RFP expresses the owner's intent and serves as the basis for preparing proposals. While content and provisions vary from project to project, the guidebook describes 21 requirements to consider for the RFP, such as Basic Configuration and Alternative Technical Concepts. Contractual obligations of both parties are reflected in the RFP and the successful proposal at contract award.

2.2.2.6 NCHRP Alternative Technical Concepts (ATCs) Guidebook

The NCHRP Alternative Technical Concepts Guidebook (Gransberg et al. 2014) is part of a series of studies synthesizing practices and knowledge authorized by AASHTO through the NCHRP and conducted by the TRB. This guidebook synthesizes highway agency methods incorporating Alternative Technical Concepts (ATCs) to improve projects technically and reduce costs. The report also evaluates the design-bid-build and construction manager/general contractor delivery methods. The report provides a literature review, survey of DOTs, content analysis of DOT solicitation documents, and case studies.

ATCs are used across the spectrum of project delivery methods though most commonly in design-build. ATCs stimulate innovative design solutions by providing proposers an opportunity to present and receive owner approval before proposal submission. This reduces the risk of innovative designs offered during project performance being disapproved.

ATC practices identified in the report are legal and contracting issues and policies and procedures. Three primary legal and contracting concerns are confidentiality, ownership rights, and design liability. Contractors desire confidentiality to maintain a competitive advantage, with most review processes providing confidential one-on-one meetings for clarifications and indication of acceptability. Ownership rights of the ATC design is another legal and contracting concern. Owners often offer compensation in the form of stipends to unsuccessful proposers for their efforts, and acceptance surrenders ownership rights of these designs. Design liability is an additional legal and contracting concern with ATCs. The engineer-of-record is responsible for design defects. The owner assumes responsibility for ATC designs when using design-bid-build and construction manager/general contractor. A team member of the design-builder is the

engineer-of-record when using design-build, and specific contract language assigns design risk to them. However, a "mutual mistake" may result in shared risk among the parties.

Policies and procedures for submittals and evaluations is another grouping of ATC practices covered in the report. Submittal practices for ATCs deal with the required initial information, its form (narrative, drawings, or both), the inclusion of cost information, and the limitations on the allowable number of proposed ATCs submitted. It is the practice of some owners to allow preliminary or conceptual submittals followed by formal ATC proposals only on acceptable ideas. Some owners desire cost information to aid in evaluating the potential benefits of the concepts, while others believe the evaluation should be purely technical.

Evaluation is done by a technically qualified evaluation team determining the viability of the proposed concept. This team is often separate from the team reviewing the technical proposal to avoid the appearance of impropriety.

2.2.2.7 NCHRP Design-Build Post-Award Contract Administration Guidebook

This guidebook was developed by AASHTO (Molenaar et al. 2020a) to provide design-build contract administration tools for local adaption by agencies to assist with the significant procedural and cultural changes required for design-build after observing many current agency design-build manuals focus mainly on pre-contract award decisions. The guidebook is developed in five significant steps. (1) A state-of-the-practice review is conducted reviewing current literature and manuals/documents of 31 transportation agencies identifying design-build contract administration tools. (2) A detailed process model of design-build contract administration is developed to guide data collection and guidebook layout. (3) Case studies of 19 projects of varying sizes are conducted to identify additional design-build contract administration tools. (4) A survey is used to calibrate the tool effectiveness relative to project size, complexity level, and

contract administration phase. (5) The guidebook is developed and tested through an NCHRP panel review using ongoing and completed projects from agencies across the country. Additional details about these steps can be found in the research report (Molenaar et al. 2020b).

The guidebook identifies 28 design-build contract administration tools categorized by phases and contract administration strategies. Four overlapping phases identified in the process modeling are Alignment, Design, Construction, and Closeout. Alignment phase tools foster a strong team foundation through integration and cohesion. Design phase tools aid in promoting communication and collaboration among the team members in developing the design. Construction phase tools assist in performing and measuring the work, monitoring quality, and solving problems. Closeout phase tools support completing the work and turning over the facility to the owner. Examples of tools useful during these phases are a kickoff meeting, co-location of crucial personnel, design-build specific partnering, and delegation of authority, respectively, for the four phases.

Contract administration strategies organize the 28 tools into practices dealing with Alignment, Scope, Design Quality, Construction Quality, and Construction Efficiency. Alignment strategies establish clear project goals and build participant relationships through such practices as an external stakeholder coordination plan. Scope strategies ensure the project team understands the project scope and their roles and responsibilities. Design Quality strategies seek to safeguard a quality design through design reviews. Construction Quality strategies assure facility quality through adherence to the contract requirements, undertaking processes such as over-the-shoulder reviews and incentive/disincentive programs which lead to superior quality. Construction Efficiency strategies focus on efficiency and implementation of roles and

contractual responsibilities during construction through witness and hold points, among other processes.

The guidebook also describes each tool by answering four questions and providing case study project examples. First, answering "What is it?" is used to describe the tool. Second, answering "Why use it?" explains the purpose of the tool, potential benefits, and which of the five contract administration strategies it addresses. Third, answering "When to use it?" identifies its utilization for which contract administration phase and project size and complexity. Fourth, answering "How to use it?" provides suggestions on project implementation.

The literature review continues with a literature review on "relational contracts." This review was performed in an out-of-sequence research order to provide a background to this subject while accomplishing four relevant objectives: (1) provides current relational contract theory applications in construction, (2) offers confirmation of research findings, (3) documents paralleling theoretical connections made by other researchers, and (4) allows the present work to be viewed in the context of these other works.

2.3 Relational Contracts

Research findings from this study suggest relational contracts are a good fit in modeling design-build efforts and shaping its principles. The following discussion provides a brief treatment linking this concept to construction with a more extensive treatment of relational contracts provided in Chapter 5.

Some researchers have recognized relational parts of the construction industry. Their work (Cheung et al. 2006, Harper and Molenaar 2014, Chan et al. 2009, Ballard and Howell 2005) notionally links construction techniques such as partnering, joint ventures, alliances, public-private partnerships, and lean construction to "relational contracts."

A relational contract is embedded in participant interactions, much like a reporter might be embedded in a military squad, becoming so much a part that the reporter is almost no longer distinct. Macaulay (1963) introduces relational contracts in his empirical work focusing on non-contractual relationships in business. MacNeil (1974a, 1974b, 1975, 1978, 1980a, 1981, 1983; MacNeil and Gudel 2001) labeled and conceptually developed the idea in extensive publications.

McInnis (2000) makes the first link between relational contracts and construction (Chan et al., 2009). In a conference proceeding, McInnis (2000) indicates the legal concept of relational contracting is present in various guises within the construction industry, such as partnering, alliances, joint ventures, long-term contracting, and other collaborative arrangements. The literature reviewed within this section focuses on relational contracts and construction since the initial work by McInnis. It is organized into four categories: boundaries, actors, planning, and time.

2.3.1 Boundaries

A boundary separates and defines; it is a "physical, arbitrary or imaginary line of demarcation acting as a barrier to segregate one's territory and define the limits of a common culture and jurisdiction" (Crowley and Karim 1995). Summarized below are the works of researchers identifying organizational structures and relational elements of arrangements from design-bid-build to the firm. This boils down to the placement and nature of the organizational boundaries and what occurs at the interfaces in the context of boundaries.

Cheung et al. (2006) address the question "how relational are construction contracts?" by observing relational factors within and across the boundary of specific construction arrangements. Cheung et al. look at four design-bid-build contracts used in Hong Kong. A relational index comprises eight critical factors—cooperation, organizational culture, risk, trust,

good faith, flexibility, alternative dispute resolution, and contract duration—which are used to measure the "degree of relationalism." Although two contracts were determined more relational than the others, the results indicate relational contract concepts may not apply to the design-bid-build delivery method.

Partnering is another organizational structure addressed in the literature. Partnering facilitates more significant interaction across the organizational boundaries; although the organizations remain separate, the boundaries are permeable allowing communication at the interface. Nyström (2005) identifies nine components of the partnering process: trust, mutual understanding, economic incentive contracts, relationship building activities, continuous structured meetings, facilitator, choosing work partners, predetermined dispute resolution method, and openness. Of those nine, trust and mutual understanding are two that are always present and considered foundational to partnering. The other seven components may combine in various adaptations of partnering. Nyström indicates these nine partnering components could be helpful as a conceptual description or as the starting point for structuring the partnering relationships during the procurement phase.

Similarly, Yeung et al. (2007) use components to develop a model that depicts alliances. These components divide into "hard" contractual parts: the formal contract and provisions of gain-share/pain-share. And "soft" relational ones that include trust, long-term commitment, shared goals and objectives, win-win philosophy, equity, agreed problem resolution methods, continuous improvements, cooperation and communication, alliancing workshops, and early selection of contractors. The authors find five elements common to all alliances: formal contract, real gain-share/pain-share, trust, long-term commitment, cooperation and communication. Variants of alliances utilize and combine all the other elements. The authors suggest the model is

helpful during the procurement phase both as a conceptual description and in procuring an alliance while avoiding misinterpretations among the parties.

Another topic, lean construction, focuses on what occurs within and across the boundaries in its process. Based on efficient manufacturing principles applied to construction, Ballard and Howell (2005) see lean construction as applicable to challenges posed by the dynamic environment of the construction industry. Notably, the Lean Construction Institute held a symposium on Relational Contracting in 2004 focusing on the connection between relational contracts and lean construction, suggesting traditional contracting does not promote the ideals of lean construction. Papers from the symposium covered Flexibility in Long-Term Contractual Relationships: The Role of Co-Operation (Campbell and Harris 2005) and Project Alliancing: A Relational Contracting Mechanism for Dynamic Projects (Sakal 2005). These papers subsequently appeared in the Lean Construction Journal (2005).

Other research looks at the cost of transactions defined by the placement and nature of the boundaries for different organizational structures. Walker and Wing (1999) combine construction project management theory with transaction cost economic analysis to better understand and determine the most appropriate organizational structure for a project. Considered are structures like the market and hierarchy. Walker and Wing mention market transactions occurring between organizations are costly due to limited interaction across rigid, impermeable boundaries. The authors indicate that the transaction costs involved in providing governance through the market will include drafting the contracts, setting up mechanisms for obtaining tenders, preparing other contract documentation, and ensuring the subsequent execution of the contracts by consultants and contractors. However, transactions within a hierarchy or firm are less expensive because individual entities have highly permeable boundaries facilitating seamless

interaction. In hierarchy structures, production and transaction costs are internal to the organization. These transaction costs include identifying the project, setting up a design office and contracting organization, hiring all necessary personnel, and monitoring their performance. Hierarchical arrangements like the firm or design-build, a similar construct, are beneficial only when the resulting transaction and production costs are lower than acquiring them through the market.

Harper and Molenaar (2014) study the relational nature of contractual agreements used for four different project delivery types: design-bid-build, construction management, design-build, and integrated project delivery. In accomplishing this, the researchers identify behavioral norms associated with relational contracts, as indicated by MacNeil (1980a and 1985). Then using content analysis, the authors evaluate standard construction contract language for the presence and frequency of contractual behavioral norms. In the study, Harper and Molenaar find integrated project delivery contracts more relational than construction management and design-build contracts; design-bid-build contracts are the least relational of those studied. While there is evidence relating relational contract theory to construction contracts, the authors indicate the need for additional work in this area.

Chan et al. (2009) indicate cooperation and win-win attitudes associated with relational contracts underlie the four construction techniques of partnering, joint ventures, alliances, and public-private partnerships. The authors compile literature on definitions, critical success factors, and key performance indicators for each studied method and illustrate these using project case studies.

The final work categorized within boundaries deals specifically with relational contracts in public construction. Ning et al. (2014) believe relational contracts and network strategies

contribute to better outcomes for general construction projects but indicate that existing policies hinder public owners' use. The authors identify drivers and barriers to relational transaction practices in public projects from a survey of Singapore construction professionals. Four drivers for its use are an increased value proposition, improved business competitiveness, shortened project time, and enhanced cost performance. Four barriers identified were lack of capabilities, an ethos of public service, lack of continuity, and constraints on public institutions.

2.3.2 Actors

Actors represent the project participants. Later, this research will address who they are, how and when they participate, and their different perspectives. Here, the literature reviewed is narrowly focused on how they are expected to behave, how their background can impact them, and how someone might choose participants.

Harper et al. (2016) describes design-bid-build as segmented into separate phases of design, procurement, and construction, where construction manager at-risk and design-build is more integrated based on the combination of services and construction involvement during the design phase. The authors indicate some owners impose collaboration through integrative techniques and relational contracts to avoid estrangement of the project participants during the construction phase. They suggest relational contracting theory and norms as a means of understanding these integrated forms of agreements. Using the relational contract theory and norms, Harper et al. (2016) develop a model of project team integration using multiple indicator measurements. They use exploratory and confirmatory factor analyses to test, analyze, and validate the model indicating the model can be used to assess the integration of construction project teams in practice.

Ning and Ling (2014) study public sector projects in Singapore to determine the impact of elements of relational contracts and network embeddedness theories, i.e., relational contracting norms and network strategies, on relationship quality and outcomes. The results are positive findings that effective information sharing improves relationship quality. Good relationships enhance client satisfaction and time and quality performance. Regarding the relational contract norms, "propriety of means" is determined to have a significant impact on cost performance; whereas "flexibility" and "contractual solidarity" are found to have a substantial effect on time performance; and "harmonization within the social matrix" and "propriety of means" allow for higher levels of satisfaction.

Other researchers focus on the need for a cultural shift. Over time, project participants become part of an operative project culture, often clashing with relational contracting. Kumaraswamy et al. (2005) establish relational contracting guidelines by identifying 24 factors that facilitate its introduction and 23 that impede or deter it. The four most critical in promoting relational contracting were mutual trust, open communication, effective coordination, and teamwork, reflecting a "can do" spirit. The most significant impediment to its introduction is a lack of trust/reliability, followed by a lack of confidence and teamwork.

The selection of the actors plays an integral part in a relationship. Rahman and Kumaraswamy (2005) develop and evaluate the relative importance of individual factors in selecting participants and the strategies for building collaborative work agreements. The prioritizing of factors varied by participant group. For consultants, the technical capability is the top factor. For contractors and subcontractors, time is the critical factor. For suppliers, quality is most important. And for clients, financial strength is the top-rated factor. Trust and business ethics were the core elements of the 25 factors for building collaborative work agreements.

2.3.3 Planning

Planning constitutes preparation for action and varies relative to its amount and type. Reviewed literature deals with plan elements like risk, selection, conflict, and the technological means to coordinate further participant planning.

Palaneeswaran et al. (2003b) develop a planning model to relationally integrate the supply chain containing five relational measures: (1) risk management, (2) selections, (3) performance management, (4) conflict management, and (5) innovations. The authors suggest strengthening the relationships and the links between contractors and clients, establishing equilibrium between the "push" and "pull" forces affecting them. Push forces push one participant away from another's interests, while pull forces pull participants toward each other, helping bridge gaps and create agreements. Further, the authors suggest resolving many defects and weaknesses in construction by relationally integrating supply chains. They champion cooperative relational contracting for its win-win scenarios. The researchers indicate their model can adapt to both project requirements and the priorities and characteristics of the contractor and client.

Other authors focus on planning the management of risk. Rahman and Kumaraswamy (2002) approach joint risk management by utilizing relational contracting principles to reduce transaction costs while fostering cooperation and teamwork. A completely comprehensive contract may be impossible to achieve or expensive and time-consuming to create during the planning stage. Necessary information is indiscernible and risks unidentifiable and unquantifiable to handle contractually in an uncertain future. Alternatively, procedures might be planned to address gaps in contract provisions or risks that materialize during construction. This

approach plans for the unexpected by expecting future cooperation and is aligned with transactional cost economics and relational contract theory.

Nyström et al. (2016) addresses design, a significant element of planning. Initially, the authors speculate more degrees-of-freedom for flexibility and innovation are given to the designer in design-build contracts than in design-bid-build. However, data from five Swedish road construction projects do not support that presumption. There were three design-build and two design-bid-build projects among the five studied. For design-build projects, the owner tends to specify project requirements in ways that reduce or eliminate degrees-of-freedom for design. Overall, the results indicate no significant difference in allowed design degrees-of-freedom between the two delivery methods. One recommendation offered to parties concerned about innovative design solutions is to share the accompanying risk by utilizing relational contracting principles.

Circo (2014) focuses on design from the perspective of technology. He describes exchanges in the construction industry as exhibiting characteristics consistent with relational contract theory. These include design-build, construction management, partnering, alliances, and integrated project delivery. The author suggests Building Information Modeling (BIM) technology can aid in these relational efforts by providing an interactive database allowing participants to collaborate during all phases of the project—design, construction, operation, maintenance, and alteration. The author speculates BIM will result in the construction industry shifting more toward utilizing relational contracts with BIM, not only facilitating relationships but also motivating them.

2.3.4 Time

Time refers to temporal segments of a project. These segments might include multiple project lifecycles, a single project lifecycle, particular periods within a project, or critical points during a project where participants make important choices. While significant in construction, the subject of time in archival literature yielded only references to extended performance contracts where the relationship is extended beyond a typical project span to include additional services such as operation and maintenance.

Zheng et al. (2008) studies contractual and relational governance in long-term public-private supply agreements. The researchers evaluate both positive and negative events on relationships for two UK design-build-finance-operate contracts with 25- and 30-year lifespans. They mapped the occurrences of these events during different project phases on a timeline. The researchers found that parties' relational assumptions, experiences, and intentions influence how the participants interpret the contract and contracting process, viewing it either as a sign of distrust or a written communication of commitment. The researchers also found differences in developing relational and contractual governance mechanisms. Relational mechanisms are more incremental and fragile than contractual ones with fewer degrees of freedom and serve as an anchor throughout the project life cycle.

Zhang (2005) also looks at public-private partnerships identifying potential barriers and exploring effective measures to remove these obstacles. Respondents to a survey identified barriers classified into six categories: (1) social, political, and legal risks; (2) unfavorable economic and commercial conditions; (3) inefficient public procurement framework; (4) lack of mature financial engineering techniques; (5) problems related to the public sector; and (6) problems related to the private sector. The authors identified measures for removing the barriers

from a literature review, case studies, and interviews with experts and practitioners. The result was a public-private partnership protocol for infrastructure projects addressing vital issues in nine areas: (1) appropriate roles of governmental authorities; (2) best value for money approach; (3) effective management of adviser services; (4) formulation of appropriate public-private partnership schemes; (5) use of relational contracts; (6) improvement of the procurement framework; (7) payment structure; (8) contract monitoring, termination, and step-in rights; and (9) transfer management.

2.4 Summary

This chapter reviewed archival literature in two sections. The first section contains two parts. One is a typical literature review addressing the background of Design-Build, a delivery method combining design and construction participants on the same team. It is not a new process but has recently begun to be used more frequently. The method initially faced some legal challenges in the public sector and faces other more durable challenges, including a cultural barrier. The second part of this first section is a state-of-the-practice review of implementation guidance developed by state DOTs and the NCHRP for those using this delivery method.

The second section of the literature review describes the current state-of-knowledge regarding connections between construction and relational contracts. Researchers see specific construction project delivery systems as relationships and are beginning to alter their perspectives regarding them.

Chapter 3

Research Methodology

This chapter details the research methodology providing an "audit trail" (Wallendorf and Belk 1989) of the effort leading to the research results. This research employed a sequential triangulation process that combined theory building with theory testing using three coordinated methodologies: Delphi, Grounded Theory, and Case Study. The Delphi methodology provided an empirical dataset on Design-Build that was coded using Grounded Theory to build the theory and then utilized along with the Case Study dataset to refine and validate the developed theory through the triangulation of these multiple methods. The value of the theory is subsequently demonstrated through application to state-of-the-practice design-build procedures.

The following discussion will provide a general overview of triangulation and the three research methods acquainting the reader with each technique's definition, background, and processes. Then, a stepwise research process is laid out along with a discussion of these methods tailored to the research effort at hand.

3.1 Triangulation

Triangulation is a research method that uses multiple measures to study the same phenomenon producing more reliable and trustworthy results. Denzin (1970) identifies four basic triangulation techniques in capturing this multi-dimensional view: data, investigator, theory, and methodological triangulation. Data triangulation uses multiple data sources focusing on varied measures describing the phenomenon. Investigator triangulation uses multiple observers of the same object or phenomenon rather than just one. Theory triangulation consists of applying multiple explanatory models to the same phenomenon. Methodological triangulation involves using multiple strategies within a single method or multiple methods to examine the data.

The triangulation term and guiding approach originate in surveying and navigation. Multiple reference points distributed in a triangulated configuration allow determining the spatial location of a remote object using geometry (Smith 1975). While a triangle is commonly used as a visual representation of the method, Sandelowski (1995) prefers the image of a crystal as a more appropriate metaphor suggesting its varied dimensions better illustrate the purpose of triangulation which is to obtain a multi-dimensional view of the same phenomenon, not to converge on a simplistic, one-dimensional view of it.

The origin of triangulation is often traced back to the 1950s, when it became prominent in social science research, although the basic idea of triangulation in research predates this later use. Maxwell (2016) traces it back before the 19th century when researchers used a combination of data and quantitative and qualitative methods. Maxwell says this approach was seen first in astronomy, geology, medicine, and epidemiology. This early use was before triangulation gained more general notice with its use in the study of social problems. The beginning of the systematic development of triangulation is often traced back to Campbell and Fiske (1959), who used multiple methods to converge data regarding psychological traits. Johnson et al. (2007) describe the process in this original formulation as more of a technique for measurement and construct validation than a full research methodology. The ideas of Campbell and Fiske (1959) were extended by Webb et al. (1966), who are credited with associating the term "triangulation" with this approach. Later Denzin (1970) further expanded on the method by identifying four types of triangulation, as discussed above. Triangulation continued to be developed by others, such as Jick (1979), during what Johnson et al. (2007) described as the formative period of the methodology occurring from the 1950s to the 1980s.

Triangulation quickly spread beyond its social science emphasis to fields of business for account management research (Modell 2005), economics to unite different traditions of economic and social thoughts (Downward and Mearman 2007), organizational research for the diagnosis of organizational problems (Paul 1996), and construction management to understand influences on organizational and project performance (Love et al. 2002).

There is no single process for implementing triangulation. It varies from study to study, with researchers designing the process around the goal of the research. There may be instances in which multiple investigators are used, looking at the same phenomenon to provide different perspectives. Similarly, circumstances may occur where various data sources, theories, or methods offer different perspectives. In certain studies, the goal is to seek convergence in which multiple viewpoints may be obtained to see if each tells the same story about the phenomenon. In other studies, the goal is to explore how a sequential research process may be likely with qualitative data being used during the first phase, followed by quantitative data in the next. In some studies, the goal is to explain how the likely process would have quantitative data being collected and analyzed, then used in the subsequent qualitative data collection. In studies that focus on testing theory, the theory will be discovered or developed in the initial phase of the research and then validated in a subsequent phase. In other studies, concurrent rather than sequential triangulation may be used in which different data is collected simultaneously and analyzed together to provide a complete view of the phenomenon. More examples and information on these and other aspects of the method can be found in works such as Creswell (2009), Jick (1979), Webb et al. (1966), and Turner et al. (2015).

3.2 Delphi

Delphi is a research methodology used to obtain expert opinions in areas that lack well-articulated knowledge. This methodology uses an iterative series of questionnaires interspersed with controlled feedback that continues until a consensus opinion is reached by the group of experts (Dalkey and Helmer 1963) or the investigator determines consensus is unlikely.

Delphi makes use of the "informed, intuitive judgment" (Helmer 1967) of experts, which Helmer (1983) suggests is not incompatible with scientific objectivity. To preserve neutrality, Helmer recommends a researcher regards himself as an experimenter dissociated from the experts, using them as measuring instruments of reality much like a scientific instrument measurement is taken as an indication of some property. He says these experts can be viewed as black boxes receiving questions as inputs and producing answers as outputs. Objectively, different experimenters using different but comparable black boxes should be expected to arrive at similar results.

The Delphi method was developed by Olaf Helmer and Norman Dalkey while working at the RAND Corporation. Initially used for military planning, the first notable Delphi study titled "Project Delphi" was conducted by Helmer and Dalkey for the Air Force in 1951. The purpose of this study was to decide the optimal targeting and necessary size of a Soviet nuclear attack to eliminate a significant portion of the United States defense industry. The method was kept confidential for years because of the classified nature of the initial Delphi studies. After being declassified, Dalkey and Helmer (1963) published the study. But according to Linstone and Turoff (1975), it took a later RAND paper, "Report on a Long-Range Forecasting Study," published in 1964 by T. J. Gordon and Olaf Helmer, to bring Delphi to the attention of those outside the defense community.

The Delphi method soon began to be applied to long-range social, technological, and corporate planning, with it quickly spreading to Europe and other parts of the world (Helmer 1983). The use of Delphi became common (Gupta and Clarke 1996) in areas such as economics (e.g., Cicarelli 1984), organizational research (e.g., Brancheau and Wetherbe 1987, Robeson 1988), and even civil engineering (e.g., Corotis et al. 1981, Saito and Sinha 1991).

The Delphi process can be formalized around three main steps. Selecting the experts, polling them, and providing feedback to them with the last two actions performed iteratively until there is convergence, or it is determined convergence will not occur, thus concluding the Delphi rounds. Choosing the expert panel is a critical component of the process. Helmer (1983) says if an analysis relies on the judgmental inputs from experts, then the quality of results is predicated on the quality of those inputs. Helmer states the individuals selected to supply these judgments should be highly qualified experts possessing knowledge vital to the study topic.

Polling the experts occurs through interviews or questionnaires, allowing the experts to communicate with each other anonymously and thereby reducing the psychological factors associated with face-to-face communication such as persuasion, unwillingness to abandon publicly expressed opinions, and the bandwagon effect of the majority opinion (Helmer 1983). According to Helmer (1967), the Delphi process itself should be refined for each study; however, the initial questionnaire asks the experts to respond to a question in most cases.

Providing feedback to the experts involves the researcher compiling and feeding the responses back to the experts in a subsequent questionnaire. This questionnaire provides the experts with their opinions from the previous round coupled with those of the group, allowing them to reconsider in light of the responses from the group. When using quantitative responses, the experts are provided group statistical data such as the median, mean, and interquartile range.

This opportunity to reconsider their opinions is provided at least once and may be repeated as necessary.

Iterations of polling and feedback continue until the researcher determines whether a consensus opinion has been reached or likely will not be. While the objective is consensus, the queried experts may indicate a more complex problem in which convergence may not occur around a single value but several values (Helmer 1967). In such cases of non-consensus, Helmer says the Delphi technique has still served its purpose of crystallizing the reasoning process that leads to several positions on an issue, thus helping to clarify the subject even in the absence of a consensus.

3.3 Grounded Theory

Grounded Theory is a research methodology used to develop theory from empirical data (Glaser and Strauss 1967). This methodology emerged from research on death and dying in hospitals conducted by sociologists Barney G. Glaser and Anselm L. Strauss (1965) and is detailed in their book The Discovery of Grounded Theory: Strategies for Qualitative Research (Glaser and Strauss 1967). It has since been used in fields such as nursing (Morse 1991), business management (Burgelman 1983), and organizational studies (Turner 1983). The method can also be combined with other research methods (Strauss and Corbin 1998).

Grounded Theory methodology develops a theory by breaking data apart, i.e., extracting critical elements from the data, connecting it back together, i.e., grouping and linking these elements, and then finding a theoretical scheme under which the data fits. This scheme can be used as a general principle on which other specific instances and conclusions can be explained. Those using this methodology initially perform inductive reasoning by taking “ground truth” raw data and fracturing it into underlying concepts or categories known as phenomena through an

open coding process. Then continuing abstracting the data, these categories are analyzed during axial coding to determine if these observed data elements are part of an axially time-ordered sequence of antecedent condition, action, and consequence, thus making them subcategories in a broader governing phenomenon. The final process in this data abstraction and the terminus of the inductive reasoning effort is to consolidate the various identified phenomena under a central or core category using selective coding. This central or core category creates or identifies the general principles at work as they are expressed in original raw data.

Following the inductive reasoning that led to a general governing principle, the deductive reasoning steps are taken up. These steps take the inductively derived theory and refine it by trimming and filling in details associated with the theory. Then, the refined theory is validated by testing its application and utility with the original data or those that provided it. The inductive and deductive reasoning for Grounded Theory is illustrated in Figure 3.1. The inductive coding steps leading to the general principle framework on the left side of the graphic are separated from the deductive application of this framework as it is refined and verified on the right side.

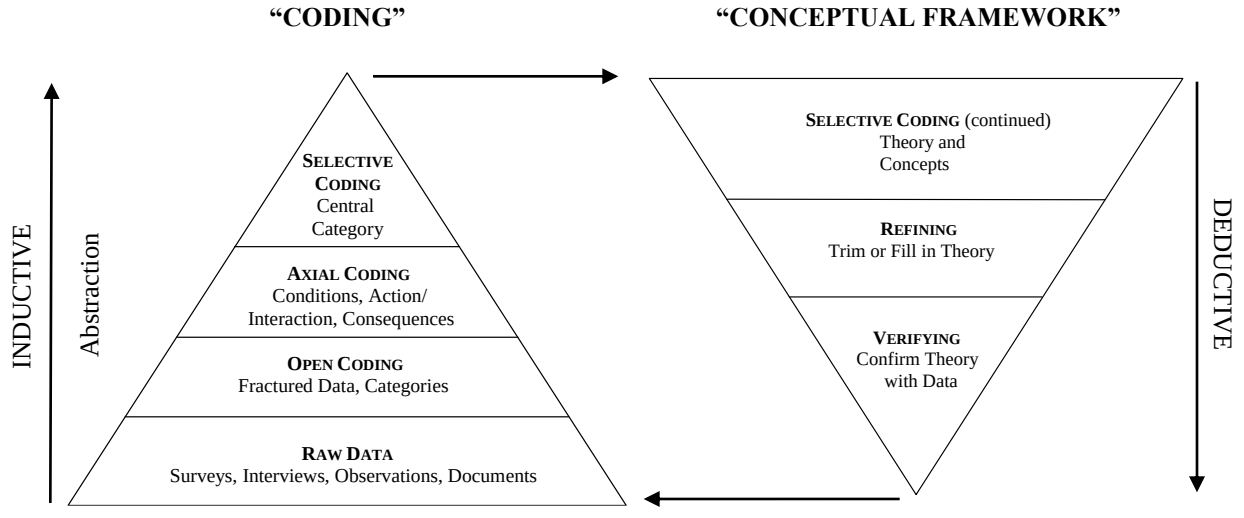

Fig. 3.1 Inductive and Deductive Reasoning in Grounded Theory

For in-depth information about the method, the works of Glaser and Strauss (1967), Strauss and Corbin (1998), and Dey (1999) are recommended. The underlying steps of the methodology are detailed below, beginning with the open coding process.

3.3.1 Open coding

During "open coding," data are broken apart and grouped into categories. The process begins with the researcher analyzing the data and identifying essential concepts. These concepts are then evaluated and grouped by similarities into categories. The categories also referred to as phenomenon, are labeled and described by their properties as characteristics or attributes of a category and dimensions representing the property's location along its continuum (Strauss and Corbin 1998). As an example, Strauss and Corbin use the concept of "color" to illustrate this with its properties, including shade, intensity, and hue. Its dimensions along a continuum describe each property; color can vary in shade from dark to light, its intensity from high to low, and its hue from bright to dull.

After the data has been fractured into categories or phenomena, the process of putting the data back together begins by determining connections between the categories, a process referred to as "axial coding."

3.3.2 Axial Coding

The axial coding process allows a phenomenon to be better understood by identifying the structure/conditions preceding it, the actions/interactions occurring in response to it, and the consequences resulting from it. These three sequential elements or subcategories of the "axial coding paradigm" identified by Strauss and Corbin (1998) are illustrated in Figure 3.2. Structure and process are linked through this time-ordered sequence of events. The structure is a precondition for a phenomenon that leads to actions/interactions and then consequences. In most

instances, Dey (1999) indicates these elements overlap, signifying certain elements continue to have an impact after another aspect of the event has begun, such as intervening conditions mitigating ongoing actions and interactions. Archer (1995) indicates this sequence can repeat with the consequences of one set of actions becoming conditions in a subsequent action/interaction event.

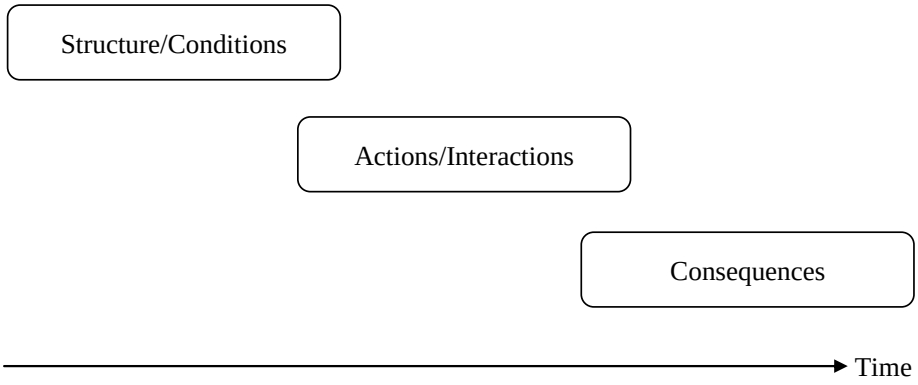

Fig. 3.2 Axial Coding Paradigm Using a Cognitive Behavior Framework. (Adapted from Archer 1995)

Drawing from Strauss and Corbin (1998), each element or subcategory will be addressed in turn. The first is the Structure/Conditions that create the circumstances in which the phenomenon is either situated or arises. Structure/conditions are represented by questions such as why, where, and how come. These conditions can be causal, intervening, or contextual. Causal conditions are sets of events or happenings that influence a phenomenon. Intervening conditions tend to mitigate or alter the impact of causal conditions on the phenomenon; such conditions would occur during the overlap in the elements. Contextual conditions are a specific set of conditions intersecting at the same time and place, creating circumstances or problems requiring a response through an action/interaction.

The second element or subcategory is Actions/Interactions referring to tactics used by the actors in response to the encountered situation or problem. These tactics can be either strategic or

routine. Strategic actions/interactions are purposeful, deliberate actions that are taken to resolve a problem and, in turn, shape the phenomenon. Routine actions/interactions are habituated ways of responding to occurrences. In either case, these actions/interactions answer questions such as by whom and how.

The third element or subcategory is Consequences that result from the action or interaction, sometimes intended and at other times not. These consequences answer questions such as what happened due to the actions or interactions or failure to act or interact.

The general process in using this axial coding paradigm is that the analyst studies the open coded categories initially identified as concepts in the data. When carefully evaluated, some of these categories answer questions such as how, why, and when, making them subcategories of a broader phenomenon. This means sorting open coded categories into main categories that identify phenomena from their subcategories that identify the phenomenon's conditions, actions/interactions, or consequences. Through this process, not only are connections between categories and subcategories established but the data is further abstracted, allowing connections to begin to be made between the main categories. Strauss and Corbin (1998) indicate that what is essential in utilizing the coding paradigm is determining relationships between the data. The following coding step seeks the highest level of abstraction in the data.

3.3.3 Selective coding

During "selective coding," major categories are integrated into a theoretical framework that reflects a set of well-developed concepts helpful in explaining or predicting phenomena (Strauss and Corbin 1998). In building this framework, a central "core" category is identified that accounts for the data as a whole. Strauss and Corbin state the central category can emerge from the data itself or be identified using existing literature to suggest the unifying theme and further

define the theory. Eisenhardt (1989) states enfolding literature during this process helps define and clarify the construct.

Dey (1999) suggests the core category restricts theory to prevent users from being overwhelmed by the density of grounded theory and to integrate the theory for clarity and coherence. However, Dey cautions that focusing on a single category may result in a one-dimensional analysis.

3.3.4 Theory Refinement

After the theory has been developed, it must be refined. This step involves reviewing the theory to fill in its gaps and trim excess information. Strauss and Corbin (1998) say all notable concepts should be identified, while any extraneous concepts that clutter the theory and contribute little to its understanding should be dropped.

3.3.5 Theory Validation

The final step in the grounded theory methodology is validating the theory. Although the theory emerged from the data, it remains an abstraction, so the theory must be verified to make sure it fits. Strauss and Corbin (1998) indicate the theory can be validated by either presenting it to the respondents for their reactions or comparing it to the raw data.

3.4 Case Study

A case study is a scientific inquiry in which the researcher studies particular events involving human subjects over time. These studied events include the actual occurrence of interest, what led up to it, and what resulted from it. Abbott (1992) describes this as looking "along the tracks." Case studies are often used to teach generalized truths embedded in a narrative. Case studies can also discover patterns in evidence to develop general laws or

determine if the data support a developed theory. A leading resource on this method is Yin (2003).

Cases have been seen throughout history as providing a means of discovery. The initial use of the case method is traced back to the late 1800s when used for teaching purposes at Harvard Law. In this setting, students discover and are taught general principles of law through case descriptions. This same vein of discovery is seen while utilizing the case study technique as a research tool. In the early 1900s, sociologists began to use the case study research method as a means of discovery by using developed life histories. The method was also used in psychology and social work but fell out of favor for a period in the mid-1900s as quantitative methods began to rise (Stoecker 1991). Its use started to return in the 1970s with its close associations with the grounded theory methodology as introduced by Glaser and Strauss (1967) and other research methods. Like grounded theory, which is mainly inductive and used to discover general theories, case studies are used to identify patterns for building theory or in conjunction with grounded theory as a deductive tool to validate and test a hypothesis.

Case studies have been used in different ways across a broad range of fields. Examples of some of these fields and the problems addressed include such field/problem couplings as political science to analyze causal relationships (Bennett and Elman 2006), business to improve product innovation (Dougherty 1992), and organizational studies to evaluate decision making (Pfeffer and Salancik 1974).

The overall process of case study research mirrors that of scientific experiments, except the data is collected from an uncontrolled environment. Case study research begins with developing the research question, which is either a deductive question focusing on testing a general theory or an inductive question generating the necessary information needed to develop

theory. In either instance, cases are identified that relate to the question being studied. Evidence is then collected in these cases and can include documents and interviews of the participant's observations and experiences. This evidence is then analyzed to identify critical information about the subject, allowing a narrative to be crafted (Collingwood and van der Dussen 1993). This narrative has either the evidence of the theory or patterns of an emerging theory within it. Analysis by the researcher determines if the tested hypothesis is consistent with the evidence in the narrative or if there are consistent patterns in the data supportive of its generalization into theory. Once concluded, findings can be generalized and reported. If typical of other cases, the results can be generalized beyond the individual study.

3.5 Stepwise Research Process

This section details the research process used in developing and applying the conceptual framework for design-build. The process involves seven steps:

1. Collecting the data
2. Discovering the categories
3. Discovering the central category
4. Developing the theory
5. Refining the theory
6. Validating the theory
7. Applying the theory

Steps 1 through 3 were performed as a set that inductively led to the discovery of the central or core category being identified through literature as relational contracting with its associated 12 characteristic subcategories. The research results of these steps are provided in Chapter 4. Steps 4 through 6 refine and validate the grounded theory by applying it to observed

facts and the provided experiential knowledge. Step 7 demonstrates the theory by applying it to current design-build procedures.

Steps 1 through 6 can best be described with the aid of a triangle, as shown in Figure 3.3, where the vertices represent both the methods used and the data collected. The links represent the connections between the methods and the flow of information provided from a method to input into another.

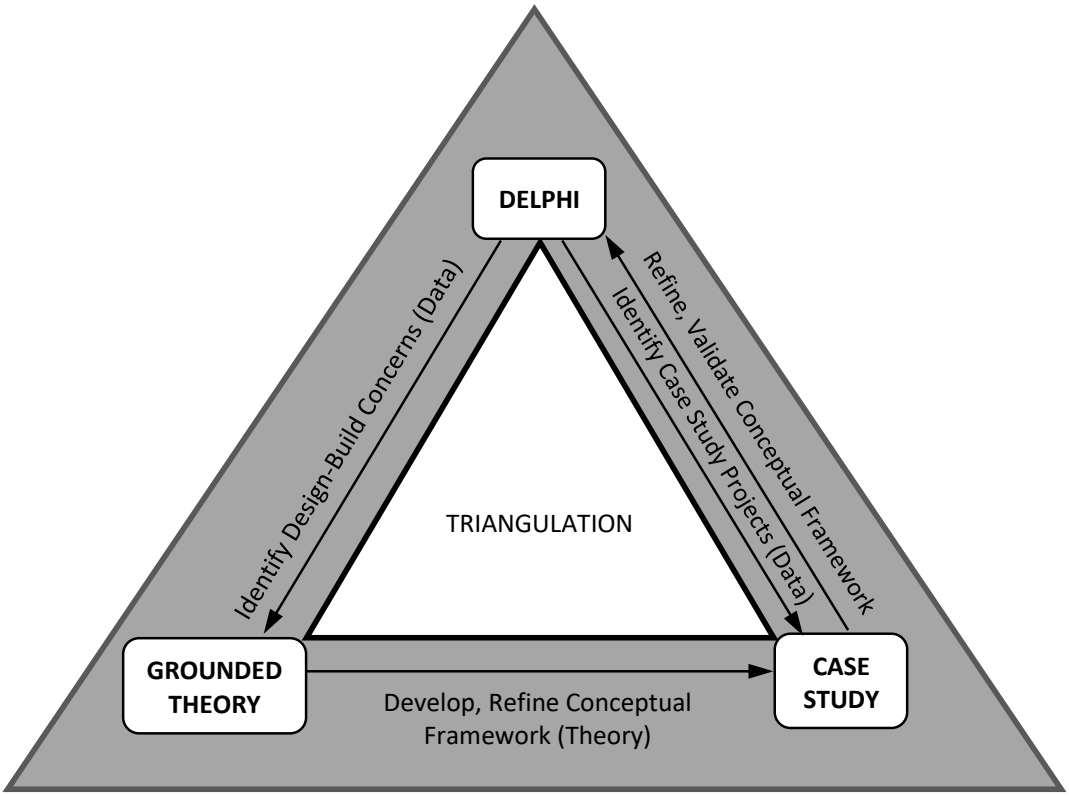

Fig. 3.3 Grounded Theory using Triangulation

The process begins with data collection, the first point on the triangle. The data is organized into categories, and then using Grounded Theory as the second point on the triangle, the categories are abstracted into a central category expressed in the conceptual framework of the

twelve characteristics of relational contracting. The theory is refined through the case studies constituting the third point on the triangle. The triangle closes back to the starting point by validating the theory with the original Delphi data.

This flow around the triangle was repeated individually for each of the twelve Relational Contract characteristics. Each characteristic, in turn, became the focus of the triangulated process. The Delphi comments referencing or alluding to the characteristic were identified. Literature was added to develop and enrich the understanding of that characteristic further. Then, the literature was condensed into a conceptual framework that was applied to and illustrated with applicable case study project elements. The conceptual framework was finally validated by selecting a particularly relevant Delphi panel concern associated with the characteristic and utilizing the developed conceptual framework to address that concern. The information for each characteristic is provided in the research results included in Chapter 5. Each of the seven steps is addressed more fully below.

3.5.1 Collecting the data

Data is collected using Delphi and Case Study methodologies. The Delphi process involves assembling a panel of well-respected experts knowledgeable about the topic and conducting multiple rounds of written responses and feedback. Building the expert panel included a nomination round querying individuals who have recently published literature on design-build or participated in the Transportation Research Board Conference on design-build. They were asked to nominate either themselves or others who they considered experts on design-build. After this Nomination Round was conducted, a panel of ten experts consisting of those who either self-nominated or were nominated by more than one of their colleagues was assembled. The expert panel contained a mixture of professions, including a construction

attorney and several engineers from both the public and private sectors, providing the perspectives of both owners and designers.

Four rounds of the Delphi process were conducted, seeking a consensus about design-build concerns from the expert panel. Originally the researcher had a narrow focus on design-build scoping and, as a result, based the initial questionnaire on this topic; however, the Delphi panel did not limit its responses to scoping, suggesting concerns beyond this narrow focus. As a result, and in keeping with the fluid and dynamic aspect of grounded theory, the researcher adapted to accommodate this broader focus by dealing with the concerns as presented.

Through the four rounds of the Delphi process, the panel provided both qualitative and quantitative data in the form of design-build concerns that they ranked in importance. As part of this process, the Delphi panel was also asked to identify successful and failed design-build projects for subsequent case study analysis, representing the second part of the data collection.

These two sets of data were input for the research methods that followed. The first set of data was a list of 50 design-build concerns identified in the Delphi panel responses that were used as the input for the grounded theory methodology. The second set of data was a list of 28 successful and failed design-build projects recommended by the Delphi panel for case study analysis. The researcher's Graduate Advisory Committee reduced this list of projects to eight public sector transportation projects, four considered successes, and four failures. Because one project team could not participate, seven projects consisting of three successes and four failures were analyzed. The data collected from these projects was the input for the case study methodology. The information collected on these projects included project participants' interviews and project documents, including scoping documents, contracts, and change orders. These case study projects are documented in Appendix B.

3.5.2 Discovering the categories

The Delphi process yielded critical success factors considered raw data to be organized into categories by the "open coding" process in grounded theory. Each critical success factor was analyzed and grouped based on similarities into seven categories and subsequently labeled.

This data abstraction reduces the large volume of data down to the few categorized groupings. In classical grounded theory, the next step would be to use the axial coding paradigm to identify groupings that reflect time-oriented subcategories of the structure/condition antecedence, the action/interaction response, and the consequential effect of the expressed phenomenon. However, the collected data from the Delphi panel didn't lend itself to this intensive axial coding process due to the panel relaying synthesized knowledge more so than observable facts, so axial coding was skipped in favor of next utilizing selective coding, the third coding process within Grounded Theory which is discussed next.

3.5.3 Discovering the central category

The grounded theory process continues integrating data with theory by identifying a central or "core" category by pulling categories discovered in the data together into a single, holistic theme through "selective coding." This process is accomplished for this study by searching the literature for a body of knowledge that coordinated the Delphi categories with existing literature by pattern-matching. This selective coding process led to the discovery of "Relational Contracts" (MacNeil 1974a), defined by twelve characteristics (MacNeil 1974a, 1980a), which closely match the seven open coded Delphi categories. This central category and its twelve characteristic components capture design-build essence and organize the collected Delphi data. These 12 relational contract characteristics were used in the research moving forward because of its more comprehensive coverage than the more limited list of seven

developed using the Delphi data. The difference in comprehensiveness can be explained in that the relational contracts literature represents the accumulated work in a mature, developed area of study; the initial research focused on the limited topic of scoping using the project experience of the ten-member Delphi panel.

3.5.4 Developing the theory

Another critical element of selective coding is developing the theory. The core category is the foundation of the theory, but its properties and dimensions must be defined, and for this research, the literature is used for this purpose. The raw Delphi data and the case study projects are initially reviewed to provide guidance and a starting point for the literature search conducted across various disciplines such as law, sociology, and economics. While performing the literature search, the Delphi and case study data are reviewed to ensure alignment with the discovered theory and its defining concepts. This iterative process where established theoretical knowledge from literature is compared to experiential data can indicate a need to reorganize the data or may even highlight an expanded perspective of the data. After the theory is defined, the researcher describes how this general definition of the theory can be illustrated in the context of commonly experienced and well-known construction activities.

3.5.5 Refining the theory

After the theory has been developed, it must be refined. This step involves reviewing the theory to fill in gaps and trim excess information. Strauss and Corbin (1998) say all notable concepts should be identified, while any extraneous concepts that clutter the theory or contribute little to its understanding should be omitted.

In this research, the theory is refined through the case study process. During this step, the theory is iteratively tested for its ability to explain events that occurred in a real-life context.

Because these projects represent "ground truths," they test and refine the conceptual framework, much like actual rainfall data is used within a hydrologic study (Bitsch 2005). The information for these case studies was collected after the Delphi process and thus is independent of and before the actual discovery of the theory that is being refined. This case study data includes interviews with project participants who represented the owner, designer, and contractor; project documents that contain procurement documents, contracts, and job files; and news reports and articles from web searches. The refinement using the case study process involved identifying exemplar project incidents and examining and explaining them using the conceptual framework while refining the framework. Showing the ability of the conceptual framework to explain project incidents also provides evidence of its applicability and credibility.

3.5.6 Validating the theory

The next step is validating the theory, which closes the triangle. Although the theory emerged from the data, it remains an abstraction, so Strauss and Corbin (1998) suggest it must be verified and tested to make sure it fits by presenting it to respondents for their reactions or comparing it to the raw data. In accomplishing this validation effort and demonstrating its usefulness for design-build, the developed theory was used to address and provide theoretical insights on the concerns initially offered within the Delphi data. For each of the twelve relational contract characteristics, a Delphi comment is selected as "best in class" and most representative of similar categorized concerns and then analyzed using the conceptual framework for that category. This step demonstrates the value of the theory, making it operational through its application by indicating how project participants can use the developed characteristics to organize their varied project experiences while guiding them as to how they can make choices for future projects.

3.5.7 Applying the theory

The final research effort applies the developed conceptual design-build model consisting of twelve characteristics to a select few state-of-the-practice procedures. Current knowledge of the field is largely limited to factual and procedural knowledge reflecting the "how's" of the design-build method, as manifest in ubiquitous procedures. While lacking in design-build, conceptual knowledge is essential by providing practitioners with the theory and understanding of "why" things work, e.g., why specific processes are followed and choices made. This knowledge and its application distinguish a novice practitioner who merely exercises a routine procedure from an expert who more competently analyzes the situation, observes multiple cues, and applies relevant knowledge to adapt routines, if necessary, to achieve the desired intent. This effort demonstrates the current relevance of the conceptual model and reveals a conceptual framework helpful in understanding the "why's" of the procedures.

The first step of this effort identifies a sample of design-build procedures in current practice, which would be deemed significant to the design-build method. In achieving this, a state-of-the-practice review is provided in the literature review of four state DOT design-build manuals and several synthesis guides consolidating and segmenting current design-build policies into procurement, Alternative Technical Concepts (ATCs), and post-award contract administration.

Then, taking each selected procedure, identify the conceptual model characteristics relevant to the procedure using the table in Appendix D. Next, analyze this procedure from the lens of each of the selected conceptual characteristics. After this, using the figure in Appendix D, consider interrelationships between the identified characteristics supporting or hindering the procedural objective. Next, evaluate the procedure in producing the selected conceptual

characteristics. Finally, suggest modifications to the procedure to better deliver the conceptual characteristics of design-build. The results of the theory application are provided in Chapter 6.

3.6 Summary

This section describes the methodologies used in this research and the specific process utilized in developing, refining, validating, and applying a theoretical model of Design-Build. The theory is grounded by triangulating between the data generated from the Delphi process, the theory developed from the literature, and the case studies of real-world projects. The triangulation process begins with Delphi and case study data collection. The Delphi data is organized into multiple categories and then integrated into the single-core category on the way to developing the grounded theory. The theory is defined using literature and then refined into a conceptual framework before further refinement and illustration with case studies. The triangle is then closed with the theory being validated with the original Delphi data. The theoretical model is then applied to current design-build procedures to illustrate its current relevance and usefulness.

Chapter 4

Data Collection and Selective Coding

4.1 Introduction

The following two chapters present the research results using a triangulation methodology. This methodology allows observations from multiple vantage points in developing a clear, accurate conceptual understanding of the studied phenomenon that can then be refined and rigorously validated. These multiple vantage points take the form of two data sets—Delphi panel data and seven Design-Build case studies—and three research methodologies in addition to the triangulation—Delphi, Grounded Theory, and Case Study. One data set and two research methodologies are used in developing the theory presented in this chapter. Two data sets and three research methodologies are used in refining and validating the results in the next.

The theory is developed using Delphi and Grounded Theory in concert. Using iterative rounds, the Delphi panel is queried to establish a consensus view of the critical success factors which initially focused on design-build scoping. In seeking its own consensus opinion of the essential elements for design-build the somewhat self-directed panel of experts included many factors not directly tied to the scoping effort. Using this data as knowledgeable expressions of key design-build factors, the researcher organizes these using Grounded Theory's open, axial, and central coding approach to develop a design-build conceptual theory.

4.2 Data Collection

Data collection for this research occurs in two parts: Delphi and Case studies. The Delphi data provides the information to develop the theory, while the case study design-build projects that were recommended by the panel provide information to refine and validate the results. The author addresses the Delphi data collection and briefly summarizes the case study projects within

this chapter but utilizes them more fully in the next. In addition, the researcher includes more detailed information on the data and projects in Appendices A and B.

4.2.1 Delphi

The Delphi process develops a list of critical factors for scoping public agency design-build projects and compiles a list of potential projects for case study analysis. This process began with a Nomination Round to assemble the expert panel. In the nomination round, individuals that had published design-build articles, presented on design-build at the Transportation Research Board conference, or participated in the Design-Build Task Force meeting were asked to nominate themselves or others they considered experts in the design-build field. This group chose twenty-nine experts, which the researcher reduced to a panel of ten that were either self-nominated or nominated more than once by others. There were three reasons for this reduction: it was a manageable size, it contained knowledgeable individuals representing a range of roles, and it was believed the response rate through multiple rounds of the process would be higher if those who self-nominated were involved. The panel contained two architects, an architectural engineer, a construction attorney, and six engineers with experience in both the public and private sectors. Additional information about the expert panelists can be found in Appendix A.

The Delphi process was conducted in four rounds beginning in Round One with general questions to develop a list of critical success factors for public agency design-build scoping and identify potential design-build case study projects, both “successes” and “failures.” Data analysis for Round One consisted of extracting a list of critical success factors from the responses and compiling the list of successful and failed projects identified by the panelists. In Round Two, the critical success factors and proposed case study projects from the previous round were presented to each panelist for rating on a Likert scale from 1, least important, to 5, most important. The

panel communicated with each other in iterative rounds inside the process. Each panelist was provided his ratings from the previous iteration along with information about the overall group's scores and then given the opportunity to suggest additional factors. This process continued for two rounds until the small response variations indicated the panel had reached a consensus opinion. Through the Delphi process, the group identified 50 critical factors and 28 projects. See Appendix A for details.

The 50 critical factors identified by the panel ranged from comments such as "the owner should let go of the controls and allow the design-build team flexibility" and "provide a detailed scope" to questions like "who typically leads the scoping process? Owner? A/E? Design-Builder?" and "how critical are contracts being in place to the scoping process?" The rating system allowed the panel to indicate some factors as more important than others. The following five factors received the highest rating possible with 5's from all the panelists suggesting these are the most critical success factors: "shared understanding of the scope," "parties understand what is expected of them," "pick the right team," "technical competence of the designers and builders," and "clear understanding of what information can be relied on by the design-builder."

The 28 projects suggested by the panel ranged in scale from a small parking garage to the largest design-build project completed at that time during the modern era. These were located across the United States from the West Coast to the East, Alaska, and Hawaii. The projects ranged from buildings to light rail and roadways.

4.2.2 Case Studies

Data collection yielded information for use in the case study analysis. First, the Graduate Advisory Committee reduced the number of projects for potential case study analysis using the following suggested criteria. (1) Limit to public sector projects, (2) Limit to transportation

industry to narrow focus to a particular project type, (3) Select those in the Southeast region to reduce travel costs with the exception of the I-15 project that is considered “best in class” for design-build, and (4) When using a “failed” project of a particular owner use a successful project from that owner as well. As a result, the committee selected eight case study projects—four successes and four failures as identified by the Delphi panelists. The researcher contacted the owners of each project with one owner being unable to participate reducing the number to seven projects—three successes and four failures. The seven projects are:

“Successes”

I-15 Corridor Reconstruction, Salt Lake County, Utah

Knightdale Connector, Wake County, North Carolina

St. George Island Bridge, Franklin County, Florida

“Failures”

I-77 Reconstruction, Mecklenburg County, North Carolina

I-85 Reconstruction, Mecklenburg County, North Carolina

I-10 Blackwater Bridge Replacement, Santa Rosa County, Florida

I-4 Reconstruction, Polk County, Florida

Second, the researcher collected and reviewed project documents such as the RFP, proposals, contract, plans, change orders, and project reports; and supplemented this with additional information from literature including newspaper articles and organizational newsletters. The researcher conducted interviews with members of each of the major project teams—the owner, designer, and contractor—to allow the participants to provide their perspectives of the events that occurred on the projects.

4.2.3 Case Study Project Summaries

The author provides a synopsis of each project containing details and unique aspects below with more in-depth information in Appendix B. It is important to note the line between success and failure can be difficult to define as many of the failed projects did so due to one aspect and had been successful in other ways. And similarly, a project that was considered a success may have also experienced difficulties along the way.

4.2.3.1 I-15 Corridor Reconstruction

The Interstate 15 project in Salt Lake County, Utah involved the reconstruction and widening from 6 lanes to 12 of approximately 17 miles of existing roadway. The project owner was the Utah Department of Transportation, and the selected design-builder was Wasatch Constructors, a joint venture of Kiewit, Granite, and Washington Construction Companies.

The I-15 project was unique because of its size and the time constraint for completion. At the time, I-15 was the largest project to utilize design-build in the modern era. Its success made it a prominent example of the design-build delivery method. The project presented a unique challenge with the upcoming Winter Olympics requiring the improved facility to be delivered faster than usually possible with a design-bid-build process. The decision was made to use design-build; a method that had never been used in the area before and was approved as part of the Federal Highway Administration's Special Experimental Project-14 for Alternative Contracting.

The time constraint led the owner to make choices to facilitate faster delivery. For instance, the owner chose to provide a full geotechnical investigation to all proposing design-build teams. The owner also contributed full designs for some long lead project elements. Despite the time constraint, the owner wanted to ensure a quality product and incorporated

"quality hooks" such as an option to add a warranty after observing the construction effort. Also, the owner established the right of continued involvement in decision-making during the design process through "over-the-shoulder" reviews.

4.2.3.2 Knightdale Connector

The Knightdale Connector in Wake County, North Carolina involved the construction of a new 6-lane facility approximately 1.4 miles in length. The project owner was the North Carolina Department of Transportation, and the selected design-builder was Barnhill Contracting Company.

This project was the first design-build where the owner assigned responsibility for the environmental permits to the design-build team. The Department of Transportation was constructing the Knightdale Connector at the same time as the Knightdale Bypass, so the owner obtained preliminary permits that included both projects assigning the Knightdale Connector design-build team the responsibility for the permit modification and compliance. The design-build team chose to add a special environmental consultant to their team and have "over-the-shoulder" reviews with the owner to facilitate this process.

An issue arising during construction was an omitted segment connecting the Knightdale Connector with the Knightdale Bypass. The owner indicated that the nature of the design-build delivery method allowed them to easily add the connecting ramp to the Knightdale Connector project. The owner considered this a successful project despite this particular challenge of a non-assigned ramp, which the owner and design-build team easily resolved.

4.2.3.3 St. George Island Bridge

The St. George Island Bridge, located in Franklin County, Florida, replaced the existing bridge with a new 2-lane bridge approximately 4.1 miles in length. The project owner was the

Florida Department of Transportation, and the selected design-builder was Boh Brothers Construction. At the time, this was the largest design-build project undertaken by the Florida Department.

This environmentally challenging project is across the Apalachicola Bay where approximately 90% of the State's oyster production takes place requiring care to minimize disturbance to the bay bottom. The owner focused on selecting a team sensitive to the environmental concerns of the project and chose to retain responsibility for oyster relocation given its impact on the local economy and the commercial fishermen. The owner involved the fishermen directly in accomplishing this work.

4.2.3.4 I-77 Reconstruction

The Interstate 77 project in Mecklenburg County, North Carolina involved median widening of an existing 4-lane facility to 8-lanes and rehabilitation of the existing pavement over a length of approximately 8.8 miles. The project owner was the North Carolina Department of Transportation, and the selected design-builder was Rea Construction.

Although experiencing three significant challenges, the project was considered a failure mainly due to the guardrail. The owner provided flexibility "where possible" allowing the design-build team to design the guardrail with the stipulation that it meets State Standards. The team offered a double line of guardrails that matched the established scope but not the owner's expectations owing to continuing maintenance difficulties with this type of installation.

The second major challenge was the bankruptcy filing of the design-build firm during the project. Another company purchased the bankrupt firm and handled the transition without negative project impact. Many of the project team members remained the same although changes occurred at higher levels in the organization.

The third major challenge was reconstructing and widening the roadway within the median of this high-volume facility while protecting the safety of the traveling public. The owner had anticipated construction occurring at night and focused proposal selection heavily on schedule, safety, and innovation. The selected design-build team developed an innovative solution building a temporary earthen ramp to the highway median from a crossing bridge allowing construction traffic access to and from the site from a smaller, adjacent roadway. The ramp access allowed work to occur during the day, lowering the costs and shortening the delivery time.

4.2.3.5 I-85 Reconstruction

The Interstate 85 project begins in Mecklenburg County and ends in Cabarrus County, North Carolina. The 6.9-mile-long project consisted of widening an existing 4-lane facility to 8-lanes and rehabilitating the existing pavement. The project owner was the North Carolina Department of Transportation, and the selected design-builder was Blythe Construction.

This project "failed" due to the need to modify a proposed acceleration/deceleration lane. The original proposal was designed using owner-supplied traffic data that was later determined to be wrong requiring a redesign to accommodate higher traffic volume.

A positive aspect of this project was the design-build team's innovative design. The owner's preliminary design included a non-preferred right-hand merge into the fast lane of the interstate with the construction of a bridge on the interstate. The design-build team reconfigured the initial approach to provide a more traditional and safer left-hand merge with a smaller highway bridge spanning over the interstate. This modification provided a safer facility for the public, reduced the required number of bridges, reduced construction time and cost, and was

expected to reduce the owner's maintenance costs because a bridge over the interstate requires less maintenance than one on the interstate.

4.2.3.6 I-10 Blackwater Bridge Replacement

The Interstate 10 Blackwater Bridge project located in Santa Rosa County, Florida was approximately 3000 feet in length and consisted of replacing two existing 2-lane bridges with new structural steel bridges. The project owner was the Florida Department of Transportation, and the selected design-builder was Traylor Brothers Construction.

This bridge was an emergency reconstruction project where the already deteriorating structure became severely damaged by a hurricane requiring immediate replacement. The project was fast-tracked resulting in virtually all aspects of the project from scope development, proposal submission, and delivery reduced from a typical timeframe.

The design-build team designed using owner-supplied soil data that did not indicate the actual poor soils in an area of the project. The team had to redesign and reconstruct a portion of the project during construction when structural issues occurred due to poor soils. The owner and design-build team could not agree on who was responsible for the modification, and a Dispute Review Board was needed to settle the issue. The Board ruled in favor of the design-build team requiring the owner to compensate them for the change. The relationship between the two parties deteriorated resulting in the need for the Dispute Review Board to resolve other subsequent, but smaller issues.

4.2.3.7 I-4 Reconstruction

The Interstate 4 project located in Polk County, Florida was approximately 32.4 miles long and divided into four sections. Three sections were design-build with approximate lengths of 6.3 miles, 16.3 miles, and 9.8 miles. The work consisted of widening the existing 4-lane

facility to 6-lanes and rehabilitating or reconstructing the existing pavement. The project owner was the Florida Department of Transportation, and the selected design-builders for the three contracts were Jones Brothers Construction Company, The Lane Construction Company, and Hubbard Construction Company.

There were two significant challenges faced on the project, one related to the extensive utility involvement and the other to team dynamics. The owner believed the numerous existing utilities on the project would likely lead to higher contractual contingencies from the design-build teams due to the uncertainty of the utility work. To mitigate this potential, the owner chose to handle the utility work itself, removing the effort from the contract. Unfortunately, the owner adversely impacted ongoing construction by failing to complete portions of the utility work on time.

The team dynamic proved to be a challenge for this project. The selected engineering firm had experience with design-build projects, although the assigned team had none. The designers had difficulty working on a contractor-led team throughout the project. Also, the inspector had conflicting connections to the three parties. He was an employee of the engineering firm, reported to and worked on behalf of the owner, and was under contract to the contractor. This problematic organizational structure hindered the parties developing the types of cooperative relationships important in design-build. A guardrail issue illustrates this poor relationship dynamic. The contractor wanted to reuse existing guardrail in a new installation to save time and reduce costs, but the designer opposed and vetoed this idea.

4.2.4 Data Collection Summary

This section highlights the two parts of the collected data: Delphi and Case Studies. The Delphi process developed a list of critical factors for public agency design-build projects along

with a project list of potential case study candidates for analysis. The case study process yielded project information in the form of participant interviews, project documents, and literature. These two sources of data provide the research foundation.

4.3 Open/Axial Coding

The 50 critical factors identified by the Delphi panel needed to be analyzed and organized. In a typical grounded theory approach, researchers query participants with open-ended interviews and observations that provide wide-ranging answers and comments. The researchers open code these into organizing themes and subsequently perform axial coding to identify the structure/conditions that preceded the phenomenon, the actions/interactions that occurred in response to it, and the consequences that resulted. Using a Delphi panel to address the issues results in a combining of the open and axial coding that a researcher might commonly perform as theory is being developed using Grounded Theory techniques.

The focus going into the Delphi process was to create a list of critical success factors for public agency design-build scoping. On analysis, the panel provided a broader range of factors. While the group did address concerns related to the scope, they also indicated that design-build is about more than just getting the scope right. Some suggested the critical importance of teams or the exercise of power for design-build. Being mindful that the Grounded Theory approach develops theory inductively from the data, rather than deductively in confirming an initial hypothesis, the focus of the research broadened in step with the collected data. As a result, rather than referring to the Delphi generated list as critical factors for scoping, they are seen more accurately as critical factors for design-build.

The Delphi comments were analyzed individually and then placed into categories based on similarities. Because some tracked to multiple areas, the researcher repeated this process until

the best fit was determined. Category labels reflected the principal concerns addressed within each group. In some instances, the name was taken directly from a comment, in other cases, the researcher created one for the group.

The seven categories that best fit the 50 critical factors identified by the Delphi panel are as follows:

(1) The Right Team
(2) Stakeholders
(3) Expectations
(4) Shared Understanding of Scope
(5) Reliance on Something
(6) Reliance on Someone
(7) Power

4.4 Delphi Categories

This section provides a more in-depth look at the seven Delphi categories with the author describing each and providing illustrative Delphi comments. The full list of the comments organized under each category is in Appendix A.

4.4.1 The Right Team: "People Make the Difference"

"The right team" is a group of project participants who individually and collectively are the best fit for the project possessing both the right technical and relational skills. A public sector engineer states it is important to "pick the right team" to have a successful design-build project. He continues by saying "the selection process must be carefully structured to select the best-qualified team." Two points stand out among his extended comments. First, "the right team," should be "the best-qualified team." Second, team selection should occur using a carefully structured process. This panelist, operating in the public sector with a principal focus on costs, sees the importance of allowing increasing focus on the team provided by this delivery method. In a subsequent Delphi round, another panelist commented on the importance of the right team

saying, “Picking the right team is important for success. The wrong team may result in a poor project outcome.” Also, he said, “People make the difference in both the owner’s organization as well as in the design-builder’s organization.”

The entire Delphi panel endorsed the importance of having the right team with all panelists giving it the highest possible rating of “5” tying with four other issues as the most critical. The emphasis on having the right team is in keeping with the design-build approach where people become more important as more project aspects are left to be determined after the contract is signed. This approach creates a relational environment in which the right design-build team has both technical and relational skills including the ability to communicate, cooperate, and collaborate.

4.4.2 Stakeholders

“Stakeholders” are individuals whose input is critical to project success. Some stakeholders are directly involved while others might be represented by surrogates. Nine different comments either named stakeholders or spoke about the interaction between stakeholders although the Delphi panel did not use this specific term. The end-user is the stakeholder whose participation is furthest away from the scoping effort and yet most critical to the project’s ultimate success. A Delphi panelist mentioned that “users should review and have a full understanding of the project based on the initial program requirements.” When responding to this comment, the panel ranked it among the top ten issues. A second comment on the importance of the customer was “getting the customer’s input is key to scoping the project properly.” The Delphi panel ranked this issue as twenty-first out of the fifty comments. Both comments suggest that future concerns as reflected in the voice of the customer should inform current decisions.

Surrogates voice end-user concerns with the Delphi panel mentioning three types: oversight agencies, the owner's departments, and evaluators. One panelist indicated having an oversight agency involved during the scoping process is beneficial not only to voice their concerns but also to expedite approvals. The oversight agency mentioned by the panelist was the Federal Highway Administration although other regulatory agencies would serve in this role as well. The panel ranked this comment relatively low at forty-second which seemed to result from voting along professional lines. The highest ratings, three "5's" and one "4," were provided by the public sector engineers who are directly affected by the involvement of an oversight agency; the lower ratings, one "3" and three "2's," were from the private sector engineer, the two architects and the attorney who may not directly deal with an oversight agency.

The owner's department members serve as surrogates not only for the end-users but also for the project owner as representatives interfacing with the design-build team. A member of the Delphi panel said, the "collaboration between offices during scope development is critical and should be mandatory." He later referred to his department's process of using participants from multiple offices including roadway, geotechnical, and structures among others in developing the scope. This comment tied for twenty-first when ranked by the Delphi panel.

The evaluators who are typically from the owner's departments serve as surrogates in selecting the design-build team. A Delphi panelist indicated "In a competitive public selection process, it is essential that the evaluators are competent, unbiased, and knowledgeable of the project's needs," and the panelist suggests that early involvement in the scoping process can provide this knowledge. The group ranked this comment tied at twenty-fifth.

Also mentioned are surrogates able to reflect the concerns of the proposing design-build teams that will be involved later in the process. One panelist suggested, "Getting the contractor's

input before the proposals are submitted is critical to finding holes in your scope." The Delphi panel ranked this comment tied at thirty-ninth. Another panelist mentioned the need to involve peers to represent the designer. The panelist provided a comment referencing a specific project where "Extensive peer reviews were used to ensure the scoping was not excessive." This issue was ranked forty-sixth. The need for contractor/designer surrogates will end after award because the selected contractor and designer will provide those voices during project performance with the designer also having a continuing professional responsibility as a surrogate for the end-users.

A Delphi panelist who noted the importance of the quality of interactions between stakeholders included "Level of Trust between Owner's Team and D/B Team" as critical to design-build success. It tied for eighteenth among panel rankings. Another panelist was concerned with good faith before contract award posing the following question:

> "How critical are contracts being in place to the scoping process? i.e., are people working on good faith or do they have a contract. If working on good faith, does that make them behave differently during the critical scoping phase?"

The panel ranked the issue of contracts being in place during scoping at forty-seventh.

Stakeholders and their interactions are critical to success, and it is a given the owner, designer, and contractor are the core project stakeholders, but other stakeholders benefit from continued involvement during the scoping process as well. The Delphi panel provided a non-exhaustive listing of specific stakeholders who may contribute to accurately defining the scope in a design-build context. All those mentioned may not be important for every project and others not identified may play a central role in particular projects. One must identify all the key stakeholders for a specific project, have them involved during the scoping process, and ensure quality interactions between them so they can express their interests, expectations, and present

and future concerns for inclusion in the scope. The right people must be involved in the right way.

4.4.3 Expectations

"Expectations" relates to an understanding of what will happen and may be either implicit or explicit in the agreement. The Delphi panel recommends "clear owner objectives/expectations" and suggests project participants "be clear about what the project is to accomplish." Expectations are the focus of three different critical issues identified during the Delphi rounds, panelists introduced two during the first round and one during the second round attempting to unite opinions around a statement proposing more flexibility.

A first-round issue stated one should define "what the project is to accomplish" in the scoping effort. With the result in mind, the parties could be guided not only by project expectations but the resulting product as well. This issue ranked seventeenth among the panel with the engineers' provided rankings of "5" recognizing function and form naturally encompass the expected results that are essential in scope development. The lawyer recognized this as a necessary way of expressing the intent of the parties also ranked this issue "5." The architects provided the lower ratings of "3" and "4" perhaps feeling a constraint on their creative vision.

The second first-round issue was to have "clear owner objectives and expectations." It was a similar comment to the one above and was scored independently with a panel ranking of seventh demonstrating a higher-valued phrasing of the same idea. The difference in the scores for this issue was a result of an architect not fully embracing this form of the factor and assigning it a ranking of "4" while all others provided "5's."

During the second round after the panel had read and scored the above two comments, a panelist proposed a consolidating concept as follows: "outline all expectations, specifics where

necessary, flexibility where allowable." This second-round refinement would be expected to have a more highly favored ranking due to a supposed closer alignment with the central concept shared by the panel. This panel did not fulfill this expectation with ranking this tenth; an outcome of a high-valued consensus by six panelists providing "5's" with two panelists, an architect and a private sector engineer providing "4's." It is evident there is a high-valued consensus regarding expectations as a critical issue. The flexibility issue will be discussed later with additional comments that embrace flexibility as a core critical issue in scoping.

Expectations that are clearly defined is a critical success factor for design-build. When the end-result of a project is not fully defined in keeping with design-build, expectations take a more central role as the basis for agreement and relationship. Although expectations can define explicit and implicit promises, they become particularly important for the implicit ones that determine the intent of unspecified portions of the agreement.

4.4.4 Shared Understanding of Scope

"Shared Understanding of Scope" is mutual knowledge about the project plan suggesting a "meeting of the minds" regarding project work. One comment titled "shared understanding of scope" tied with four others as the highest-ranking Delphi concerns. A panelist mentioned experiencing difficulty on a project in which planning in all four categories identified below was either deficient or not well executed resulting in a different understanding of the project among the participants. In planning the project, the owner had not adequately identified the unforeseen conditions encountered later. When faced, there was conflict over who was responsible because the owner hadn't allocated it to a participant. Collaboration between the parties deteriorated, and they were no longer able to maintain open communication.

This understanding is a function of planning referred to in more than half of the Delphi panel comments which fall into four categories: (1) Planning the work, (2) Planning the roles and responsibilities, (3) Planning for collaboration, and (4) Planning for flexibility in performance.

"Planning the Work" is the first category of shared understanding containing issues specifically related to the description of the work requirements. Panelists share four issues related to the special requirements of the work. The first is "identify special project requirements." The Delphi panel ranked this comment in the top ten with one rating of "4.5" and all others "5's." A second is "long-term maintenance, if required, should be well-scoped." The panelist refers to a project where participants neglected long-term maintenance, and difficulties associated with this topic arose later. The panel ranked this issue among the top ten. The third is "identify potential unforeseen conditions" which was not as well received by the whole panel ranking in the bottom half of critical issues attributable to the low ratings of "1" by two panelists, one an architect and the other an attorney. Another panelist who ranked this issue as a "5" offers a potential clue to the low rankings of others with the question "If we can identify it how can it be unforeseen?" The fourth is "include expectations for project specific insurance" by addressing while planning the types of insurance and indicating who should obtain the insurance. Panelists provided mid-range values of "3" or "4" placing it at the bottom of this subcategory of issues.

Panelists suggest three different planning options in communicating the work requirements including: in specific terms, in general terms, or something in between. The specific expression of requirements means more is determined by the owner, general expression leaves more to be determined by the design-build team, and the combining option allows the owner to provide some requirements while still allowing the design-build team flexibility on others.

Specific expression of requirements is often described as “detailed scoping” and includes covering all desired work requirements, encompassing all disciplines and activities, containing written program requirements, and utilizing specific language. One panelist’s comment of providing a “detailed scoping” was ranked by the panel in the middle with all “4” and “5” ratings except one panelist’s rating of “1” perhaps seeing value in allowing the design-build team flexibility through a less detailed description of the scope. A second comment suggesting “cover all desired work requirements” as one component of a detailed scope ranked in the middle of comments receiving ratings of “3.5” to “5” except one, the same mentioned above, providing a rating of “1.” A third comment was suggesting one should “encompass all disciplines and activities.” It received average ratings with two ratings of “3,” one “4.5,” and all others “5’s” except for the single outlying panelist from above again providing a rating of “1.” A fourth comment recommends “written program requirements,” and a fifth suggests it is important for the “language to be specific.” The Delphi panel ranked the last two comments among the top half of issues.

A second communication of requirements option is for the owner to use a general description reflecting a “conceptual design” that might include any of the following: “relationship diagrams,” “written program requirements,” and “specific language.” This approach provides a minimal design from the owner leaving much to be determined by the design-build team. The panel ranked this among the bottom half of factors, receiving its lowest ratings of “2” and “3” from panelists who placed higher values for either written program requirements or performance specifications over the conceptual design. “Relationship diagrams” may serve as a component of conceptual design and a panelist referred to a project requiring significant design innovation from the design-build team to fit all functions on a restricted site.

The project owner communicated the work requirements through relationship diagrams, performance specifications, and written program requirements. The Delphi panelists ranked this comment/issue among the bottom five with ratings of "2." "Performance specifications" is mentioned by panelists as a means of communicating the work requirements bridging between "relationship diagrams" and "written programs." The Delphi panel ranked this near the middle of the critical factors list. The author will discuss it below in greater detail with flexibility. "Written program requirements" is another method of communicating a conceptual design and while it might vary in the specificity of detail, the panelist suggests the language itself should be specific.

"Planning the roles and responsibilities" is the second category of shared understanding involving aspects of planning to ensure responsibilities are clearly allocated and properly understood by the participants. A panelist commented there should be a "clear allocation of responsibilities" and the Delphi panel agreed by rating this among the top ten factors. The same panelist offered a corollary comment that suggested not only must allocation be clear, but "parties must understand what is expected of them." The Delphi panel strongly agreed by giving unanimous ratings of "5" for this as a number one concern, tying with four other issues. "Transfer risks to the party best able to manage the risks" is another aspect of the planning of responsibilities in recognition of the idea that this party can most efficiently and effectively deal with the risk by using their uniquely applicable capabilities and resources. The Delphi panel saw this as one of the top ten issues for design-build scoping. Among the risks addressed would be those of unforeseen conditions where a panelist referred to the importance of "identifying responsibility for unforeseen conditions outside areas where borings were provided." This issue also tied for tenth and is noted here because it relates to the allocation of responsibility of risk during the planning and is discussed further in the section on "Reliance on Something."

"Planning for collaboration" is the third category of shared understanding referring to parties maintaining open communication throughout the project. A Delphi panelist mentioned two issues about communication after contract award: "have meetings at the jobsite" where design and construction teams are not co-located and "specify who must attend the jobsite meetings." The Delphi panel ranked these at the bottom of critical issues.

"Planning for flexibility in performance" is the fourth and final category of shared understanding. A noted advantage of the design-build project delivery method is designer/contractor teams are potentially afforded flexibility to achieve significant economies through innovation. The Delphi panel comments indicate the participants could achieve flexibility through four means: use of performance specifications, revised participant roles, communication before contract award, or use of general terms. Three panelists in support of performance specification standards offered comments ranging from a simple suggestion to "use performance-style specifications" introduced during the initial round to more involved performance-style specifications centering on "reasonableness" and "objectivity" surfacing during second round discussions. The Delphi panel ranked both near the middle of the critical factors.

Four comments suggest flexibility to revise participant roles. One comment worded as "allow design innovation" ranked among the top twenty factors. Another comment suggested rebalancing relational power by encouraging the owner to "let go of the controls" while allowing the design-build team to "provide the best and most innovative product." The panel ranked this in the bottom half of critical factors. Another comment worded as "even after contract award, allow the design-builder flexibility to modify the design while delivering a product that meets safety and lifecycle costs" suggests a flexible relationship while providing an external

performance standard. The Delphi panel ratings placed this comment in the bottom half of factors. A final comment placed within this grouping suggests the design-builder have the "flexibility to modify the design as long as basic requirements are met." The panel ranked this at the bottom of the list as well.

One panelist comment reflected communication before contract award as a means of "planning for flexibility in performance" offering one ought "specify the level the design-build team will develop the ideas before selection and the extent to which they must communicate them in their proposal." This option suggests proposers be allowed maximum innovation and creativity during the pre-contract stage while requiring the team to specify their solution in detail before contracting. The Delphi panel ranked this comment among the top twenty factors.

Two panelist comments concern "planning for flexibility in performance" in general terms. One panelist suggests providing "outline performance expectations for the design-builder" thereby giving the relationship flexibility while being governed by standards of performance. The Delphi panel ranked this comment in the top ten critical factors. Another panelist was supporting this general approach suggesting "scope should not be overly prescriptive." This comment seems to strike a balance allowing the design-build team flexibility to innovate while also allowing the owner to incorporate requirements through general standards that are not overly detailed. The Delphi panel ranked this latter issue at the bottom of the list of factors.

In summary, a shared understanding of scope is a critical success factor for design-build scoping. One can achieve it through a planning process involving four focus areas: planning the work, planning the roles and responsibilities, planning for collaboration, and planning for flexibility in performance. Each area is essential but must exist together and be well-executed and well-understood by the participants for project success. The resulting shared understanding

of scope provides a basic structure within which the participants develop common project goals, determine the actions that will lead to the attainment of the final product, ensure that their actions are consistent with the fulfillment of the requirements, and judge whether their efforts have been successful.

4.4.5 Reliance on Something

"Reliance on something" is the dependence on information—such as project documents, studies, and data—provided by another party and the degree one might rely on it for project performance. Reliance is a critical issue on projects. A private sector engineer panelist commented during the second Delphi round that "a clear understanding in the scope needs to be provided on what information can be relied on by the design-builder, for example, survey and soil boring data." The Delphi panel provided unanimous rankings of "5" and this factor tied with four others as the most critical factor.

Soil, budget, and scope are three types of information relevant to this topic. Soil information is the first expression of this critical success factor. A public sector engineer serving as a panelist refers to an emergency bridge project encountering a soil issue indicating they should have either "provided sufficient soils surveys to identify this problem or made it clear in the scope that the D-B firm was responsible for unforeseen soil conditions outside of the areas where borings were provided." The Delphi panel ranked the issue of sufficient soil surveys thirty-seventh among the factors as a result of individual rankings from a low of "1" to a high of "5" suggesting a potential of professional bias in rating. On the one hand, a construction attorney offered the lowest score likely due to who collects soil information doesn't directly bear on his contractual issue focus.

On the other hand, engineers on the panel offered the highest rating with values of "4" or higher, likely due to soil information directly impacting the project work they are required to perform. The second part of the panelist's comment indicates those scoping the project could have identified responsibility for unforeseen soil conditions outside areas with supplied soil information. The Delphi panel ranks this comment which is referring to naming the responsible party when the information is not reliable as tenth overall tying with six other issues with consistently high ratings of "4" and "5." The construction attorney that provided the lowest rating of the previous comment rated this issue a "5" indicating his preference is assigning contractual responsibility not stipulating in principle who should supply the information.

An architect panelist offered budget and scope information as a critical reliance issue. The architect's comment addresses the importance of reliability in the form of congruent information referencing three projects that had low budgets coupled with high scope expectations. On one project he notes "scoping was flawed because the owner would not reduce scope to match the budget available." The Delphi panel ranked the issue "scope matches the available budget" as tenth tying with the previous soil related issue and five others.

The three types of project information are not exhaustive with many other informational aspects of the project appropriate to consider in this category of reliance. For example, an owner supplied schedule could easily fit within this critical factor of providing reliable information.

The relational nature of design-build means agreement is often multifaceted and implicit. These promises and agreements involve actions generated by reliance on another party and are not always fully expressed. Owners' statements and actions directly impact those of the design-build team operating under the implied belief the provided information is sufficient and reliable. Since this may not always be the case, a clear description should be provided on what

information the participants can rely on and the extent of this reliance. The partially defined scope coupled with the relational aspect of design-build means participants must believe they can rely not only on each other but also on the information they share, or at least know the extent to which they can.

4.4.6 Reliance on Someone

"Reliance on someone" is the dependence on other individuals. Reliance becomes increasingly crucial in a design-build environment where owners don't fully define the project before entering a contract. The nature of design-build varies, and as design-build methods move further away from dependence on information toward dependence on relationships reliance on someone becomes increasingly critical. During the second Delphi round, a panelist suggests three critical factors related to aspects of reliance on someone; two factors deal with the competence of participants and the other with trust between participants.

"Reliance on someone" to have the necessary "technical competence of the designers and builders" is the first of three factors. This issue can be viewed from multiple perspectives: the designer's reliance on the builder, the builder's reliance on the designer, and the owner's reliance on both. Although assumed that designers have general role competence in transforming the owner's vision into a design solution and likewise the builders translating the design solution into a built reality, the technical competence takes on an additional aspect for design-build projects. Now designers and builders must be able to collaboratively work with a partially defined scope in competently developing and implementing innovative solutions. The Delphi panel unanimously scored this with "5's" tying with four other number one factors.

This same panelist worded another factor as follows: "in a competitive public selection process, it is essential that the evaluators are competent, unbiased, and knowledgeable of the

project's needs." The design-build teams expend a considerable amount of time and resources developing their proposal while relying on the owner and his evaluators for a competent, fair, and unbiased proposal evaluation. The Delphi panel ranked this among the middle of potential factors.

This panelist offered a third factor that there needs to be "trust between the owner and design-builder." The design-build team assumes the responsibility for completing the design and delivering the project the moment the contract is signed. The project owner must trust the team to not only deliver the project but also adequately and accurately interpret their needs. Trust must also extend in the other direction with the design-build team relying on the owners to provide resources and participate as indicated in their agreement. Trust and their ability to rely on one another is the glue holding the parties together as they strive to collaborate, cooperate, communicate, and provide give-and-take accommodations in a dynamic, non-specific environment. The panel placed this factor among the top twenty.

4.4.7 Power

"Power" is the right to control. A participant with power has authority over others for certain portions of the project. A design-build approach with an incomplete design before contract award allows power over the design to be exercised potentially by any of several different participants. During the second Delphi round, a panelist posed two related questions about who should have this power with the following: "Who typically leads the scoping process? Owner? A/E? Design-Builder?" and "How critical are contracts being in place to the scoping process?"

In responding to who should lead the scoping process, the Delphi panel overwhelmingly held the owner as most important scoring this factor among the top ten issues. The panel's

response to whether the A/E or design-builder should lead the scoping process appears somewhat equal with the design-builder slightly ahead; however, both ranked well below the owner by the panel scoring this factor as one of the least supported issues. The panel found the importance of contracts being in place during scoping as among the least critical as well, falling to the bottom of the overall list.

The project roles of the panelist may bias their rankings. Four of the five engineers on the panel are members of owner organizations, and each gave ratings of "5" for owner leadership in the scoping process. These four engineers consistently dropped to much lower ratings for whether the other participants should lead the process; two ranked the other parties leading with "3's" and the other two with "1's." The architect among the panelists ranked the owner leading with a "4," ranking his profession slightly lower with a "3," and then the design-builder considerably lower with a "1." The panelist who posed the questions, an architectural engineer, was the only one to see the A/E as the most important to lead the process with a ranking of a "4." He next ranked the design-builder at "3" and then was the only one to consider the owner the least important with a ranking of "2." This outlying position of the panelist posing the question further suggests his struggle with the design-build method, the parties' roles within it, and ultimately who should oversee the project.

There are two likely explanations for the anomalous response from the panelist bringing the issue to light. One explanation is his unique point of view as the only architectural engineering on the panel biases his rankings. The second explanation is as an architectural engineer his role has experienced the most dramatic change moving from a traditional delivery method to design-build. Addressing this from his unique architectural engineering perspective is helpful.

As is apparent from his questions, this panelist struggles with and is concerned over whose interests should dominate in this new design-build system as parties make and influence decisions and outcomes. Traditionally, the designer consults with the owner in developing the plans, addressing the owner's intent, and dealing with the functionality and safety of the facility in the context of the design-bid-build paradigm. The owner takes these completed plans to the market for bidding and subsequently contracting with a builder for construction that conforms to the prepared drawings. The designer is left to administer the contract and be the mediator of performance under the contract terms. In this approach, all interests are contained in the bargain with safety and long-term viability of the facility scripted into the designer's completed plans that are then used as the basis for construction.

In transitioning to the new design-build paradigm, the owner makes and enfolds certain choices into partially complete plans with other choices to be made during the proposal phase which can then be incorporated into the contract or post-contract during construction. The designer no longer controls design decisions that were contained in the governing documents when using design-bid-build, but rather the contracting parties must defend their interests after the bargain has been made.

The originating panelist's second question concerns the importance of contracts being in-place during the scoping process. The panel's rankings on this issue place it at the bottom of the issues list with ratings ranging widely from "1" to "5" but with no discernable pattern indicating a need for further study and a deeper understanding of this portion of the design-build effort. A clue to direct this future study might be inferred by the dramatic change likely experienced by the architectural engineer panelist posing the question in transitioning to design-build. Using the design-bid-build delivery method, the owner has a consulting contract with the designer and a

fully scoped contract with the contractor. Alternatively using a design-build method, the owner has a single contract with the design-build team based on a partially complete scope of work. The designer and contractor have a contract during which they will complete the project scope. How much scoping is done before contract award and thus incorporated into the award and how much is left to be determined post-award significantly influences who has power over scoping.

4.4.8 Summary

This section describes seven categories identified as organizing themes of the Delphi data. “The Right Team” is the first of seven categories reflecting a need for participants to possess the right technical and relational skills for the project. “Stakeholders” is the second category of critical success factors and pertains to the identification and interaction of parties reflecting the numerous and varied interests involved in the project. “Expectations” is the third category of critical factors for design-build given that projects are not fully defined by contract and that explicit and implicit promises take a more central role as the basis for the contract and relationship. “Shared Understanding of Scope” is the fourth category and pertains to mutual knowledge acquired through planning regarding project work, roles and responsibilities, collaboration, and flexibility in performance. “Reliance on Something” is the fifth category and suggests participants in design-build must be able to rely on shared information or at least know the extent to which they can. “Reliance on Someone” is the sixth category and reflects interdependence among project participants in an incompletely defined project environment with decreasing reliance on information and increasing dependence on relationships. “Power” is the seventh and final category and represents authority over certain portions of the project with Delphi comments directed toward considering who should control the scoping process in a design-build effort.

These seven categories organize the 50 individual comments suggested and scored by Delphi panel. In the next section, these seven will be unified into a central category in contemplation of the theoretical model reflecting Design-Build conceptual knowledge in accordance with Bloom's Taxonomy.

4.5 Selective Coding: Central Category

Using a Grounded Theory approach, the researcher conducted a literature review in search of a single central theme unifying the seven open/axial coding categories identified above. This search began with partnering, a similar process to design-build based on the goal of cooperation. Crowley and Karim (1995) represent partnering organizations using boundaries as a means of characterizing the interactions between project participants. Searching for additional information about boundaries and organizational structure led to Brown (1983) that addresses boundaries, lines of demarcation, and the potential for conflicts to arise where boundaries meet at organizational interfaces. Brown's use of boundaries to define different organizational structures led to additional literature on organizational structure (for example, Ranson et al. 1980).

Organizational structure is closely tied to organizational design that coordinates the framework and configuration of roles and processes for an organization (Ranson et al. 1980). Organizational design led to the literature on inter-organizational structures in business (for instance, Gadde et al. 2003) which then led to the work of Williamson (1975, 1979, 1985) in the field of economics. Williamson's work focuses on two structures: the market in which a discrete transaction occurs with limited interaction between the parties and a hierarchy in which there is vertical integration within a firm. Williamson references Macaulay (1963) and MacNeil (1974a, 1978, 1981) whose work focuses on an option positioned between the market and hierarchy referred to as "relational contracts." Macaulay's (1963) empirical study on non-contractual

business relationships is considered the seminal idea of relational contracts. Through email correspondence with this researcher, Professor Stuart Macaulay recommended a case study (Klein and Gulati 2004) on the construction of a hospital that created a parallel line-of-thought between the literature of relational contracts with the construction focus of this research.

Much of the pioneering work for relational contracts was done by Professor Ian MacNeil in the 1970s and continued to be developed by him in the years that followed (MacNeil 1974a, 1978, 1981). Professor MacNeil locates contracts on a spectrum running from discrete to relational and extending to the firm at the far relational end, although he indicates he does not push that far (MacNeil 1978). A discrete contract is one occurring between parties who have little or no interaction—merely a transaction—while a relational contract happens between parties who have extensive interaction. Professor MacNeil's work on discrete and relational contracts not only parallels design-bid-build and design-build in construction but highlights many of the concerns expressed by the Delphi panel providing a classifying framework for these concerns. Design-bid-build projects are ones in which the owner enters a contract with a contractor to build a project that had been entirely designed by a designer. The contract between the owner and builder is explicit, written, and detailed regarding the scope. Alternatively, design-build projects are ones in which the owner enters a contract with a design-build team to complete the design and build the project. These contracts are implicit, only partially written, and not completely detailed regarding scope thus creating the need for a robust cooperative relationship between the parties.

Professor MacNeil indicates the classic theory of contracts is based on the idea of discrete transactions ignoring more complex contracting situations where agreements enable and sustain relationships. Beginning with his seminal article (1974a), "The Many Futures of Contracts," he

continued with other works that expanded and refined his relational contract theory. In 1999, there was a symposium held at Northwestern University School of Law commemorating the immense contribution of MacNeil in developing the relational contracting paradigm. His work has been accepted and supported by other researchers who have continued to contribute to the theory of relational contracts in the area of law (Feinman 1993, 2000; Stipanowich 1996, 1998; Campbell 2004) and expanded it into other fields such as economics (Williamson 1975, 1979, 1991) and organizational theory (Stinchcombe and Heimer 1985).

In this research, the relational contract theory is used as the central category able to enfold the seven Delphi categories developed above into MacNeil's (1974a, 1980a) twelve enumerated characteristics of relational contracts that serve to differentiate discrete and relational contracts. These characteristics are listed and defined in Table 4.1. The initial notional match between his twelve characteristics and the seven Delphi categories is shown in Table 4.2 indicating his work could be relevant to this research.

With this promising development, the researcher performed a more in-depth analysis matching Prof. MacNeil's work to the Delphi data with results shown in Table 4.3. This analysis revealed far more connections between the two frameworks and is attributable to the fact that the items all stem from a common, naturally related theme. Thus, the same elements can be seen reflected differently in another characteristic providing a unique perspective of the same phenomenon. For instance, the Delphi category "The Right Team" relates to four MacNeil characteristics: Overall Relation Type, Attitudes, Future Cooperation, and Obligations.

Table 4.1 MacNeil's Enumerated Relational Contract Characteristics with Definitions

Relational Contract Characteristics	Definitions
1. **Overall Relation Type**	The nature of the personal relations between the participants
2. Measurement and Specificity	The amount of detail provided about the subjects of the exchange when the transaction is initiated
3. Basic Sources of Socioeconomic Support/Sources of Contractual Solidarity	The things sustaining the transaction
4. Duration, Commencement and Termination	The time elements related to the length, beginning and end of the transaction
5. Planning	The extent and nature of preparation regarding the exchange
6. Future Cooperation	The extent and nature of the interaction between the participants after contract award
7. Benefits and Burdens	The advantageous and difficult elements of the transaction and the handling of them
8. Obligations	The things participants are bound to do
9. Transferability	The ease with which the transaction is conveyed, when it occurs and what is exchanged
10. Numbers	The parties involved in the transaction
11. Attitudes	The participants' perspective regarding the transaction
12. Power, Hierarchy, Command	The ability of certain participants to impose their will on others

Table 4.2 Initial Match of Delphi Categories and Relational Contract Characteristics

Delphi Categories	**Relational Contract Characteristics (MacNeil)**
The Right Team	Overall Relation Type; Attitudes
Shared Understanding of Scope	Planning
Reliance on Someone	Numbers
Reliance on Something	Transferability
Expectations	Obligations
Power	Power, Hierarchy and Command
Stakeholders	Numbers

Table 4.3 In-depth Analysis and Match of Delphi Categories and Relational Contract Characteristics

Delphi Categories	**Relational Contract Characteristics (MacNeil)**
The Right Team	Overall Relation Type Attitudes Future Cooperation Obligations
Shared Understanding of Scope	Planning Benefits and Burdens Obligations Measurement & Specificity Future Cooperation
Reliance on Someone	Numbers Transferability Future Cooperation Basic Sources of Socioeconomic Support/Contractual Solidarity
Reliance on Something	Planning Transferability
Expectations	Obligations Planning
Power	Power, Hierarchy and Command Planning Obligations Future Cooperation Attitudes
Stakeholders	Numbers Overall Relation Type Planning Future Cooperation Transferability

"The Right Team" contains individuals who can operate and thrive in a relational environment described by the "Overall Relation Type." The team members have "Attitudes" that fit this environment in which "Future Cooperation" is required and "Obligations" are often not explicitly defined initially.

The Delphi category "Shared Understanding of Scope" has at least five MacNeil matches: Planning, Benefits and Burdens, Obligations, Measurement and Specificity, and Future Cooperation. A "Shared Understanding of Scope" requires proper "Planning" which naturally

includes planning “Benefits and Burdens” and “Obligations” in an environment with less “Measurement and Specificity” in areas and a significantly enhanced reliance on “Future Cooperation.”

The Delphi category “Reliance on Someone” is connected to four MacNeil characteristics: Numbers, Future Cooperation, Transferability, and Basic Sources of Socioeconomic Support/Contractual Solidarity. “Reliance on Someone” means certain participants should be included in the “Numbers” as important to the relationship. Reliance on others is inherent in the “Transferability” of this type of contract and is an element of “Future Cooperation” and one of the “Basic Sources of Socioeconomic Support and Contractual Solidarity.”

The Delphi category “Reliance on Something” has at least two MacNeil matches: Planning and Transferability. The “Planning” for a contract can create a reliance on certain things provided in the transfer thus influencing “Transferability.”

The Delphi category “Expectations” is seen as having at least two MacNeil matches: Obligations and Planning. Expectations often focus in part on “Obligations” which the nature and extent of these can be established during “Planning.”

The Delphi category “Power” links to five MacNeil characteristics: Power, Hierarchy and Command, Planning, Obligations, Future Cooperation, and Attitudes. Power held by participants can be directly related to the nature of their position on the project team, hence the connection to “Power, Hierarchy and Command.” The power can also be influenced by the nature of “Planning” with the participant performing the planning having more power than others by their ability to assign and influence “Obligations.” The power structure can influence the nature of participants’ “Future Cooperation” and “Attitudes.”

The Delphi category "Stakeholders" is matched to the five MacNeil characteristics: Numbers, Overall Relation Type, Planning, Future Cooperation and Transferability. Stakeholders should be included in the "Numbers" and take on different project roles based on the "Overall Relation Type." The stakeholders may be involved directly or indirectly in the "Planning" and "Future Cooperation" which impact the "Transferability" of the contract.

In keeping with grounded theory and its iterative process of data analysis and theory building, the concepts identified from the central category were compared with the original Delphi panel data and the category labels refined to align with the established relational contract theory more closely. For instance, the Delphi category labeled "The Right Team" originally included the Delphi concerns of "who typically leads the scoping process? Owner? A/E? Design-Builder?" but upon review of MacNeil's work it became evident that this concern could best be described in a separate category labeled "Power."

The twelve characteristics are concepts describing relational contracts and are used to define the theory as it is developed here. And while MacNeil identifies these characteristics and provides basic information about each, additional literature was needed to define and develop each concept more fully. This grounding of the theory in literature is presented in the next chapter in which selective coding continues as the data and theory are integrated and validated. Going forward MacNeil's characteristics will be utilized in developing a complete Design-Build theory because his work is more comprehensive, extending beyond what the Delphi panel experienced and expressed in their comments.

Another connection between the Delphi data and MacNeil characteristics is that each of the original Delphi comments loads on at least one of the MacNeil characteristics irrespective of the initial seven groupings developed by this researcher. This fit demonstrates the relevance of

MacNeil's work to this research and provides additional support for the use of his characteristics moving forward. The details of this fit are provided in Appendix A.

There are two significant observations worth noting. The first is the large loading of Delphi comments under "Planning." This loading is likely due to the original research focus on scoping and the targeting of Delphi questions in this direction. However, the Delphi panel did not confine their responses to this scoping topic alone because they could see larger design-build components at work. This heavy loading of "Planning" also leads one to notice the relatively lean loading on categories such as "Overall Relation Type" and "Duration, Commencement and Termination."

The second major observation is the placement of the Delphi concern "pick the right team" in multiple locations. There was an attempt to limit placement to best-fit categories in placing most Delphi concerns. However, with the high Delphi ranking of the team, it seemed appropriate to show its fit into the numerous MacNeil characteristics and indicate how some significant Delphi concerns can overlap into various characteristics. This approach proved valuable in shifting an elusive goal of picking the right team to a more organized approach that this team should have these characteristics.

4.6 Contractual Spectrum

MacNeil (1974a) identifies twelve individual factors that vary as contracts range along the contractual spectrum organizing collaborative human endeavors. While markets, relational contracting, and firms are important distinct forms of this organization, Williamson (1985) notes organizations run the gamut from discrete market exchanges at one extreme, to a centralized hierarchical organization at the other, with a

myriad of mixed or intermediate modes filling the space in between. Williamson (1991) refers to these mixed modes as hybrids and Medlin (2003) as plural modes.

MacNeil (1981) illustrates the full range of the contractual spectrum by sequencing approaches of securing coal for a smelting operation ordered by an increasing relational component, four approaches are highlighted here. The first approach illustrating the pure market end of the spectrum has the smelter acquiring coal as a spot purchase from a stranger in a crowded "market of many sellers" with delivery at the smelter's yard simultaneous with a cash payment. Slightly displaced from pure market exchange, the second approach adds a relational component as the transaction incorporates a time lag between the agreement and the subsequent transfer with terms likely documented in a discrete contract. Delivery of the coal is to occur at a future date(s) as described in the contract with payment of the agreed price to be made within thirty days of delivery.

The third approach illustrates relational coordination occupying the middle of the spectrum with MacNeil (1981) suggesting the smelter contracts for its annual coal supply from a specific mine at a specified price with quarterly price adjustment if changes in the market merit revision. Additionally, the parties agree to negotiate a new price if either party becomes dissatisfied with its arrangement or refer matters on which they can't agree to an arbitrator for an equitable determination.

The fourth and final approach illustrates hierarchical coordination at the end of the spectrum with the greatest relational component where MacNeil submits the smelter and coal mine merge by joint agreement retaining the same management and workforce while hiring an engineer to build and operate a conveyor system from the mine head to smelter. Each of these four subsequent approaches illustrates movement along the contractual spectrum with MacNeil

adding a greater relational component to the organization while reducing reliance on transient market forces in the exchange. MacNeil's twelve factors identify and characterize changes reflected in this movement along the spectrum.

Others recognize this phenomenon using different terms and organizing themes. Ebers and Oerlemans (2016) indicate prominent features varying among organizations along the spectrum fall into categories of governance and embeddedness. Williamson (1991) identifies the four governance dimensions as ownership autonomy, incentive intensity, administrative controls, and adaptation. Ebers and Oerlemans describe transitioning from market through intermediate hybrids to a hierarchical governance structure is marked by reducing ownership autonomy, a gradually decreasing reliance on incentives, increasing administrative controls, and decreasing autonomous adaptation. These governance dimensions do not fully account for the dependence of hybrid organizations on broader social structures characterized by Ebers and Oerlemans as embeddedness which includes past collaboration, trust, and prevalence of industry norms.

Shifts in the organizational features of governance and embeddedness trace a similar path along the contractual spectrum advocated by MacNeil. At the discrete end of the contractual spectrum, a market transaction occurs between a buyer and seller in an instantaneous exchange of a good or service for a specified price within a competitive marketplace. Each deal is independent of all others guided solely by the price mechanism of a free, competitive market between parties who have had no prior and plan no subsequent interaction (Webster 1992). When considering the governance dimensions, discrete transactions are controlled most strongly by the intensity of the output pricing incentive and adaptation to market conditions. As movement occurs toward transactions

taking place in the near future, these two governance dimensions continue to dominate with focus on output-oriented pricing, but the presence of a contract allows for extensive adaptative clauses to deal with unexpected market disturbances and agreement on decision rights for the principals as to who and how they can intervene (Ebers and Oerlemans 2016). As a result, adaptations are no longer exclusively based on the market environment, but also on a contractual agreement.

Continuing along the contractual spectrum, first hybrid and then ultimately hierarchical governance structures replace market governance to better deal with both increasing asset specificity from dedicated capital investments and behavioral uncertainty exposing trade to the misuse of opportunistic advantage. Transacting parties chose hybrid governance structures when the dependency is strong enough to require close coordination and adaptation, but not strong enough to induce full hierarchical integration (Ebers and Oerlemans 2016). These hybrid methods span the mid-section of the spectrum focusing on cooperation where legally autonomous entities work together, mutually adjusting with little help from the price system, and share or exchange technologies, products, capital, and services without the unified ownership seen with firms (Ebers and Oerlemans 2016). Embeddedness of the relationship overshadows the governance dimensions with parties relying heavily on the social structure of their relationship brought about by past collaboration, trust, and shared industry norms. Past collaboration, as suggested by Ebers and Oerlemans, makes the parties more knowledgeable about each other's capabilities and reliability, reducing expectations of opportunistic behavior, and lowering the need for monitoring and protective safeguards. Positive past collaboration supports trust between the parties thereby creating less need for administrative controls and protective contractual safeguards, encouraging reciprocal coordinated behaviors when adapting to unforeseen

disturbances. Industry norms create a convergence of expectations and common identity. Because these norms comprise binding expectations for appropriate conduct, they provide incentives to perform because of possible social sanctioning thus reducing the need for administrative controls.

With further movement along the spectrum, there are longer-term relationships in the form of network structures (Podolny and Page 1998), contract-hierarchies (Stinchcombe and Heimer 1985) and ultimately the integrated firm (Coase 1937; Williamson 1975, 1991; Hart 1988). As the end of the spectrum is approached, focus centers on power with the potential economic bargain largely structuring the power dynamic. Hierarchical organizations internalize function when deemed more efficient than the market. Administrative and bureaucratic controls replace the market control that exists at the other end of the spectrum making this a prominent feature of this type of organization. Another prominent governance dimension is that parties no longer have autonomous ownership over their resources (Ebers and Oerlemans 2016). Viewed as an employer and employee agreement, the employer has the right to deploy the employees' resources by fiat (Williamson 1991).

MacNeil's contractual spectrum dovetails with Medlin's multi-dimensional diagram (Medlin 2003) reproduced in Figure 4.1. The three coordination modes along the leading-edge anchor the layout and correspond to the progression of MacNeil's spectrum. "Coordination by the Market" depicted at the rear left is synonymous with MacNeil's discrete transactions. "Relational Coordination" shown at the middle front and "Coordination by Hierarchy" at the rear right reflect versions of MacNeil's relational contracts being either between firms or within a firm, respectively.

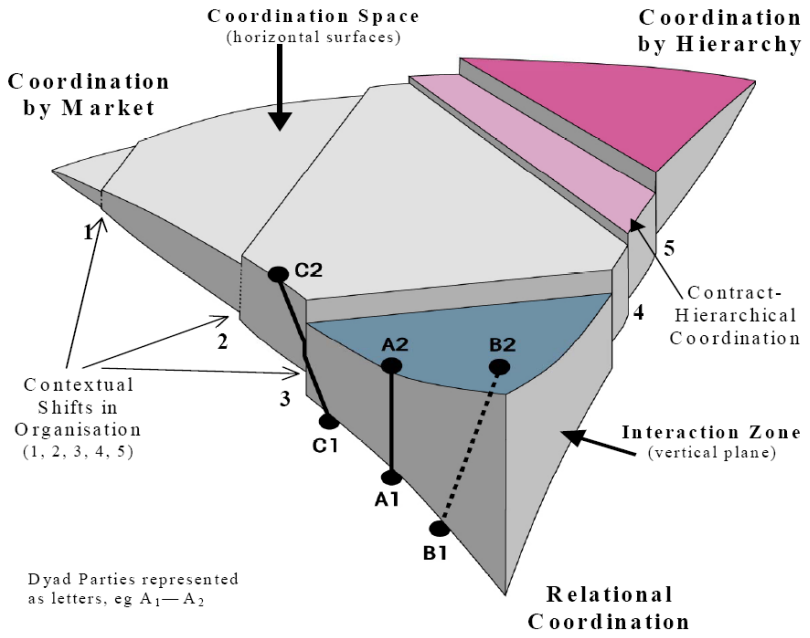

Fig. 4.1 Interaction Possibility Space Model (Medlin 2003)

The horizontal plane of the diagram which Medlin refers to as the "coordination space" maps transitions from one coordination mode to another. Medlin suggests that despite a common belief that shifts occur gradually between methods, they are often abrupt as illustrated in the fractured horizontal coordination plane showing five specific "contextual shifts" in the organization. Medlin states contextual shift "1" in the back left represents a move from a "one-off" discrete transaction to continuous market transactions. Contextual shift "2" illustrates a change from market to plural forms of coordination. Contextual shift "3" depicts a significant change to relational coordination. Contextual shift "4" represents a move from plural modes to contract-hierarchy while shift "5" represents a change to pure hierarchy. These abrupt contextual shifts reveal interacting parties often have different preferences or perspectives regarding the relationship.

The top and bottom horizontal surfaces are used by Medlin to individually depict the parties involved in the exchange with illustrative positions indicating the parties preferred

coordination mode labeled using a shared letter for a single transaction and designated numbers 1 or 2 identifying the parties. The connecting line references the linkage between the parties. The near vertical tie between A1 and A2 suggests close alignment between the parties' preferred modes of coordination. The sharply angled coupling between C1 and C2 shows party 2 preferring a more discrete arrangement than party 1 with their interactions disrupted by a fault line along the linkage. Similarly, the angled tie between B1 and B2 indicates party 1 preferring a more relational arrangement while party 2 shades more toward the hierarchical structure although no disruptive fault lines occur in the interaction space.

The vertical plane which Medlin refers to as the "interaction zone" is delimited within the top and bottom horizontal planes illustrating the freedom of interaction within a coordination mode. At the two spectrum ends, the small interaction space shown at coordination by market and coordination by hierarchy is a consequence of their governance dimension. At the market end, limited interaction is a function of an "arms-length" transaction with minimal party interaction. With hierarchical coordination, limited interaction space reflects both the merging of parties into a single organization and the imposition of constraints on interaction by an authoritarian party. These interaction spaces contrast with those of relational coordination where parties interact freely and rely on the embeddedness of the relationship to complete the incomplete contract and make obligations specific during the effort.

Medlin (2003) acknowledges the complexity of exchanges indicating multiple models may be needed to visualize some situations accurately. To illustrate this potential, consider instances of numerous participants involved in a design-build transaction with

both a central contractual relationship and other subordinate interactions that could be modeled using these diagrams. Also, the adaptability of the model means that in a field like construction where relationships often change in various project phases a coordination snapshot could be created reflecting changing situations for different project stages. And, while a project overall might exist at a particular location on the spectrum, parts of it might be modeled elsewhere based on choices made by the owner.

Construction

This contractual spectrum can describe construction project delivery methods and shifts in their use. A project owner is using the Design-Bid-Build delivery method where seeking a market price bid on work defined in the design documents before entering a construction contract with the low bidder. Near the discrete end of the spectrum, Design-Bid-Build is a market transaction that occurs in the future with limited interaction space between the parties aside from the dictates of the contract as shown in Medlin's diagram. The parties engage in formal, written, communication through a discrete contract detailing both sides of the exchange, styling the party interactions, and providing remedies for any conceivable contingencies. At this point on the spectrum, price competition is the focus, and the market is the mechanism of control. Price competition creates little need for interaction, command-and-control, or cooperation. Output pricing is the basis for rewarding participants and simultaneously reducing the owner's concerns for the opportunistic behavior of shirking regarding input or effort while increasing the opportunistic behavior of cheating regarding output or measurement (Hennart 1993). The owner provides autonomy to the contractor in his delivering the planned facility to incentivize output prices from the market, with slight oversight by the owner to assure quality. So, while this

method has the incentive for the intensity of action, the owner must monitor for quality and quantity.

This environment of competing self-interested parties tends to create adversarial relationships. A contractor may seek a competitive advantage by requesting changes for errors or omissions that they had earlier identified in the plan documents, or a designer may overdesign as protection from design liability. A large number of changes and claims along with the lack of involvement of parties at stages in the project where their contributions would be invaluable led some owners to try other delivery methods such as partnering.

Partnering occupies a point closer to relational coordination than design-bid-build although still on the discrete end of the spectrum. Designers communicate project requirements in documents developed during the design phase with little or no interaction between the affiliated parties. These parties continue to have a discrete agreement with the transaction continuing to be controlled by the market, although once selected based on output pricing, the parties agree to a partnering relationship during construction allowing cooperation and communication in resolving encountered problems. The contractor's involvement beginning only after design completion prevents their design input for constructability. To remedy this by forming relationships earlier in the project lifecycle, some owners started using design-build.

Design-Build exemplifies relational coordination in the middle of the contractual spectrum. The large interaction space depicts the flexibility of the method in dealing with the incomplete nature of relational contracts with participants relying less on the governance dimensions and more on the social aspects of relationships based on past collaboration, trust, and

industry norms. Overlapping design and construction phases allow designers and contractors to complete the design while incorporating construction knowledge in the effort.

Medlin (2003) suggests the fault lines in transitioning to relational contracts are due to shifts in trust, commitment, and the use of partial scope which make the use of design-build difficult for some owners. Some of these challenges can be illustrated in Medlin's diagram. For instance, some owners continue to occupy a position closer to the discrete end of the spectrum holding on to familiar aspects of the design-bid-build delivery while the design-build team occupies a position closer to the relational middle reflecting a fault line in their interactions much like that illustrated on the diagram along C1-C2. As a result, some owners shifted to other methods with some pushing back to construction manager-at-risk while others, troubled by the lack of focus on long-term project issues, pushed forward toward the firm.

Owners moving to construction manager-at-risk prefer a complete plan formalized in a discrete contract while also wanting construction phase knowledge incorporated into the design. This delivery method accomplishes this by using a contractor surrogate to advise the designer on construction knowledge during the design effort, but still results in a complete plan before construction. The owner can then seek a market price for the described work allowing the contractor surrogate to compete with others to become the construction manager for the project.

Other owners dissatisfied with the short-term focus of design-build participants pushed further in the relational direction toward contracts including not only design and construction but also operation and maintenance, referred to as Design-Build-Operate-Maintain. In this delivery method, the organization continues its involvement in the project for a specified period after placing the facility in service.

The firm is at the far relational end of the spectrum with vertically integrated participants within the organization capable of handling multiple aspects of the project. Often the initial plan is incomplete with authority figures directing the work and assigning tasks during the delivery. This delivery method requires strong administrative controls for providing behavioral constraints given the inherently low incentive intensity and high shirking potential associated with this form of delivery.

The firm is a static organization with the tendency to fit projects to available resources that are frequently idle between projects. In response, this researcher believes the industry will move more toward an activated network delivery method using a flatter, horizontal structure where a firm coordinates a dynamic network of multiple relationships by activating the necessary resources on a project-by-project basis.

4.7 Summary

The Delphi panel identified fifty critical factors for design-build that were organized into seven categories. Literature was then searched for a single organizing theme for the Delphi comments. The search led to the work of Professor MacNeil on relational contracts. The characteristics he defines for contracts match the Delphi categories and even extend beyond the concerns expressed by the panel. As a result, the relational contract and its defining characteristics are the theory on which this research will be grounded.

Chapter 5

Theory Refinement and Validation Using Triangulation

5.1 Introduction

This chapter presents the triangulation results that refine and validate using MacNeil's twelve factors characterizing discrete and relational contracts differences as a theoretical model in approaching the design-build project delivery method.

The triangulation of each factor has three reference points. Delphi panel data is the first reference point providing ranked comments of concerns aligned with each factor. The inclusion of the Delphi data occurs at the abstracted level, where a direct match occurs between a factor and a group of Delphi comments. If there is no match, but the data suggests inferences from concerns that are potentially more fully formed in the factor, then individual comments are taken up at a more detailed level.

Literature is the second reference point providing a unifying conceptual underpinning to the panel concerns while expanding on the ideas introduced by Professor MacNeil. Literature serves to take comments and rankings reflecting panelists' individual and shared experiential learning from varied project histories, label this collection of experiences within a studied field, and provide a further conceptual understanding of the underlying issues from those publishing in the generic field of study.

Case study projects are the third reference point providing specific project examples illustrating and proofing the concepts gleaned from the literature. The closing step in the triangle returns to the original Delphi panel concerns applying the developed conceptual framework to demonstrate its usefulness in understanding complex issues associated with Design-Build.

Each section begins with a descriptive summary of MacNeil's factor. Next, the author presents a subset of the Delphi data matching with or hinting at the studied category, followed by the presentation of literature further defining and describing the data and factor. Identified concepts are then illustrated using a range of standard construction project delivery methods. Subsequently, these concepts are condensed into a conceptual framework for illustration with case study projects. The final step closes the triangle with an application of the conceptual framework to a Delphi comment best reflecting related concerns to demonstrate the value of the developed theory.

MacNeil's 12 factors are grouped based on similarities into four topic areas: boundaries of organizational and relational structure, actors pertaining to participants and their interactions, time referring to occurrences along the project timeline, and planning relating to the preparation for action. These groupings are used to organize the discussion through placing individual factors where they best fit, although many can and do overlap into other topic areas.

5.2 Boundaries

The contractual spectrum can be examined in terms of boundaries that separate and define participants by considering their nature, noting what occurs inside and outside of them, and observing how interaction happens across them. This category contains three of Professor MacNeil's factors: "Overall Relation Type" and the combined discussion of "Basic Sources of Socioeconomic Support" and "Sources of Contractual Solidarity."

5.2.1 Overall Relation Type

5.2.1.1 MacNeil

MacNeil (1974a, 1980a, 1981) uses the work of sociologists Broom and Selznick (1979) to distinguish between discrete and relational transactions using three parameters reflective of

overall relation type which are: personal involvement, types of communication, and subject matter of satisfaction. Participants in a discrete transaction are involved only to the extent necessary for conducting the exchange making participation readily transferable to others if needed. Communication between participants is often restricted to public modes of interaction not intended to reveal deeper layers of personality, is limited to specific topics, and is conducted formally if of any length. Participants' satisfaction in the transaction derives from the economic exchange itself reflecting pure, monetized motivations.

Participants in a relational transaction engage the "whole person," responding to aspects of the other participant's background and character which allows feelings to enter the relationship making the transfer of participation to others difficult. Communication between participants is deep, extensive, and informal with few limits placed on the range and mode of communication. Participants engaging in relational transactions derive complex personal non-economic satisfaction; they are accepted as a person, not simply as a means to an objective.

5.2.1.2 Delphi Panel

There were no direct references to the "Overall Relation Type" among the Delphi Panel comments although one might infer shadow references to this concept in comments such as "pick the right team" and "it is important to have meetings at the jobsite when the location of the design team is separate from the construction team." Both comments make tangential references to personal involvement, types of communication, and derived satisfaction of the participants that are the defining parameters of the "Overall Relation Type."

The first shadow reference "pick the right team" is suggested by two panelists, one said "picking the right team is important for success" the other simply saying "pick the right team." One might infer from the phrasing of these comments a consideration of individual qualities and

synergistic interactions that are significant for design-build success. Using a ranking scale of 1 (lowest) to 5 (highest) the Delphi panelists all initially provide the highest possible rating of "5's" except for one rating of "4" which is increased to a "5" in the final round providing unanimous support of its importance.

The second shadow reference "it is important to have meetings at the jobsite when the location of the design team is separate from the construction team" addresses communication and is suggested in conjunction with the comment "it is important to specify who must attend the jobsite meetings." This joint jobsite meeting suggests a deeper involvement among the participants, enriched in-person communication, and the shared satisfaction associated with building a constructed facility. When initially presenting the joint jobsite meeting comment for rating, it received three "5's", two "4's", two "3's" and one "1." Two adjustments were made during the final rating with a "4" down to "3" and a "3" up to "3.5" placing it 37th out of the 50 factors. Professional role bias may be present in the ratings with all "5's" provided by public-sector engineers, the mid-range ratings provided by the architects, and the lowest rating provided by a private-sector engineer. Considering the insights possible from the "Overall Relation Type," perhaps the jobsite meetings will no longer be judged as simply a meeting but rather as an opportunity to strengthen the relational aspects of the transaction.

5.2.1.3 Literature

"Overall Relation Type" is supplemented with literature on the nature of organizational boundaries, how interaction takes place across them, and the characteristics of those spanning between them.

5.2.1.3.1 Organizational Boundaries

Crowley and Karim (1995) define a boundary as "a barrier to segregate one's territory and define the limits of a common culture and jurisdiction." These authors characterize boundaries as flexible or rigid and permeable or impermeable. Flexible boundaries are those able to be repositioned allowing an organization to decentralize, reorganize, or restructure its resources while rigid boundaries are fixed and closed. Permeable boundaries allow active communication and interaction across the boundary which facilitates the exchange of ideas and information, while impermeable boundaries block communication and interaction.

These organizational boundaries separate communities of different cultures, ways of knowing, and expertise that meet at boundary interfaces characterized as their "meeting grounds" (Brown 1983, Feldman et al. 2006).

5.2.1.3.2 Boundary Objects and Boundary Spanners

While boundaries define organizations, "boundary objects" set at their interface define the inter-organizational relationship, and "boundary spanners" operate through those objects and across that interface.

Boundary Objects

Boundary objects are shared "passage points" satisfying the information flow between intersecting social, professional, institutional, and organizational worlds. Each object maintains its singular, collective identity throughout its use while concurrently adapting to local needs by translating concepts, perspectives, and beliefs across boundaries; and consequently, allows autonomy for each community while they undertake their parallel internal activities. At times, these objects serve as enablers facilitating communication and sharing of knowledge, technical

information, and social standards and at other times as barriers inhibiting or filtering community interactions (Star and Griesemer 1989, Huvila 2011, Emad and Roth 2009).

Boundary objects take many shapes. Star and Griesemer (1989) identify such divergent items as maps, animal specimens, field notes, forms, and museums as reflecting a common functional classification of things they named boundary objects in their organizational study of the early, formative years of Berkeley's Museum of Vertebrate Zoology. Bresnen (2010) and Wenger (1998) add terms, concepts, documents, and artifacts as providing similar functions in organizing the interconnections of cooperating communities of practice. Suchman (2003) includes a contract as an artifact functioning at the boundary between parties articulating their joint agreement. Garrety and Bodham (2000) recognize expectations between distinct social worlds and structured patterns of interaction as functioning to shape actions and interpret events between parties. Briers and Chua (2001) identify institutionalized codes or recognized best practices as a means to facilitate collaboration between different communities of interest. Owners, designers, and builders use complete plans and specifications as a passage point of information flowing between their intersecting communities. These documents enable the translation of owner choices and design decisions into construction details while inhibiting and filtering the exchange of voluminous supporting engineering calculations, the dictates of applicable design codes, and numerous non-selected alternatives.

Boundary objects function to align, without dislocation, multiple communities of interest and practice; but these objects and supporting infrastructure are subject to interpretation and as a result, misinterpretations as it "sits in the middle" of a group of actors with divergent viewpoints undertaking a cooperative endeavor (Star 1989). This "interpretive flexibility" (Bijker et al. 1987) can lead to problems when participants do not share a common understanding that often

results in dislocations as graphically depicted by the fault and diagonal lines across the horizontal planes in Medlin's Interaction Possibility Space Model shown earlier in Figure 4.1.

Barrett and Oborn (2010) suggest the use of a boundary object by different actors create the dual potential for an upside of collaboration and a downside of conflict due to "interpretive flexibility." Wenger (1998) says when a boundary object serves multiple constituencies each has only partial control over the interpretation of the object. For instance, an author working within their jurisdiction controls what they write, but the reader within their domain controls what it comes to mean to them. As a result, a boundary object requires processes of coordination and translation between each partial jurisdiction to achieve a common understanding that is depicted graphically as an unbroken, straight, vertical line between participants as shown in Figure 4.1.

Boundary objects carry this duality in other ways as well, being both stable and dynamic (Huvila 2011); concrete and abstract (Star 1989); barriers and enablers (Bresnen 2010); and technical and social (Bechky 2003). Huvila (2011) states a boundary object may suggest relative stability in the case of concrete boundary objects, but also dynamism concerning social infrastructures in more abstract boundary objects.

These boundary objects are created, managed, and put into action by individuals known as "boundary spanners" (Emad and Roth 2009).

Boundary Spanners

Boundary spanners are actors possessing abilities, skills, and personal characteristics that empower constructive behavior in bridging interests, professions, and organizational boundaries (Noble and Jones 2006, Williams 2002 and 2010). Boundary spanners engage with others by breaking down barriers and building trust through active listening and communication. They effectively compromise by wisely balancing relative benefits for both themselves and others.

They thrive in fluid conditions easily coping with ambiguity and stress. Boundary spanners possess leadership skills that facilitate productive working groups within teams of diverse memberships and with others over whom they have no authority (Child et al. 2005). Boundary spanners are skilled in bargaining tactics, negotiations, unconventional approaches in problem-solving, and creative and lateral thinking (Williams 2002, Brown 1983). They think strategically and understand the big picture (Williams 2002).

Boundary spanners exhibit three defining personal characteristics. First, they're extroverts tending to be outgoing, personable, sociable, friendly, people-orientated, and cheerful. Second, spanners are morally sound exhibiting respect, openness, honesty, and underlying character. Third and finally, they're unwavering in their commitment, persistence, and hard work (Luke 1998, Williams 2002 and 2010).

These concepts are used below to generally illustrate both discrete and relational contracts and then to illustrate more specifically these concepts using familiar construction project delivery methods.

5.2.1.3.3 Discrete transaction

A discrete transaction reflects "coordination by market" as illustrated on the left side of Figure 4.1 and is described by MacNeil (1974a, 1980a) as having an overall relationship characterized by little personal involvement, limited formal communication, and strictly economic satisfaction. To better understand this, consider the organizational boundaries and their interface. Figure 5.1 from Crowley and Karim (1995) depicts companies X and Y with rigid, impermeable boundaries PO and QO functioning in a traditional business relationship with an arms-length distance maintained at the interface. These boundaries shield the interests of each company providing a protective function by buffering or closing off the organization. These

closed-off organizations often define technical and functional specializations within “functional silos” (Diamond et al. 2004).

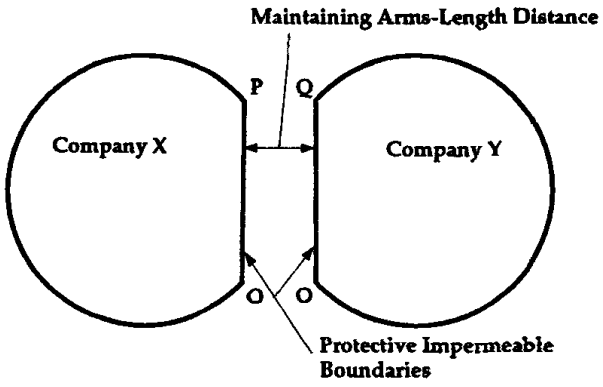

Fig. 5.1 Traditional Relationship with Impermeable Boundaries (Crowley and Karim 1995)

The arms-length distance between the boundaries results in little personal involvement or “boundary spanning” and thereby creates a need for formal communication through “boundary objects.” The principal boundary object in a discrete transaction is the contract that regulates inter-organizational activities, designates roles, and assigns responsibilities in the interaction (Gal et al. 2008). In construction, drawings are also boundary objects, the “social glue” between the designers and constructors (Henderson 1991). The role of these boundary objects for transferring knowledge from one individual or organization to another when there is little interaction and personal communication is captured in Bodker’s description of boundary objects as “intellectual tools that fulfill roles as containers and carriers” (Bodker 1998). The closed-off boundaries also lead to what Webster (1992) describes in market transactions as actors who are self-interested, profit-maximizing individuals driven by economic rewards.

5.2.1.3.4 Relational contract

A relational contract is in the middle of the spectrum as shown in Figure 4.1 with a large interaction space having an “overall relation type” characterized by whole person involvement,

informal communication, and social and economic satisfactions as described by MacNeil (MacNeil 1974a, 1980a). Figure 5.2 from Crowley and Karim (1995) shows the flexible, permeable boundaries of Companies X and Y merging to form the interface PR that facilitates inter-organizational exchange and open communication. The boundaries are thin with the parties having extensive "boundary spanning" interaction at the interface distinguishing this relational contract from a discrete one.

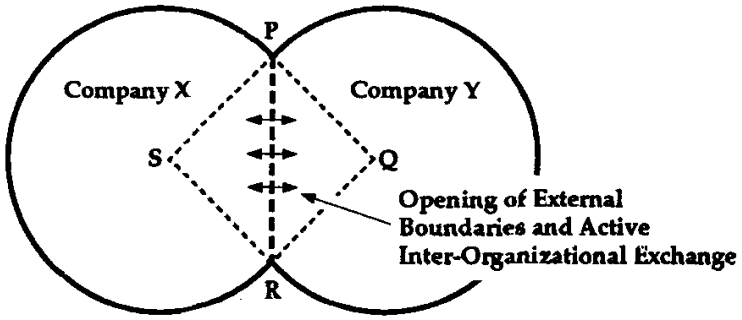

Fig. 5.2 Relationship with Permeable Boundaries (Crowley and Karim 1995)

Boundary objects in relational contracts fit the interactional perspective described by Barrett and Oborn (2010) in that boundary objects are brought to life through social interaction as actors negotiate collective meaning through and around them. Barrett and Oborn suggest boundary objects promote sharing of knowledge across different groups as the object and the interactions they mediate are in a state of becoming.

At this interface, organizations whose goals and assumptions may be diverse rely on each other for critical information or resources (Brown 1983). Their individual goals, which may include economic satisfaction, become secondary goals as they focus on common goals (Crowley and Karim 1995), which likely result in the social satisfactions described by MacNeil. Friend et al. (1974) also stated an individual within a relationship is "guided by other motives at the more personal level such as the desire to be liked or esteemed by his associates."

5.2.1.4 Classifying Overall Relation Type in Current Construction Practices and Trends

These concepts of "overall relation type" including boundaries, interfaces, boundary objects, and boundary spanners are illustrated using five well-known construction delivery methods: design-bid-build, partnering, design-build, construction manager-at-risk, and the firm.

Design-bid-build

Design-bid-build uses a discrete contract with functional specialization resulting in rigid, thick, and impermeable boundaries that impede interaction. Communication is limited and occurs through 100% complete construction documents, such as the contract and accompanying drawings and specifications, serving as boundary objects. As the boundary spanner between the owner and contractor, the designer creates the boundary object and remains involved to monitor adherence to it and modify it, if necessary.

Partnering

Partnering is a hybrid of the discrete and relational exchanges having a discrete contract as the primary boundary object supplemented by a partnering charter that acknowledges shared goals that embed a relational component into the transaction. The partnering charter and participants' commitment to engage as partners create a need for boundary spanners working together to solve problems as they occur during construction. The boundary spanners engage in extensive communication and, rather than strictly focusing on the discrete contract, have a give-and-take type approach to the relationship. This interaction is facilitated initially by a rigid and impermeable organizational boundary in the delivery of the functional specialization of design that is then thinned and made flexible and permeable during construction.

Williams (2010) describes the essence of partnering as an interpersonal relationship superimposed over a formal structure to expedite communication, resolve conflict, build trust, and speed decision-making.

Construction manager-at-risk

Construction manager-at-risk exists as a hybrid of discrete and relational exchanges using a discrete contract as the primary boundary object during construction but with a relational component during the design of the boundary object. Boundary spanning occurs during the design phase as the contractor-surrogate advises the designer by contributing construction knowledge.

Design-build

Design-build uses a relational contract between organizations defined by flexible, thin, and permeable boundaries that facilitate the extensive interaction necessary in utilizing an incomplete contract as a boundary object supplemented by other objects such as industry norms, good faith, and best practices. Selected members serve as boundary spanners to facilitate working together in completing the construction documents and transforming them into a finished facility.

Firm

The firm creates a more collaborative environment functioning around a common purpose with in-house participants interacting in a command-and-control environment where authority serves as a boundary object. This “community of practice” and the thin, highly permeable boundaries within the organization facilitate comfortable boundary-spanning activities allowing the participants to easily share knowledge and develop an expectation over time of how things will occur.

5.2.1.5 Conceptual Framework

Three elements can be used to break down MacNeil's factor of "Overall Relation Type" which are: boundaries, boundary objects, and boundary spanners. Boundaries separate, and divide making it challenging to interact outside of them. Boundary objects and spanners at the interface help overcome this difficulty with the nature of the interfaced boundaries influencing the form of the boundary object and the role of the boundary spanner.

When interfaced boundaries are thick and impermeable, the boundary object is usually written communicating a complete account of the transaction and replacing independent participant interactions at the interface with scripted roles detailed in the object. The primary boundary object is a contract addressing all conceivable aspects of the transaction, detailing the two sides of the exchange, the date of the exchange, if it occurs in the future, and such other things as decision rights, contract adjustment procedures, and the inclusion of any possible contingencies. Boundary spanners execute the contract as stipulated.

Boundary spanners become more critical as interfaced boundaries become thinner and more permeable. The contract, representing one of many boundary objects, is initially incomplete creating a heavy reliance on the interaction of boundary spanners to complete it. This interaction is guided in part by additional boundary objects such as industry norms, good faith, and past working relationships which are all aspects of the embeddedness of the boundary spanners in a broader social setting.

When interfaced boundaries become essentially non-existent due to their extremely thin and highly permeable nature, multiple functions vertically integrate into a collective organization that is less dependent on either boundary spanners or boundary objects. Boundary spanners help facilitate cooperation among the parties in some instances, but the administrative controls of the

vertical structure mostly sustain the organization leaving one to conceivably identify power as a boundary object within the established hierarchy creating a power structure for much of the interaction and communication that occurs. Those in positions of authority establish common, corporate goals and direct those in the organization to perform the work necessary to achieve these goals as tasks become apparent.

5.2.1.6 Case Study Illustrations

Three case study examples show how experiences may be viewed from a fresh perspective using the conceptual framework of the "overall relation type." The first two examples are from the I-15 project. In one instance the owner develops a boundary object solution and in the other instance boundary spanning accomplishes a similar objective. The third example highlights an owner's challenge from an atypical boundary when using the design-build delivery method.

A major concern of the I-15 owner was a quick project delivery, so the owner identified long-lead items having the potential to impact the pace of the design-build work. Bridges were one of those identified which the owner dealt with by developing complete plans for specific locations as if using an "overall relation type" akin to a discrete exchange. The plans were easily transferable to any of the design-build teams that might be eventually selected allowing construction to begin immediately on this long-duration portion of the project while preventing the potential for idle construction resources during the initial stages of the effort. The owner addressed his concern with time by using complete plans as a boundary object for the long-duration bridge construction.

The I-15 owner utilized boundary spanning in another instance using a two-level "over-the-shoulder" review process making design review more efficient. At the lower level, co-located

participants constantly interact during design development; and at the higher level, participants have scheduled interactions. The "over-the-shoulder" boundary spanning process allows questions and concerns to be addressed immediately, eliminating the time lag of the review/approval process typically experienced in design review. The structure of the process highlights the organizational boundaries and relationships. At the lower level, the boundaries are thin and highly permeable allowing boundary spanners to easily interact at the working level in designing an evolving boundary object and at the higher level, where the boundaries are thicker and less permeable, different boundary spanners protect organizational interests.

The I-77 owner provides a flexible scope allowing the design-build team freedom in completing. A portion of this flexibility was for a guardrail design that met the specifications but not the owner's expectations owing to its difficult long-term maintenance. On this project, the participants encountered difficulty resulting from the atypical boundaries and boundary objects of design-build. Design codes and the designer's typical fiduciary obligations were relied upon within the flexible scope to meet the owner's expectations. The minimum code requirement would govern the guardrail design solution as expected because of the owner's competitive solicitation of the project. Simultaneously, the designer is within the teamed organizational boundary of the contractor rather than a more typical location providing services as an agent to the owner with direct communication about design decisions. The designer, freed from service as an agent to the owner, selected a low first-cost guardrail design solution that increased the owner's annual maintenance costs because low first-cost was indirectly included in the owner's competitive selection criteria while annual cost was not. In this case, the designer's continuing fiduciary role obligation to the owner is limited to safety considerations for the traveling public.

5.2.1.7 Delphi Application

The Delphi panelists present lingering concerns about design-build, and while this conceptual frame benefits our understanding of numerous Delphi comments, the focus will be on two that initially appear to conflict, one advising to provide a "detailed scope" and the other "flexibility." These two comments span the contractual spectrum representing different choices available to owners with one referencing a boundary object that is a complete detailed design and the other providing flexibility through a limited or partial scope. A spectrum anchored by these endpoints offers a means to see the range of possible answers to another Delphi concern which when paraphrased equates to: "Where along the spectrum should the contract be positioned?" It is difficult to provide a single answer to this question or pick one panelist's position on the spectrum over the others because each situation is unique depending on such things as project attributes and the owner's preference. So, while there is no attempt at a specific solution, a framework is offered for considering options.

Boundaries, boundary objects, and boundary spanners create different overall relationship types. In addressing the Delphi concerns, the author discusses boundary objects presenting both detailed and flexible scopes to include how boundaries influence these objects and in turn influence the nature of the boundary spanning.

Detailed scope

A detailed, complete scope embedded into a boundary object formally communicates across organizational boundaries that are typically thick, rigid, and mostly impermeable. These boundaries not only close the organization off by minimizing communication and interaction outside the boundaries, but also define distinct organizational goals and concerns of those within them. This complete boundary object communicates all requirements in written form creating

little need for boundary spanning other than merely facilitating the transfer of information across the boundaries and ensuring compliance with the requirements.

This type of boundary object is prevalent for discrete contracts and those closely adjacent to the discrete end of the spectrum, but it is also useful for directing portions of relational contracts to be completed in a particular way if these portions have specific concerns or owner desired requirements.

Flexible scope

A flexible scope is an incomplete boundary object with thin, flexible, and permeable organizational boundaries that facilitate interaction with limited direction while requiring boundary spanning in its completion. Used with relational contracts, the lack of specificity in the boundary object creates a need for supplemental boundary objects like industry norms, intent, codes, and selection criteria guidance.

The choice to have an incomplete contract establishes a need for extensive interaction and communication across boundaries placing a heightened reliance on individual participants with unique skills and personalities that allow them to smoothly and comfortably work with others in a dynamic environment. As essential members of the "right team" these boundary spanners can be fully engaged in relationships requiring problem-solving, compromise, and cooperation in accomplishing their joint undertaking.

5.2.1.8 Summary

MacNeil describes an overall relation type in which interaction involves only a segment of the person, where communication is limited and formal, and the principal source of satisfaction is economic. This type of interaction is based and dependent on a boundary object and the team's ability to execute its prescribed instructions. This relation type occurs in discrete

contracts with rigid, impermeable boundaries, limited participant interaction, and at a detached arms-length distance.

Alternatively, MacNeil describes an overall relation type characterized by whole person involvement, extensive communication, and social satisfaction. This type of relation engages around a team's ability to span the boundaries effectively. The "right team" for relational transactions like design-build would be one that not only has the skills and resources to execute the design but also skills necessary for boundary spanning. This relation type occurs in relational contracts with flexible, permeable boundaries facilitating extensive interaction and social engagement.

5.2.2 Sources of Contractual Solidarity

5.2.2.1 MacNeil

In "The Many Futures of Contracts" MacNeil (1974a) identifies "Basic Sources of Socioeconomic Support" as a distinguishing characteristic of discrete and relational contracts but a later work, "The New Social Contract" (MacNeil 1980a), replaces it with "Sources of Contractual Solidarity" addressing the same concept but from a slightly different perspective. The earlier work (MacNeil 1974a) focuses more broadly on society, and its support mechanisms for exchange; the more recent work (MacNeil 1980a) focuses more specifically on solidarity and support for contracts.

For discrete contracts, contractual solidarity is a function of the "social matrix" reflecting society and other sources that are outside the transaction providing moral, legal, social, and economic support for exchanges. Examples of this support include a socioeconomic environment of social stability, enforcement of promises, and other basic requirements such as property rights and the law of contracts (MacNeil 1974a).

In addition to the social matrix and its external socioeconomic reinforcement, relational contracts generate contractual solidarity from a complex web of interdependence created by social relationships that exert aspects of governance in the exchange (MacNeil 1974a, 1980a). MacNeil (1974a) says this internal relational support is one of the most important distinctions between discrete transactions and relationships affecting every facet from casual day-to-day operations to major planning to social reinforcement and control.

5.2.2.2 Delphi Panel

The Delphi panelists do not speak directly to "Basic Sources of Socioeconomic Support" or "Sources of Contractual Solidarity," but their comments validate its importance nonetheless. For instance, "provide a detailed scope" and "language should be specific" are elements of scope definition often associated with the legal aspects of external socioeconomic support and "trust between the owner and design-builder" and "pick the right team" reflect internal relational solidarity. The first two comments were from public sector engineers with experience mostly from design-bid-build where specificity is essential for achieving external support for relationships. The latter two comments supporting more relational solidarity in design-build were ranked higher overall by the full Delphi panel than the earlier comments.

The Delphi panel initially rated "provide a detailed scope" with four "5's," one "4," two "3's" and one "1." In the final rating, both "3's" were raised and one "5" lowered to "4's" resulting in three "5's," four "4's," and one "1" tying this factor with two others as 28th among the 50 comments. The lowest rating is from a construction lawyer with extensive design-build experience whose ratings throughout the Delphi process indicate his preference for scope flexibility. The comment suggesting "language should be specific" was rated by all panelists with either "4's" or "5's" except for the construction lawyer who rated it "1" initially but

subsequently adjusted his rating to a "4" in the final round of the process. This comment tied with three others to rank 21st among all the critical factors.

When asked to rate the importance of "trust between the Owner's team and D/B team" the panel provided six "5's," one "4," and one "3." Three panelists who initially provided ratings of "5" did not respond in the final round, but all other panelists remained consistent with their ratings resulting in this factor placing among the top half of the critical factors at 18th out of 50. When "pick the right team" was presented to the panel for initial ratings all panelists gave the highest possible rating of "5" except for one rating of "4." In the final ratings, all panelists provided a rating of "5" resulting in a tie with four others as the most critical factors.

5.2.2.3 Literature

Solidarity is defined by Durkheim (1933) as the generalized capacity of societal agencies to bring behavior in line with the integrative needs of the system, to check or reverse disruptive tendencies toward deviant behavior, and to promote the conditions of harmonious cooperation.

MacNeil (1980a, 1986) credits solidarity as central to holding exchanges together. He identifies patterns of exchange and various contractual and social solidarity processes at work that have a common goal of establishing and maintaining trust. Exchange patterns vary based on the level of exclusive reliance and trust placed on external sources of contractual solidary. High reliance leads to discrete transactions scripted by contract terms, while low reliance relegates the contract to more of a planning effort between the parties. Exchange patterns vary as social solidarity ranges from low during bartered exchanges between strangers to medium in a partnership to high in a husband-wife relationship (MacNeil 1986).

Contractual solidarity aligns through contracts with support from socioeconomic sources external to the organizational boundary. Social solidarity aligns through relationships providing

internal support through harmony in the relationship coupled with the external backing provided by societal norms.

5.2.2.3.1 External Contractual Solidarity

Contractual solidarity is external support expressed as social, economic, moral, and legal support for economic transactions provided by a "social matrix" (MacNeil 1974a). Social support for transactions is offered through a structured society where labor specialization can be sustained through a system of exchange. Parsons (1949) suggests without specialization there is no utilitarian basis for the formation of society because the mutual advantages of exchange constitute the main motive for abandoning the state of nature and entering social relationships. Durkheim (1933) states,

> "But if the division of labor produces solidarity, it is not only because it makes each individual an exchangist (sic), as the economists say; it is because it creates among men an entire system of rights and duties which link them together in a durable way. Just as social similitudes give rise to a law and a morality which protect them, so the division of labor gives rise to rules which assure pacific and regular concourse of divided functions."

Social support is also offered by a shared language leading to promises expressed in contracts (MacNeil 1974a). Economic support is provided by a system in which money serves as the medium of exchange capable of satisfying material needs through transactions (MacNeil 1986, 1992). Economic support is also provided by basic economic institutions such as markets within which transactions are organized (Williamson 1985). Moral support is provided by things such as fear of jail for theft or fear of paying damages for breaching contracts, both of which are used as a moral force serving to modulate behavior (MacNeil 1980a). Durkheim (1964) describes it as follows:

> "Everything which is a source of solidarity is moral, everything which forces man to take account of other men is moral, everything which forces him to regulate his conduct through something other than the striving of his ego is moral…"

Legal support is provided by a system of order and a mechanism of enforcement. Within society Durkheim (1933) points to complex actions in pursuit of individual interests taking place within the framework of a body of rules formulated in law and enforceable in courts. Without the institution of law, Durkheim (1933) says men would be in a state of war, but with it individual interests are pursued in a manner mitigating this latent hostility, promoting mutual advantage, and peaceful cooperation rather than mutual hostility and destruction. At the exchange level, a contract is a formal document explicitly communicating the agreement and serving as the frame of reference orienting conduct by identifying both rights and finite, measurable obligations. Parties wishing to enter into contracts do so under societal rules and conditions existing before and independently of any specific contractual agreement. It is this structure of rules and conditions, with the accompanying mechanism of legal support and judicial enforcement, that give rise to contracts as a societal institution. Durkheim (1933) says, "In sum, a contract is not sufficient unto itself, but is possible only thanks to a regulation of the contract which is originally social."

5.2.2.3.2 Internal Social Solidarity

Social solidarity is the capacity to internally support exchange through a social relationship between participants and harmonious cooperation. MacNeil (1981, 1986) refers to social solidarity as "trust" along with a belief in being able to depend on another. The complex web of interdependence between participants gives each a present need for social solidarity (MacNeil 1986).

The role of the contract varies with organizational form. The rules shift from formal law toward informal practices in moving from discrete toward relational contracts. According to Mahoney et al. (1994), the contract continues to be an important means of planning an exchange

for the future, but in a much broader way. MacNeil (1980a) describes it as a “new social contract” with the objective of contracting to signify a commitment to cooperate. It is this social context of a relationship that is described by Mahoney et al. (1994) as an “institution” and “society’s basic socioeconomic tool” that allows an actor to trust another to abide by moral commitments.

Trust is built around customary standards, past dealings, and future expectations (Vincent-Jones 2000). Macaulay (1963) describes this in the context of business relationships stating businessmen seldomly rely on the legal system to define and enforce their relationships, but rather they create their own norms. Macaulay mentions even when contracts are used, disputes are rarely litigated, for to do so would destroy the relationship and likely one’s business reputation. MacNeil (1980a) agrees by indicating the role of formal law can be played down in relationships when dealing with trouble by asking and answering Macaulay’s rhetorical question, “What manufacturer goes to law in the event of trouble with another manufacturer? Stuart Macaulay is certainly correct when he says almost none.” MacNeil (1978, 1980a) follows this by saying the law is a backup system seldomly used but there to ensure parties do what they agree to do and only when conflict exceeds the resolution capacity of bargaining and other processes will other techniques of dispute resolution be used.

5.2.2.4 Classifying Sources in Current Construction Practices and Trends

Five project delivery methods illustrate sources of support beginning with design-bid-build then moving with shifts in the industry along the contractual spectrum ending with the firm.

Design-bid-build

With design-bid-build, the exchange is fully described in a formal contract supported through external sources. For example, economic support is provided by a system of money in which the owner seeks the lowest possible cost for the product desired. Legal support is provided by courts who resolve disputes by interpreting and enforcing the contract terms.

Partnering

Partnering began to be used by some owners attempting to foster more of a relationship while reducing the amount of litigation during construction. This method retains strong external support due to the fully detailed contract with added internal relational support to deal with issues less formally, and rarely resorting to outside assistance. With its recognized successes, owners began to desire a more substantial relational component along with a less formal contract, resulting in the move to the design-build delivery method.

Design-build

With design-build, the external support system remains but shifts to the background as internal social solidarity dominates. Working as a team, participants rely on industry norms and cooperation to sustain the relationship. Disputes are often worked out between the participants or handled through less formal legal means such as arbitration. This delivery method creates the relational atmosphere the owners were seeking, but also led to difficulties related to scoping and organizational structure driving some owners back toward more discrete methods.

Construction manager-at-risk

Construction manager-at-risk is like partnering in that it combines a contract with a relationship, but the critical difference is the relationship is established during design with the contractor advising the designer. Like with design-bid-build, a complete contract is developed,

so all sources of support in the external social matrix remain, but there is also internal support generated by a relationship between the key participants who work together combining their knowledge during design; and perhaps during construction, if the contractor is selected as the construction manager.

Firm

The firm is at the relational end of the spectrum generating strong internal support based on its in-house and hierarchical organizational structure. Despite its benefits, there are concerns about properly engaging external support when planning for uncertain future events in an exchange where the contract plays such a small role, often providing only a description of intent.

5.2.2.5 Conceptual Framework

Solidarity for exchanges can be described either as external contractual solidarity or internal social solidarity. Contractual solidarity comes from socioeconomic sources of support outside the exchange boundary, while social solidarity comes from relational sources within it.

The relative prominence of the two mechanisms for supporting the exchanges varies with location along the contractual spectrum. At the discrete end, the owner will meticulously craft the contract in clear and specific terms, and when this is done, courts will support the exchange by enforcing the specified obligations. As a result, the support for discrete exchanges is primarily external, with the legal backing provided by an outside party. Although the focus is often on the contract, there are other sources of external support, such as the economic support of the market in exchanging a particular product or service at a specified price.

At the relational end of the spectrum, the owner futurizes the contract to provide flexibility resulting in a lack of specified obligations making it more difficult for an outside party to provide support for the exchange; instead, support comes primarily from the relationship. In

fostering this relationship, owners can plan procedures, rights, and obligations for participant interaction during execution. For example, an owner could specify procedures for communication, rights to remain involved during the performance, or obligations for team meetings. Communication and interaction between the participants help build trust and a vital relational bond as the parties work together. Also, there are things like building codes, industrial norms, and the professional obligations of certain participants the parties can rely on to provide support.

5.2.2.6 Case Study Illustrations

The researcher illustrates the above concepts using project case studies. These studies show some projects succeeding after careful planning to provide the expected and necessary support; alternatively, other projects fail due to inadequate preparation for this support.

The I-15 owner planned parts of the contract in detail, relying on external support provided through specified plans while leaving other parts flexible, counting on internal support through planned relationship-building procedures. The owner chose to deliver complete documents on long-lead items to allow work to begin at project award, much like a discrete transaction. These included a full geotechnical investigation and complete bridge designs. Other parts were left flexible with the owner planning procedures to foster the relationship. “Over-the-shoulder” design reviews and partnering were two procedures initiated at multiple levels in the organizational structure. At lower levels, these procedures provide virtually constant interaction and communication; at higher levels, the interaction occurs during regularly scheduled meetings. Also, participants created a joint project office affectionately called the “Hub” to co-locate the design, construction, and owner’s teams.

The I-10 Blackwater Bridge project provides a contrasting illustration with the owner expecting an internally supportive relationship, but his planning reflected a discrete transaction relying on external support. For this, his first design-build project, the owner edited a traditional design-bid-build agreement expecting that design-build would naturally foster a relationship. During the project, the parties disagreed on who was responsible for necessary changes caused by encountered geotechnical problems and used the contractually established procedure of an external Dispute Review Board, which resolved the issue in favor of the design-build team. Using a third party to resolve this contentious issue destroyed the relationship and contributed to the participants' inability to generate internal relational support for dealing with encountered trouble in the future.

On the I-77 project, the owner provided the design-build team flexibility in designing the guardrail specifying only that it must meet specific codes that reflect an industrial norm providing internal support for a relationship by establishing an acceptable minimum standard. Despite the guardrail meeting this standard, it didn't meet the owner's expectations for ease-of-maintenance, likely thinking this issue would be within the role obligations of the designing engineer akin to when the engineer is an agent of the owner. In this design-build effort, the engineer's professional role obligation pertains to the traveling public's safety, not project lifecycle costs. Providing anything higher than an acceptable minimum in a competitive environment puts the design-build team at an uncompensated disadvantage. It seems the owner failed to plan to support his maintenance objective properly, instead implicitly relying on a combination of the stipulated safety code and a false expectation concerning the engineer's actual obligation.

5.2.2.7 Delphi Application

Solidarity of exchange is presented within a conceptual framework of various external and internal sources of support for contracts on a spectrum between discrete and relational. Case studies illustrate the manifestation of these sources in both project successes and failures within this context. The author uses this frame to develop knowledge and competence in addressing illustrative concerns reflected in relevant Delphi comments. One comment expressed by the Delphi panel is to "provide the design-build team flexibility," and another similar statement said in part, "owners should let go of the controls and provide the design-build team flexibility." For owners, the overarching concern with flexibility would seem to be the relinquishing of control. Flexibility means the owner provides an incomplete scope with another party given the right to complete it. This power transfer may seem particularly daunting for public agencies to provide desired flexibility while still honoring their public responsibilities.

Skill in providing the desired flexibility for design-build while safeguarding project objectives is the competence to properly engage sources of support for both contractual and relational solidarity. Owners should recognize that the same external legal support for discrete contracts such as courts or arbitrators remains available for relational contracting with an incomplete scope, but the process is different. Rather than applying the specified requirements of a complete contract, an outside source would have to fill the incomplete contract gaps using codes and industrial norms. Supporting this process of external gap-filling requires stated project objectives and minimum scope reflecting information that serves as the basis of the bargain, allowing the parties to reach a "shared understanding" of the agreement and the ability for an outside entity to infer one. While this external support is detrimental to a relationship, it must never-the-less be planned if external support is later found necessary.

Internal support for the relationship should be fostered as well. The parties should agree to cooperate throughout the effort. If desired, the owner could establish within the contract his right to remain involved during delivery through procedures such as "over-the-shoulder" reviews and authority to accept and reject ideas. The design-build team may also choose to have team-building activities, for instance, celebrating project milestones, participating in joint athletic events, creating a project newsletter, co-locating, or having team meetings as one Delphi panelist suggests. As an aspect of internal support, the owner's team should include individuals to protect his interests and those who are skilled "evaluators" able to deal with innovative designs during the proposal and delivery phases.

5.2.2.8 Summary

MacNeil presents two characteristics of contracts: "Basic Sources of Socioeconomic Support" and "Sources of Contractual Solidarity," reflecting two ways of looking at solidarity. Contractual solidarity manifests in discrete contracts with support from sources outside the organizational boundary described by MacNeil as an external social matrix. Social solidarity is pivotal in relational contracts with backing from relationships formed inside the organizational boundary reflecting an internal social matrix. These two sources of support co-exist. The contract and its supporting mechanism are the main focus in discrete transactions, and the relationship and its interdependence are the main focus in relational transactions.

5.3 ACTORS

This section focuses on the participants: who they are, how and when they participate, and their attributes. Three MacNeil factors are included in this category: "Power, Hierarchy, and Command" "Numbers," and "Attitudes."

5.3.1 Power, Hierarchy, and Command

5.3.1.1 MacNeil

"Power, Hierarchy, and Command" was not initially (MacNeil 1974a) identified as a factor but added when it became clear to MacNeil (1980a, 1980b) that power is an essential root of a contract. MacNeil (1980b, 1981) defines power as "the ability to impose one's will on others irrespective of their wishes" and identifies two kinds of power useful in analyzing discrete and relational contracts, unilateral and bilateral power.

Unilateral power can be exercised to subject another person to a consequence without their consent; for instance, members of society with property or other rights have unilateral power to impose sanctions if someone interferes with those rights (MacNeil 1980b, 1981). Contractual participants can acquire unilateral power in three fundamental ways (MacNeil 1980b): (1) by first exercising bilateral power giving rise to an obligation, for example, a promise to repay money being lent; (2) by external conveyance of such power, for example by giving an employee the power to recover damages for racially discriminatory practices; and (3) by creating conditions of dependence, for example, the position of a car owner with it in pieces halfway through a repair job.

Bilateral power arises when the possibility of exchange exists by which two parties can bargain their respective unilateral powers. For instance, a potential employee may consider giving up some of his liberty in exchange for a potential employer giving up some of his property rights in money (MacNeil 1980b, 1981). Bilateral power is exercised through exchange.

The interplay of unilateral and bilateral power is seen in contracts. At the discrete end of the contractual spectrum, the exercise of bilateral power in an exchange of existing items resulting in a simple reciprocal rearrangement of unilateral power through property rights

(MacNeil 1981). This changes when the exchange occurs in the future; when the agreement is made and bilateral power is mutually exercised, each party acquires new unilateral power. The seller can impose whatever sanctions society has available for enforcing the promise to buy goods. The buyer has similar power for implementing the commitment to sell (MacNeil 1980b).

In relationships, bilateral and unilateral power are regularly present, but power relations are constantly in flux, making it a much more complex phenomenon internal to the relationship. For instance, relationships create dependence coupled with a potential lack of specificity concerning power (MacNeil 1980b, 1981). However, some relationships create unilateral power through a hierarchical command structure (MacNeil 1981).

5.3.1.2 Delphi Panel

"Power" was not explicitly mentioned by the Delphi panelists but is reflected in their comments, most notably through the expressed concerns of an architectural engineer who posed two questions: "Who typically leads the scoping process? Owner? A/E? Design-Builder?" and "How critical are contracts being in place to the scoping process?" Elaborating on the second question, the panelist commented, "i.e., are people working on good faith or do they have a contract; if working on good faith, does that make them behave differently during the critical scoping phase?"

The Delphi panelist's concerns about power and organizational structure were reformatted as four separate critical issues for rating. And there was overwhelming agreement on the importance of the owner leading the scoping process, ranking it among the top ten critical issues. The panel ranked the two other parties leading the process as the two most minor critical issues, with the design-builder only slightly edging out the A/E. The importance of contracts being in place during scoping was also at the bottom of the overall list of critical issues. When

asked how vital it is that the owner lead the scoping process, five panelists rated it "5," two rated it "4," and one rated it "2," three panelists including the one who provided the lowest rating, did not submit ratings in the final round. Still, all others remained consistent with their values.

Two general conclusions are drawn from this data. First, the experts' ratings of these factors align with their profession. For example, of the five engineers on the panel, four were members of Departments of Transportation, and all of them gave the owner a rating of "5." The architectural engineer who initially posed the question rated the A/E as the most crucial party to lead the scoping process. Second and related to the first conclusion, the experts were perhaps providing ratings based on their consideration of the project phase in which their profession has the most prominent role and therefore should have the most influence on the scope. For example, an owner's ratings would most likely refer to the initial phase of scope development, the designer's rating to the project design, and the contractor's, whose independent perspective is lacking in the panel, to the project's construction phase.

Also, the panelist whose ratings differed most dramatically from the others was the architectural engineer who posed the question; he rated the A/E as the most important with a "4," followed by the design-builder with a "3," and the owner with a "2." Although the values are tightly grouped, his perspective is different from the others being the only one seeing the A/E as the most important and the owner as the least. There are two likely explanations for this ranking pattern. As the only A/E on the panel, his ratings could reflect the professional perspectives of A/Es or perhaps professional bias. Or, as an A/E, his role has changed most dramatically given the nature of design-build and the significant differences it has from the traditional design-bid-build system.

When in the initial round, the panel was asked to rate the importance of the contract being in place during scoping, there were two “5’s,” three “3’s,” one “2,” and one “1,” values which remained consistent in the final round. These ratings indicate the panelists have varied opinions on this issue and further analysis of the data reveals no noticeable response pattern. For example, an architect and two engineers from state DOTs provided the highest possible values of “5”. In comparison, two other engineers from state DOTs and the architectural engineer posing the question gave ratings of “3.” These values were accompanied by a value of “2” from the construction lawyer and a “1” from an engineer in the private sector.

5.3.1.3 Literature

An owner has unilateral power during planning to choose how power is structured in the contract and distributed for future project phases. For discrete contracts, the owner’s unilateral power is exercised by developing a complete contract that specifies the product to be exchanged and the rights and obligations of the parties involved. In this process, the parties’ bilateral power is expressed while bargaining, negotiating, and accepting the terms of the agreement before it is entered.

In contrast, a relational contract has a specificity that evolves during project execution, meaning power can be exerted at any time before or after contract agreement through specified rights, bilateral negotiations, and the exercise of unilateral power by the authority structure. Owners establish the organizational relationships by shaping the contract’s authority structure through setting a hierarchical structure, defining standard operating procedures, creating incentive systems, expressing a value system, and allocating rights (Stinchcombe and Heimer 1985).

An owner might express his "value system" through the selection criteria that influences who will be in charge during delivery due to certain participants being better able to deliver in certain areas (Kelly and Male 2001; Palaneeswaran et al. 2003a). For example, Palaneeswaran et al. (2003a) suggest that if "completion time" was the most critical selection criteria for an owner, a contractor would most likely oversee whatever design-build team is selected. If other criteria like "improved maintainability and lower operating costs" are most important, a designer will likely lead the team.

Additionally, participant rights can be assigned in the contract while others are reserved. Grossman and Hart (1986) speak of "specific rights" as those allocated by the owner in drafting the contract and "residual rights" as all others retained by the owner. Which and how much of the owner's rights are given up will impact how he chooses to define the exchange, what his project involvement will likely be, and who will be in charge during the later project phases.

5.3.1.4 Classifying Power, Hierarchy, and Command in Current Construction Practices and Trends

Five project delivery methods illustrate power by highlighting the types and shifts in its use during project phases.

Design-bid-build

The owner, assisted by a designer, develops the full scope of the project in a detailed contract during the pre-proposal period. This exercise of unilateral power allows the owner control of the end-product and planning of the involvement of other participants. During the proposal phase, the owner and contractor bilaterally agree on the contract terms reflecting a specified product to be provided for a stipulated price. Unless otherwise specified, the contractor has unilateral power during construction for means and methods. At the project conclusion, the

owner is delivered the specified product and then exercises unilateral power during utilization for operations and maintenance.

Partnering

Partnering is comparable to design-bid-build, except participants commit to a relational approach in solving construction problems bilaterally, thus extending the negotiation period typically only seen during the proposal phase.

Design-build

The owner exercises unilateral power during the pre-proposal phase making choices concerning flexibility that influence the power he and others have in the future, including defining the amount of scope and providing guidance for the relationship. In stipulating a more significant amount of scope in the proposal, the owner has more control over the project, while defining less gives the design-build team more control over unilateral design decisions. The owner specifying rights allows structuring of his and others' involvement during the subsequent project phases modifying what might have otherwise been unilateral power for the design-build team during delivery.

During the proposal phase, the parties exercise bilateral power in negotiating the agreement with the design-build team proposing design choices and the owner concurring in them or not. At the end of this phase, the owner and selected team enter a contract marking a transition point in the power dynamic.

During delivery, unless otherwise specified, the design-build team will have unilateral power for means and methods, and any design decisions left unspecified by the owner. These design decisions are often made or influenced by the party in power. A contractor chosen as prime using a subcontracted designer means he is in a position of command relative to decision-

making unless his power is modulated by contractual procedures or regulatory authority. The owner has residual rights, but his involvement and power during delivery are specified by contract. At completion, the owner will be delivered a product for use.

During utilization, the owner has unilateral power for operations and maintenance unless delegated as part of the contractual agreement to the design-build team, who would then continue their involvement and authority in operations and maintenance for the time specified. During this extended involvement, the impacts and influences might become evident of those with power for making earlier decisions.

Construction manager-at-risk

Construction manager-at-risk is like design-bid-build, except during the pre-proposal phase, the design is developed with a contractor surrogate who provides construction knowledge as an advisor to the designer with no authoritative power and no guarantee he will be selected for project construction.

Firm

The firm uses a hierarchical command-and-control power structure internal to the organization. Contract provisions can also introduce this vertical structure at other points along the contractual spectrum.

5.3.1.5 Conceptual Framework

MacNeil (1980a) identifies power, hierarchy, and command as three related concepts. Power is control over others that is expressed either unilaterally or bilaterally. Unilateral power gives its holder authority similar to that conferred within a hierarchical organizational structure where those in higher positions command those below them. The commander's goals become the subordinates' goals (MacNeil 1975).

Bilateral power is authority conferred through negotiations and agreement on promissory elements of an exchange transaction (MacNeil 1980b, 1981). Thus, bilateral power is a derivative of those possessing unilateral power consenting to a binding exchange of rights and obligations expressed in a contract (MacNeil 1981). Rights are inextricably linked to obligations in that a right for one individual creates an obligation for another. A legal right is created in a contractual agreement to enforce the obligation agreed to in the contract and gives necessary unilateral power to enforce that obligation. These rights may be mentioned explicitly in the contract as "specific rights" or not mentioned and considered "residual rights" (Grossman and Hart 1986). Those holding rights or obligations command others over the associated matters.

Unilateral power is exercised not only to direct work or command action but also to make choices. Choices during planning may pertain to product details and how power is traded, allocated, or held. During delivery, choices may pertain to achieving the result and dealing with promissory and non-promissory elements of the exchange. The perspective of those holding power will impact these choices.

5.3.1.6 Case Study Illustrations

Several project examples illustrate power, hierarchy, and command throughout different project phases. The owner's unilateral power in making choices and specifying rights during the planning phase is demonstrated first, followed by bilateral negotiation during the proposal phase, then unilateral power of the design-build team during the performance, next the power dynamic of the design-build team, and finally the hierarchical structure for dispute resolution.

During the planning phase of the I-15 project, the owner utilized unilateral power in making choices and specifying rights in the effort. Time was the driving force behind many of the owner's decisions to meet the project's quick delivery requirement. The owner chose to use

the design-build delivery method for the first time to reduce the delay associated with the typical sequencing in the project phase. He provided a complete design similar to a discrete contract for some time-consuming bridges so that work could begin immediately upon receiving the project. To save time, the owner undertook and delivered a full geotechnical report during the pre-proposal phase. He reserved the right to request best and final offers after submitting proposals but limited it to a single round unless warranted by extreme circumstances. The owner specified the right for his team to remain involved during the design process through an "over-the-shoulder" review procedure to reduce the typical length of time required for design reviews and approvals. To ensure the focus on time would not be detrimental to the quality of the end-product, the owner stipulated the right to choose whether to enact an extended warranty provision specified in the contract at a later point during construction.

During the proposal phase, the owner and proposing design-build teams exercised bilateral power as they negotiated the two sides of the bargain where they either agreed or not to the contract terms. On the I-77 project, the owner used his unilateral power to stipulate in the Request for Proposals (RFP) night-time median work to avoid conflicting with interstate traffic. The winning design-build team offered an innovative design for an earthen ramp from an existing crossing bridge for use by construction trucks entering and exiting the median, resulting in a shorter, less costly day-time construction effort. This idea formed the basis of the design-build team's proposal. It was presented as an offer to the owner at a time of bilateral negotiations ensuring if selected, the team had the right to implement the plan. The owner agreed, and this team was awarded the contract.

The design-build team has unilateral power during the performance phase unless otherwise specified in the contract. On the I-77 project, the owner stipulated the guardrail design

would need to meet a specified code, although the specifics were left to the design-build team. The team chose to install a double-line of guardrails in the median, which met the required scope at a low initial cost but not the owner's implicit expectations of ease of maintenance. This situation highlights how the contractor's short-term perspective as a team leader selects different design choices than preferred by the owner's long-term life cycle perspective.

The power dynamic within the design-build team is illustrated in another guardrail component. On the I-4 project, the team-leading contractor wanted to reuse the existing guardrail for a new installation. The designer serving as a subcontractor disagreed with its reuse, likely due to concerns over safety, thus allowing his exercise of unilateral command based on his unique professional role obligations for public safety on constructed facilities.

The I-4 project had conflict resolution procedures within the design-build team that reinforced and supported hierarchy. Resolution is attempted at the lowest possible level. Still, it then escalates issues when necessary to progressively higher levels on the design side for design or on the construction side for construction.

5.3.1.7 Delphi Application

A Delphi panelist poses a question/concern about who should be in charge—owner, architect/engineer, or design-builder—implying that unilateral power should be assigned to a single party and asking which of the three might be best qualified in wielding that power. This question is selected to illustrate the clarity that might be gained on this issue by applying the conceptual frame developed for Power, Hierarchy, and Command. This frame recognizes both unilateral and bilateral power. Unilateral power provides authority to one holding a superior position through organizational structure or expertise to direct work or command action. It is also used to make choices during planning about product details and how power is traded, allocated,

or held. During delivery, it is used to make choices in achieving the result and dealing with various exchange elements. These choices, an expression of unilateral power, are impacted by the perspective of those holding power. Bilateral power is authority conferred in an exchange transaction by those holding unilateral power consenting to a binding exchange of rights and obligations expressed in the contract. Those having these rights or obligations command others over the associated matters. Applying the frame allows one to organize the "who should be in charge" question/concern into elements of unilateral and bilateral power, contractual rights and obligations, and choices.

The owner initially has unilateral power on any project regardless of the selected delivery method. He can use this power to make major project decisions and structure power for the future to his liking before seeking the participation of various exchange partners for their contributions and expertise. His choice of a delivery method reflects how he wants to engage participants and how power, authority, and command are expressed in the effort. Discrete and relational contracts are two generic delivery methods illustrating this concept.

A discrete contract delivers a project in sequential phases, with various participants exercising unilateral and bilateral power as a deliberate feature of the delivery method. During the initial project stages, the owner exercises unilateral power in consultation with the designer in making choices for the resulting product and terms of the contract. The designer collaborates with the owner during this time in providing services and making choices reserved to him by his expertise. The result of this early phase is a product defined by plans, specifications, and contract in anticipation of a market transaction. Power then shifts during the proposal phase to bilateral power exercised by both owner and contractor as the parties negotiate an acceptable exchange that creates rights and obligations acceptable to both. Unless otherwise established, the

contractor exercises unilateral power regarding his expertise in construction means and methods during the ensuing delivery. During this execution, neither the owner nor engineer can direct the contractor to do anything outside of the agreement unless an equitable change modifies the contract. After the product is completed, the owner once again has unilateral power for the facility's life except for expressed obligations arising from the contract or warranty.

A relational contract delivers a project in overlapping, collaborative phases. During early preliminary planning, the owner exercises unilateral power to decide how much scope to specify initially, structure the proposal process, and scope futurized portions of the project. These early choices influence his power for the remainder of the project and the extent of power held by the design-build team. The owner would retain more power by completing more design initially and diminish his power by leaving the design incomplete to be finished by the design-builder's choices. During this period, the owner might divide the project into sections specifying varying degrees of design completion, thereby exerting his unilateral power in areas of particular concern while providing flexibility with others.

The owner exercises his unilateral power in structuring the proposal process by choosing selection criteria and the amount of design specified to be completed in the proposal submission. The selection criterion expresses his value system, which is likely to influence who will oversee the design-build team. A designer will likely lead the design-build team when the criterion is heavily product-focused, and a contractor leads when the criterion is heavily project-focused. The amount of design required during the proposal period influences design-build dynamics. With the focus on design as the owner and design-build team negotiate the bargain during this relatively fluid period of bilateral power, the designer will likely influence choices more than the contractor. This emphasis on bargaining for design during the proposal phase is one way the

owner might address potential concerns about the designer's diminishing influence during delivery when the contractor is in charge.

The owner's scoping of the futurized portions of the design influences the nature of the design-build team's power. Specified procedures within the contract terms establish certain specific rights for the owner's continued involvement during design, resulting in bilateral power as design occurs while specifying outcomes instead provides the design-build team unilateral power in making choices on how that outcome is reached.

The relative importance of the project choices and which participant is best able to make these choices will influence the power dynamic. For simplistic and straightforward projects, the contractor will likely lead because the focus is on the flow of the project and the intensity by which the work is accomplished. For complex projects requiring extensive design or innovative solutions, an engineer will likely lead due to their role and proficiency in making these types of choices for transportation projects. Regardless of the team structure, there are areas of power and related tasks associated with specific participants. A designer whose control over the design is tied to obligations to protect the public gives him unilateral power for safety-related design aspects. Even if occupying the design-build command position, the contractor cannot direct the designer on matters of safety-related designs.

If operation and maintenance are included in the contract, the design-build team will have unilateral power over these project functions for the agreed period. If the agreement does not include these functions for the design-build team, the owner's unilateral power during utilization begins with the transfer of the completed facility for its use subject to any contractual warranty provisions.

Who might best employ power depends on various factors such as project type, project phase, and the presenting tasks. Consequently, the exercise of power ultimately fluctuates between unilateral and bilateral throughout most projects. For a discrete project accomplished in sequential steps, unilateral power shifts between participants as their phase or task is being undertaken. For a relationship performed in overlapping phases, bilateral power is more pronounced as joint decisions are more often encountered. However, unilateral power also has its place at certain times during the project.

5.3.1.8 Summary

"Power, hierarchy, and command" are complex elements of exchange that vary based on circumstances. Power can be bilateral or unilateral based on rights held or given and fluctuate throughout a project's phases. Hierarchy and command give individuals in certain positions unilateral power over others.

5.3.2 Numbers

5.3.2.1 MacNeil

Initially identified as "Number of Participants" (MacNeil 1974a), but later abbreviated to "Numbers" (MacNeil 1980a), MacNeil states discrete transactions involve only two parties. In contrast, relationships involve many, a difference highlighted in the bargaining stage. A discrete transaction involves a simple two-party transaction defined by an offer and acceptance; a relational transaction involves numerous participants whose interests must be aligned in the agreement creating primary relationships (MacNeil 1974a, 1980a).

MacNeil (1981) illustrates his view on "numbers" in exchanges ranging from a discrete transaction to that of a firm where the number of participants doesn't change, but what does is how he classifies, groups, or separates, and links them. Three types of exchanges illustrate these

views: a discrete transaction, a relationship, and the firm. A discrete transaction involves "two parties," implying each party consists of many participants that reveal as one follows the flow of money in the resulting exchange (MacNeil 1974a). If one were to follow the flow of money in a two-party "money for goods" exchange, the flow would lead back through a large number of discretely separated participants who contributed in some way to either the cash or the exchanged product. Based on this flow, these large numbers of participants are easily classified as members of one of two entities active in the exchange. These parties link for an immediate transfer in a spot market, but in a discrete exchange occurring in the future, the two parties link by contract using a detailed, written document as a means of communicating future requirements, obligations, and expectations.

As MacNeil (1981) moves to more relational scenarios, he begins dealing with participants in more detail, classifying them as individuals or groups based on their high level of interactions and resulting complex relationships. These are not new participants in the sense that they weren't contributors in the discrete contract, but instead, they are separated from their original collectives and classified into smaller groups. Participants form relationships and directly interact with one another during the bargaining stage and throughout the project, thereby becoming harder to identify characteristics that clearly distinguish the participants as belonging to separate entities. A contract continues to link the participants but is more relational in form.

Participants merge into a single entity in the final illustrations, the firm. A single organization now contains all participants and performs all functions. If one were to follow the money through this entity, it would flow to all the employees of the organization, highlighting a large number of participants within it. The participants are grouped and referred to singularly because they are employed by the firm with constant communication and interaction and no need

for individual contracts as links. A hierarchical structure with known organizational goals and expectations replaces contracts between participants.

5.3.2.2 Delphi Panel

The concept of "Numbers" runs throughout the following four categories of critical factors: The Right Team, Stakeholders, Reliance on Someone, and Power. While there are many relevant comments, only a selected few are used here to provide a sense of the Delphi panel's thinking.

In "The Right Team" category, a panelist identifies it is critical for the owner to "pick the right team" but doesn't specify any guiding characteristics. Recognizing many project participants, the "right team" implies a collective assessment consisting of participants interacting well with others and "stakeholders" whose voices are essential for the project. Initially, panelists scored "pick the right team" with all "5's" except one who rated it "4" but increased in a subsequent round to a "5," resulting in a united most critical rating, tied with four others.

The "Stakeholders" category includes comments drawn from the panelists' experience suggesting participants should be involved in defining and refining the scope. These comments include the following: "users should review and have a full understanding of the project based on initial program requirements," which ranks among the top ten of all critical factors, and the owner should "obtain customer input," which ranks in the top half indicating the importance of end-user input in defining the scope. The panelist providing the first comment experienced a project failing to meet the user's needs due to the lack of a clear project understanding based on its initial program. The initial rating of this comment had three panelists providing "4's," which two subsequently raised their ratings to "5," resulting in one "4" and all other ratings of "5."

Several other lower-ranking comments are placed in this category as well, including: “if there is an oversight agency, they should be involved throughout the scoping process;” “contractor’s input before the proposals are submitted is important to finding holes in the scope;” and “peer reviews can be used to ensure the scope is not excessive.” These three comments all scored near the bottom of the overall list, and panelists view these as less important.

The “Reliance on Someone” category includes two comments associated with numbers of participants: “technical competence of the designers and builders” and “trust between the owner and design-builder.” Dealing with an incomplete scope through the direct interaction of a more significant number of participants requires competence and trust. Initially, all panelists rated “technical competence” with “5’s” except an architect that rated it “3” and subsequently didn’t participate in the final round. The others remained consistent with their “5’s,” resulting in tying with four others as the most critical issue. “Trust” ranked in the top half of the factors, although viewed by the panelists as less critical.

Finally, in what seems a reflection of the many people involved in relationships and the corresponding change in organizational structure and interaction, the panel indicates specific concerns categorized under “Power.” Perhaps unsure of the power structure, one panelist asks, “who should lead the scoping process? Owner? A/E? Design-builder?” and another says, “if there is a sub-consultant designer, the sub-consultant should report only to the prime design consultant and not the design-build contractor.” When asked about these issues, the panel felt most strongly that the owner lead the scoping process placing it among the top ten factors with lesser emphasis on either the A/E or design-builder leading, placing them among the five least critical. This skewing toward the owner could be due to him originating the project and thus

identifying his desires as key to project success. At the same time, another possibility is a natural bias as more panelists come from owner organizations than from other entities.

When asked to rate the importance of the sub-consultant designer reporting only to the prime designer, the panel's initial ratings ranged from "1" to "4" with a slight upward adjustment during the final round, placing it among the least important concerns and the ratings had no noticeable underlying pattern among the panelists.

5.3.2.3 Literature

MacNeil's view of how he identifies, partitions, and links the "number of participants" within different contractual arrangements is informed using "network" literature. Podolny and Page (1998) describe every organizational form as a network that varies only by how participants are arranged and connected. A network is a collection of points paired by lines in its simplest form. Alternatively, Newman (2003, 2010) characterizes the fundamental network unit as a "vertex" also known as a "node" in computer science or an "actor" in sociology with connections between them called "edges" or "links" in computer science and a "tie" in sociology. These terms are used interchangeably throughout this discussion.

One can view these network nodes at different levels of abstraction from those reflecting individual participants through to associated groups by using "hierarchical clustering." This technique allows viewing a hierarchical network from a top-down perspective where a single node may abstractly reflect a group of nodes as an expression of "aggregated topology" (Lee 1995) that can partition into finer subsets until at the lowest level individuals are represented separately (Everitt 1974, 1993).

When one views hierarchical clustering from the bottom-up, there are successive fusions of individuals into clusters and then each cluster into larger and then larger groups, with the

process culminating with a single group that contains all individuals (Everitt 1974). These clusters of individuals are referred to as "communities" (Newman 2003), "islands" (Jackson 2008), "cliques" (Rogers and Agarwala-Rogers 1976), and "coalitions" (Tichy et al. 1979). Cluster members belong to a class having common characteristic features described by a class label (Heimer 1992, Everitt 1993).

Schaffer et al. (1993) describe these hierarchical clusters as nodes in either a zoomed or unzoomed state. Zoomed nodes can be opened like windows to display their immediate sub-network in the next level down. Unzoomed nodes are closed and reflect abstractions in which embedded details are hidden. These two extremes in hierarchical clustering can present problems; when zoomed out, there may not be enough detail, but the context may be lost when zoomed in to view detail. However, Shaffer et al. suggest different levels can be overlaid, viewing various levels of detail at once allowing the identification of boundaries and sub-boundaries in the expressed aggregated topology (Rogers and Agarwala-Rogers 1976).

These boundaries and sub-boundaries are critical defining elements used to separate and associate members. As discussed earlier, Crowley and Karim (1995) define boundaries as "a physical, arbitrary, or imaginary line of demarcation acting as a barrier to segregate one's territory and define the limits of a common culture or jurisdiction." Boundaries separate or partition by distinguishing between what is and isn't within the boundary and associate or group by attributing commonality to what is within the boundary.

The characteristics of boundaries are also important, directly impacting how groups relate to others outside their cluster. Brown (1983) says the nature of the boundary reflects the capacity to constrain or guide events within it. Brown suggests when a boundary is "closed," the regulation of internal activity is tight, and there is control of boundary transactions which limits

the discretion and flexibility of the parties' boundary representatives. When boundaries are "open," regulation is relatively loose with open exchanges of inputs and outputs. Boundaries can also describe how permeable they are to information, people, or materials (Brown 1983). "Permeable" boundaries allow active communication and interaction across the boundary facilitating the exchange of ideas and information, while "impermeable" boundaries hinder that exchange. Boundaries can also be "flexible" or "rigid," flexible boundaries can be easily repositioned to allow an organization to decentralize, reorganize or restructure its resources in keeping with specific objectives, while rigid boundaries can't (Crowley and Karim 1995).

Boundaries define groups based on shared tasks or common features, but the interfaces are essential for group survival (Brown 1983). These connections at the interface are the "links" or "ties" in the network existing at any location in the hierarchy, between groups at the highest level, between subgroups at any of the intermediate levels, or between individuals at the lowest level. The substance and type of network ties have critical implications for action and vary on many dimensions: ties can differ on their basis, either advice or task; their intensity, either weak or strong, occasional or frequent; their content, what flows through them is either information or resources; and their unit of reference, either defined by boundaries around a primary unit or a department of one (Nohria and Eccles 1992). Newman (2003) also refers to their flow direction, either directed in one or both directions.

The network link can depict a contract which is particularly crucial to this research. Some consider a contract as a formal document providing the primary means of communication, while others view it as a basic agreement reflecting underlying obligations. MacNeil (1974a, 1980a, 2001) regards a discrete contract as a binding, formal legal document enforced by courts with the content determined by referencing the formal contract terms and applying standard legal rules.

Macaulay (1963) views the contract as signifying a relationship but having little influence on the relationship itself. There is typically no intention of actually enforcing its written terms, which aligns with MacNeil's (1974a, 1980a, 2001) relational contract. Brown and Dauer (1978) see the contract as a communication device that's purpose is to serve the planning process. Williamson (1985) regards the contract as having little importance for a firm because communications between the parties are in-house, part of the same organization.

Newman (2010) says the pattern of connections and interactions between components structuring the network is crucial to the system's behavior. In a pure spot market, actors represented by nodes lack enduring ties to other actors but instead have episodic interactions that terminate after the exchange (Podolny and Page 1998). At the other end of the contractual spectrum is the firm, characterized by a rigid vertical hierarchy with subdivided tasks and roles and administration separated from production (Baker 1992). Although a firm may be a stable network, it may not be efficient if resources must be allocated to nodes not responsible for production (Jackson and Wolinsky 1996).

Williamson (1975) says alternatives to pure market and hierarchies are intermediate or hybrid organizational forms that combine elements of both, including a wide array of network organizational forms such as joint ventures, strategic alliances, and relational contracts (Podolny and Page 1998). Ashkenas et al. (1995) note a paradigm shift toward network organizations that replace boundaries that served as fixed barriers or unyielding separators with an organic perspective of boundaries as permeable, flexible, and moveable. Overall, this shift flattens vertical boundaries that differentiate status, authority, and power along with a loosening of horizontal boundaries that separate functions or groups.

Organizations become sets of resources or competencies mobilized in different ways to meet customer needs (Ashkenas et al. 1995). These network relationships exist in various states of relative activity or inertia (Salbu 1995). At times, particular collaborators are actively engaged in transactions. In contrast, at other times, the relationship remains viable but dormant; thus, activity between firms may cease, but inert affiliation remains with the aim of reactivation in the future (Salbu 1995). A "hub firm" can be characterized as a network node connected to each collaborator and playing a determinant role in defining the connectivity and managing the relationships between the collaborators. However, collaborators can also have relationships with other network members (Salbu 1995). The full network gradually forms over time through the accumulation of ties. Still, the activation of any individual collaborator will depend on the requirements of a particular task, according to Ibarra (1992). This type of network is "fluid" and "dynamic," designed to handle tasks and environments that demand flexibility and adaptability able to construct a unique set of internal and external linkages for each project (Nohria and Eccles 1992, Baker 1992). This flexibility and dynamism provide the opportunity to define the project first and then build a coalition of collaborators to implement it. Unlike a bureaucracy, which is fixed to address all problems, Baker (1992) suggests a network organization molds itself to each situation; adapting not by top-management fiat but by responding to the interaction of issues, people, and resources through relationships formed by network members. Baker (1992) suggests this self-adaptability feature led Eccles and Crane (1988) to call the network form a self-designing organization.

Mandell (2001) says activating the right players with the right skills, knowledge, and resources is a critical task. Also, bringing in stakeholders necessary to approach an issue is vital to network information (Agranoff 2012). These stakeholders can take various positions in the

network. Cross and Parker (2004) identify four stakeholders who can be identified and labeled based on their positions. First are central connectors; they have many direct relationships with collaborators. Second are boundary spanners; they connect with other groups in the organization or with other organizations. Third are information brokers; they communicate across subgroups providing valuable information. And fourth are peripheral people; they operate on the fringes and do so either because they need space or help to get better connected. Game Theory is addressed briefly in Appendix C as potentially helpful in determining how to optimize participants in the network.

Power and resilience are two final aspects of networks. Although networks typically do not have a formal hierarchical structure, some are more vertical than others which allows the authority, power, and position of a "dominant coalition" to influence the direction of the network (Mandell 2001, Nohria and Eccles 1992). Finally, is the resilience of the network to the removal of vertices. Newman (2003) states most networks rely on their connectivity for functioning. If vertices are removed, the typical length of the connective paths will increase, resulting in the tendency for a vertex pair to become disconnected; communication between the pair becomes difficult. Networks vary in their level of resilience to the influence of vertex removal.

5.3.2.4 Classifying Numbers in Current Construction Practices and Trends

The "numbers" of participants is illustrated using network concepts for five project delivery methods: design-bid-build, partnering, design-build, construction manager-at-risk, and the firm.

Design-bid-build

Design-bid-build is a discrete transaction often thought of at the highest level of abstraction as an owner and contractor entering a contract to deliver a specific product. The

contract links the two parties, represented as nodes within network organizations, where each node abstracts a collection of participants contributing to the project. Thick, impermeable boundaries surround each collective, with interaction typically occurring only at the highest levels through the contract and other supporting written documentation. A link for communication is added during construction between the contractor and designer as an owner agent, although any interaction remains minimal and governed by the contract.

Partnering

Like design-bid-build, partnering is typically viewed at a high-level abstraction as being between an owner and contractor connected by a discrete contract. The difference between partnering and design-bid-build is that during construction, the boundaries are more permeable and connections between the owner, designer, and contractor reflect greater communication and a more cooperative relationship in which problems are solved collaboratively and less adversarial than in design-bid-build.

Design-build

Like the previous delivery methods, design-build can be viewed at a high level as only two parties involved in the contract, the owner and design-build team leader, often the contractor. Connected in this case by a relational contract, it is common also to observe lower network levels where additional members of the teams can be seen. Boundaries are thin and permeable, with multiple connections and regular interactions facilitating relationships at all levels of the organization.

Construction manager-at-risk

Construction manager-at-risk is like design-bid-build with the two major parties, the owner and contractor, connected by a discrete contract. The difference occurs during the design

phase, where two-way advisory communication exists between the designer and a contractor surrogate, although the designer's authority over design decisions remains. During design, the contractor in the network may or may not be the contractor linked to the owner by contract for delivery.

Firm

In the firm, the designer and contractor reside within the boundary of an established organization and perhaps within group boundaries, and the walls are highly permeable. Numerous connections exist between the parties reflecting both communication and interaction at the lower levels and the hierarchical structure existing among participants of all levels.

5.3.2.5 Conceptual Framework

The framework for "Numbers" uses network concepts of nodes, links, and boundaries to depict the participants, how they are connected, and grouped. Nodes represent individual participants or clustered groups. Some groups are active in delivery; others are stakeholders with voices to be heard as their vested interests are essential to project success; others have specific roles such as the hub firm responsible for managing the networked relationships of most other nodes. These nodes can be depicted in a zoomed state showing features of subnetworks or an unzoomed state of abstracted nodes hiding embedded details.

Links connecting nodes have a variety of attributes. These ties can be weak, occurring over a short duration for a specified transfer with no expectation of reoccurring, or they can be strong, reflecting a long-term relationship that remains intact even if not currently active. Connections can be one-way exchanging information, skills, or resources in only one direction or two-way with exchanges occurring in both directions. Links can be short, representing a single connection between two adjacent nodes, or long, representing a series of connections extending

through multiple nodes. Links can reflect different connections depicting tasks, communication, and contracted exchanges. Links can be either active for the current transaction or inactive, signifying a viable, lasting relationship although currently dormant.

Boundaries collect nodes while exhibiting attributes that influence the grouping. These boundaries can be thick, creating a closed network of participants isolated from the outside, with little activity occurring across the boundary. What activity does is likely managed and formal. Or, boundaries can be thin, creating an opportunity for less structured interaction. Boundaries can be either permeable to facilitate communication allowing informal, regular face-to-face interaction occurring at all levels of the organization, or impermeable to impede communication resulting in a formal, often written communication happening only at the highest levels of the organization. Boundaries can be rigid, mostly fixed, more difficult to reposition or flexible, malleable, and more able to accommodate changing conditions.

These nodes, links, and boundaries combine to depict network participants; how they're connected and grouped. Varying the characteristics of each component leads to different organizational structures. These concepts are utilized in describing three locations along the contractual spectrum—the discrete end, relational middle, and relational end—along with a fourth called the activated network that falls between the relational middle and relational end.

In a discrete transaction, participants are represented by nodes with thick, impermeable boundaries connected by a link reflecting either an instantaneous exchange of a good/service or a contract projecting the exchange into the future. One often views these networks in an unzoomed state where the many involved participants are abstracted to the two parties directly involved in the exchange. The connection between the parties is a short-lived relationship with bilateral communications that are often specific and formal.

In a relational transaction, the actors are represented by nodes within thin, permeable boundaries connected by links representing an enduring relationship and informal communication. They are often viewed in a zoomed state detailing the network groups, subgroups, and individuals interacting within a cooperative, collaborative environment shown by multiple connections between nodes. Although some connections at lower levels of the organizations may be project-based, the higher-level connections tend to be long-term.

In the firm, actors are represented by nodes grouped within boundaries that are extremely thin and highly permeable. Connections representing the organizational structure power dynamic are one-way directed links from the top down but tend to be two-way when reflecting communication. The overall organizational boundary of the firm is thick, mostly impermeable, and rigid, which characterizes the organization as an established, static set of resources that may contain inactive participant nodes at times.

The activated network is a new organizational form occupying a position on the contractual spectrum to the left of the firm. Nodes represent the participants, but instead of being contained within an overall rigid organizational boundary like the firm, participants exist within a flexible boundary that is easily repositioned to meet the needs of each project. Within the project boundary, participants are organized by a hub firm activating the links as needed. The links represent long-lasting relationships and provide the opportunity to tailor the organization to specific project needs.

5.3.2.6 Case Study Illustrations

Three projects highlight the framework, two show owners extending their networks in response to unique project situations, and one shows the importance of the relationship connections.

Design-build was a new delivery method for the Utah Department of Transportation. To obtain the support of local engineers in utilizing the method, the DOT hired approximately ten local design firms to assist with the preliminary design of the I-15 project. This owner extended his network to develop and strengthen relationships with a core constituency. Each design organization is represented by a node and grouped within a boundary labeling them all as designers. The nodes are linked by contract to the owner coordinating their activities, signifying communication and outreach to establish and strengthen long-term ties with these participants, providing an early glimpse of a hub firm.

Located in an environmentally sensitive area, the St. George Island Bridge project could have a potentially devastating impact on the oyster beds in the area. In addressing this, the owner involved local oystermen in providing input and assistance with the oyster relocation effort. The owner is seen extending his network to include representatives from this important stakeholder group. This select group of oystermen represents their larger group on the project serving as boundary spanners and information brokers. The network link between the nodes for the owner and oystermen represents a two-way flow of communication in addition to the directed relocation task. The design-build team also established a connection with the oystermen group.

There are many other examples of extending the network, such as the I-15 owner's outreach to top managers for scope feedback and creating a large team of evaluators for the selection process. Another example is that of the Knightdale Connector design-build team hiring an expert to help with the permitting responsibilities. Although these examples are not explored here, they are highlighted in addressing other topics within this chapter and in Appendix B.

The final example is the I-77 project on which the contractor went bankrupt during construction. The organization buying the bankrupt firm replaces only the top management level

leaving intact the onsite working relationships among the participants resulting in little impact on the project. The numerous connections between the participants benefitted a project facing a significant challenge and exemplified the network resilience of hierarchical clustering in a network context. At the highest level of abstraction, two nodes represent the owner and contractor. When the trouble occurred, the contractor node was replaced with another organization. Zooming into the contractor node and looking at the lower level allows management changes to be observed by removing and replacing nodes. Zooming in further, the lower-level participants with links and relationships established before the bankruptcy remain the same; and as a result, the change did not negatively impact the project.

5.3.2.7 Delphi Application

A Delphi panelist who is a DOT engineer stated that "a subconsultant designer should report to only the prime designer not to the design-build contractor." That DOT was having problems with subconsultant designers reporting directly to the design-build contractor who was shopping for the most favorable answers. The panelist said the DOT would require the sub-consultants in the future to report only to the prime design consultant.

This situation is selected to illustrate the clarity gained on this issue by applying the conceptual framework developed for the Numbers of Participants. This frame uses three network concepts of nodes, links, and boundaries to depict participants, their connection, and groupings.

Participants in design-bid-build are grouped into functional silos defined by thick, impermeable organizational boundaries that establish an "arms-length" transaction limiting interaction and communication. Participants in design-build are organized in a relational network allowing them to directly interface across organizational boundaries that are thin and permeable to collaborate in the additional planning required to complete the scope. The network is

configured with the designer and contractor within a single team boundary, with the contractor often in the power position. To rebalance this power dynamic, the owner might want to consider structuring the network as suggested in the Delphi panels' concerns.

The panelist's solution of having subconsultant designers report only to the prime designer, not the design-build contractor, is illustrated using nodes, boundaries, and links. The design-build contractor and prime designer are represented by two nodes grouped within a single boundary, reflecting the design-build team linked by contract and two-way interaction. Add to this network the node representing the subconsultant designers grouped with the prime designer by introducing a thick, impermeable boundary with linkages to the designer by contract and two-way communication. There is no linkage permitting direct contact between the subconsultant designer and the design-build contractor; any necessary communication must go through the prime designer who takes on the role of a hub firm. Potential advantages of this network are that all communication between the contractor and sub-designer goes through the prime designer, and the subconsultant receives direction only from the prime designer who can efficiently manage the tasks being performed by the subconsultant. Disadvantages are communication between the contractor and sub-designers have a longer path requiring more time, creates a greater chance of miscommunication, and communication is potentially not making it to the intended participant. Another disadvantage is removing the design-build contractor from direct involvement in the subconsultant design effort might limit potential opportunities for innovation.

An alternative approach to this issue can be modeled as a network in which the design-builder and subconsultant designer are directly connected. In this case, the boundaries would remain around the design-builder and prime designer, defining them as the main design-build participants, and a permeable boundary around the prime designer and sub-designer defining

them as members of the design team. There would be a link between the design-builder and sub-designer signifying communication, but not control. Advantages include direct contact between the contractor and sub-designer, the contractor can be more informed about ongoing activities on the project, and the relationship between the design-builder and subconsultant can develop, survive, and continue even without the prime designer. Disadvantages are that the prime designer could be left out of the loop with another party potentially providing direction and communication.

5.3.2.8 Summary

The complexity of "Numbers" of participants can be addressed with networks in which nodes, links, and boundaries are used to represent participants, how they are linked and how they are grouped. Different combinations and variations of their elemental characteristics allow different organizational structures to be depicted and actors to be observed individually and collectively.

5.3.3 Attitudes

5.3.3.1 MacNeil

MacNeil (1980a) says participants' attitudes are one of the most critical behavioral aspects of contracts. Labeled initially "Participant Views of the Transaction or Relation" (MacNeil 1974a) but later renamed "Attitudes" (MacNeil 1980a), MacNeil identifies four attitudes as important: (1) awareness of conflict of interest, (2) unity, (3) time, and (4) trouble.

First, "Awareness of Conflict of Interest" (MacNeil 1980a) was initially addressed as "Recognition of Exchange" (MacNeil 1974a). In a discrete transaction, recognition of exchange and awareness of conflicts of interest are high. In a relationship, both are low. Discrete transactions involve complete measurement and planning and a sharp division of benefits and

burdens, creating intense awareness that exchange is occurring. The zero-sum aspect means each actor looks to maximize his gains at the expense of the other, resulting in competing interests, divisiveness, and selfishness. Relationships involve incomplete obligations and planning, and shared benefits and burdens. These and other characteristics requiring cooperation help minimize participants' sensing of exchange and its motivations. The lack of individualistic focus in a relationship means awareness of conflicts of interest are muted and, when perceived, controlled.

Second, "Unity" (MacNeil 1980a) was initially addressed as "Altruistic Behavior" (MacNeil 1974a), a perspective later described as too narrow. MacNeil (1974a) defines altruism using Macaulay and Berkowitz's (1970) definition: "behavior carried out to benefit another without anticipation of rewards from external sources." He (MacNeil 1980a) defines unity as "how much the participants view their individual interests as coextensive with the interests of the overall relation." MacNeil (1980a) describes this concept of unity as involving interdependence in perceiving self-interests as served through the interests of other participants and in the ultimate sense of not seeing any difference between self-interest and the interests of other participants, it also involves social unity, desiring individually to serve the relationship against competing external interests. MacNeil (1980a) says he chooses not to address whether these attitudes reflect altruism but to focus instead on if the participants perceive the relationship as a unity of which they are a part.

A discrete transaction has no sense of unity; the participants view it as a case of "me and him," resulting from a heightened awareness of conflicts of interest and focus on the parties' individual goals (MacNeil 1980a). In this setting, parties do not expect or think altruism occurs—the intense focus on exchange is associated with an anticipation of external rewards (MacNeil 1974a).

A relational contract involves unity. Because many characteristics of relationships like sharing benefits and burdens and the need for future planning create interdependence, the parties adopt the other's interests and agree to cooperate (MacNeil 1980a).

Third, "Time" (MacNeil 1980a) which was initially labeled "Time-sense" (MacNeil 1974a), was later truncated to simply "Time." In a discrete transaction, MacNeil (1980a) says the parties' goals are to "presentiate," meaning to bring the future and everything related to it into the immediate present. Presentiation is a recognition that present events bind the course of the future. The parties deal with the future as if it were the present through 100 percent complete planning. As a result, these measured and planned parts of a transaction are viewed as having virtually occurred long before they happen.

In relational contracts, parties are interested in "futurizing the present," which "leaves the future where it is; waiting to happen" (MacNeil 1974a). Thus, the future can be prepared for but not conquered; some parties choose to prepare for future events if and when it happens in particular ways, while others are open to what happens, dealing with future events as they occur.

Fourth and finally is "Trouble" (MacNeil 1980a). Labeled initially "Expectations about trouble in performance or among the participants" (MacNeil 1974a), a discrete contract theoretically cannot get into trouble because all conceivable contingencies and known risks are planned and considered in the contract price, so if trouble arises, it is not considered trouble, it is just one way the transaction was anticipated to play out (MacNeil 1974a, 1980a). This is an aspect of presentiation.

Trouble in relationships is expected as a matter of course. When it occurs, it is typically the result of poor planning, participants with personalities not suitable for the relationship, difficulties with the "whole person" relationships, or external pressures on or internal changes in

the relationship (MacNeil 1974a). There are different ways to deal with trouble. When it is anticipated, it can be planned for through details in the contract or a presentiated cost. When trouble cannot be anticipated, it is dealt with when it occurs, an option that may be used even when trouble is anticipated. In both instances, procedures to deal with trouble can be planned into the contract, and the parties' goal will be to deal with trouble in a manner that prevents the relationship from falling apart.

5.3.3.2 Delphi Panel

Although the Delphi panel does not explicitly mention any of the four components of "Attitudes," some critical factors reflect the shadows of these concerns. These fall into six categories: The Right Team, Shared Understanding of Scope, Expectations, Reliance on Someone, Reliance on Something, and Power.

The "Right Team" incorporates the other five Delphi categories. The panelist who initially presented this critical factor did not elaborate on what the "right team" meant. Perhaps he knew or just felt he would know it when he saw it. Findings here shed light on essential aspects of the right team; some were addressed in discussing the "Overall Relation Type," others are found here. The "Right Team" is one in which an "Attitude" of unity is present, participants have similar perspectives of time, can manage trouble, and minimize the awareness of conflicts of interest. MacNeil describes these as attitudes that are beneficial for relational contracts. This "Right Team" has a "Shared Understanding of Scope," common "Expectations," a firm "Reliance on Someone" rather than "Something," and a suitable "Power" structure. Each Delphi category is briefly addressed, and the connections to MacNeil's Attitudes are identified with selected examples of relevant comments.

The “Right Team” label was extracted from the comment “pick the right team.” When presented to the Delphi panel as a critical factor, they unanimously agreed on its importance, receiving the highest possible rating of “5” from each panelist, tying with four others as most critical.

As commented by one panelist, the “Right Team” should have a “Shared Understanding of Scope,” a phrase that also labels a critical factor rated with all “5’s,” which tied with four others as the most critical. A “Shared Understanding of Scope” is associated with attitudes of time reflecting either presentiation through “detailed” planning at the discrete end of the contractual continuum or “flexibility” by futurizing the effort, a characteristic of time associated with relational contracts. This factor is also related to the attitude of dealing with trouble because achieving a shared understanding of scope is essential in preventing trouble. This concern is seen in the Delphi comments such as “identify who is responsible for unforeseen soil conditions” and “identify special project requirements,” both ranked among the top ten.

The “Right Team” should clearly understand “Expectations,” which contributes to unity and alleviates trouble. Three comments by panelists, “define clear owner objectives/expectations,” “define expectations,” and “be clear about what the project is to accomplish,” all express similar concerns within this category. “Define clear owner objectives/expectations” was the highest-rated factor in this category, placing seventh in importance, with all panelists rating it “5” save one rating of “4” in both initial and final ratings.

Reliance is also an essential aspect of the “Right Team,” with Delphi comments grouped into two categories: “Reliance on Something” and “Reliance on Someone.” These categories would typically correspond to the discrete and relational ends of the contractual spectrum where presentiating and futurizing apply, respectively. The sequencing of project phases means the

handoff of information through documents (Reliance on Something). In contrast, activity synchronization creates dependence on others (Reliance on Someone). The Delphi comments in these categories reflect concerns about Trouble and Unity. Critical factors grouped under Reliance on Something are such comments as "indicate the reliability of owner-supplied information" and "identify who is responsible for unforeseen soil conditions outside of the areas where borings were provided," both drawn from a panelists' past project experiences indicating a desire to prevent Trouble. At the same time, Reliance on Someone includes such comments as "trust between the owner and design-builder" and "technical competence of the designers and builders," which would be elements essential to the development of Unity. The panel saw the two issues mentioned related to Reliance on Something as a top ten issue and the two issues mentioned related to Reliance on Someone as a top 20 concern. The highest-ranked comment in each category, the "reliability of owner supplied information" and the "technical competence of the designers and builders," were both unanimously rated with "5's" to tie as most critical with three others.

The "Right Team" must manage "Power" to create a balance between participants' perspectives of Time and dealing with Conflicts of Interest. A Delphi panelist asked, "who should lead the scoping process? Owner? A/E? Design-builder?" which is a question that in this context would amount to "whose time perspective dominates?" The Delphi panel indicates the owner's perspective is the most important of the three, followed by the designer-builder and then the A/E. Another question, "how critical are contracts being in place during scoping?" pertains to the power that participants have regarding the scope and relates to time by questioning how much of the scope is presentiated and how much is futurized at the time the contract is entered.

The panel seemed to have mixed feelings about this factor, with initial ratings ranging from "1" to "5" and final ranging from "1" to "4," ranking it among the least important of all the factors.

Based on the Delphi data, the following are important attitude-related factors for the "Right Team:" a Shared Understanding of Scope, clear Expectations, Reliance on Someone and Something, and Power. Attitudes regarding Unity, Time, Trouble, and Awareness of Conflict of Interest are developed in-depth below using additional literature.

5.3.3.3 Literature

MacNeil (1980a) introduces "Attitudes" as a single concept with four parts, and although there are interactions among them, the parts are dealt with individually here in expanding the perspectives of each. Discussed first is "Awareness of Conflict of Interest," followed by "Unity," "Time," and then finally "Trouble."

5.3.3.3.1 Awareness of Conflict of Interest

Behavior at the discrete end of the contractual spectrum is self-serving and therefore conflicting; both parties seek to maximize their exchange outcome. At the relational end, the participants continue to be self-interested; however, conflicts of interest are transformed into negotiated order by the relationship and a counterbalance of trust and unity (Davis 1995, Leblebici 1985, Dwyer et al.1987).

Conflicts of interest are still present in relationships but exist in the background. Macaulay (1965) describes the not always happy relationship between automobile manufacturers and dealers despite reasons for harmony in a seminal article. Profit is the goal for both parties to the relationship requiring significant resources and risk-taking. In this relationship, different business strategies produce varying payoffs for each party. Macaulay illustrates this by suggesting a dealer has the same immediate results by making a one-hundred-dollar profit on the

sale of one car or a ten-dollar profit on the sale of ten with little concern of what type of car he sells. The impact of these two scenarios differs significantly for the manufacturer because, in one case, it sells one and in the other, it sells ten with a keen interest in selling units from all the various models it makes.

So, while parties may share the same "common goal," their "secondary goals" (Crowley and Karim 1995) and approaches to getting there may differ. Crowley and Karim indicate participants in partnering relationships negotiate common and secondary goals that often involve trade-offs. They illustrate this with an example of an owner wishing to minimize project time requiring additional contractor resources that would adversely impact their costs. The owner compensates these costs, satisfying the contractor's secondary goal of sustaining profit. In this case, the parties' secondary goals are renegotiated for a tradeoff, additional pay by the owner for an increased effort by the contractor.

Li et al. (2001), whose work also focuses on partnering in construction, and Kreitner (2005), who evaluates conflicts of interest from a legal perspective, indicate self-interests can remain prevalent on teams. Kreitner (2005) says relational contracts build mini-communities with joint interests but indicate there is a richness and complexity that comes with these joint interests, which he says can be "double-edged," even though competitors become partners, the potential remains for traditional conflicts of interest. However, there are fiduciaries, people whose professions put them in relationships of trust. They must avoid conflicts of interest, a duty that can grow in scope and significance when there is an incomplete contract, and unexpected events arise (Kreitner 2005). Boatwright (1992) mentions certain professionals such as lawyers, accountants, and engineers who have specialized knowledge to make informed judgments. Part of the value of their professional services lies in the confidence that can be placed in these

judgments, and they are not to engage in any conflicts of interest that would interfere with their decision.

5.3.3.3.2 Unity

Discrete transactions have no unity required between the actors because there is a complete contract in which all transaction and relational aspects are contained within the formal, written document (MacNeil 1980a). Wessel (2004) refers to this as "reliance on the four-corners of the document."

Relational transactions involve unity with many factors creating high levels of interdependence, making the interests of each party become the interests of the other (MacNeil 1980a). Reliance on other project team members replaces a 100% complete contract document. Macaulay (1963) indicates formal contracts often play a relatively limited role in interfirm relationships; even if a contract exists, Heide and John (1992) suggest it is often augmented by a variety of norms and informal agreements. Wessel (2004) states that in a relational transaction, the purpose of the contract is to guide the relationship between the participants, making these transactions more about reliance on the relationship than what is in the contract.

MacNeil (1980a) lays a foundation for the concept of unity but doesn't provide a detailed description. He suggested his original approach to this Attitude (1974a), "Altruistic Behavior," was too narrow, indicating he believed a more involved dynamic was in play than just altruism alone. MacNeil (1980a) does connect unity to the concept of altruism, which he (1974a) also links to reciprocity, but without further details, he leaves open the possibility of other links to unity. A search of the literature revealed that although detailed work on unity could not be found, there was information linking altruism with reciprocity along with other concepts like trust,

cooperation, and opportunism leading one to conclude that unity is the presence of altruism, reciprocity, trust, and cooperation along with the absence of opportunism.

The characteristics of unity can be seen in an illustration developed in the 1950s by RAND called the "Prisoner's Dilemma" (See Poundstone 1992, Axelrod 1984, Rapaport and Chammah 1965 Rasmusen 2001). The Prisoner's Dilemma involves two players jointly charged with a crime but held separately by the police. Each player must decide simultaneously and independently to cooperate with the other player or defect. The payoffs to both players are highest if they both cooperate and lowest if they both defect, but the payoff to each is highest if that player defects while the other player cooperates. As with any relationship, the challenge is how to get the parties to be unified, even in the absence of the other. As Richards (2001) described, defection is the preferred strategy if the game is played once, with players receiving no benefits from cooperation. Richards indicates that if the game is repeated, mutual benefits from cooperation can be achieved using reciprocal strategies such as reciprocity and altruism. Wessel (2004) describes this as an iterative Prisoner's Dilemma, which best represents relational contracts.

Richards (2001) describes the Prisoner's Dilemma as a simple representation of the dynamic between individual self-interest and collective cooperation. It has been used in various fields, including game theory, rational choice theory, economics, sociology, philosophy, and increasingly in discussions of contracting behavior and contract law, as indicated by Feinman (1993). It has also been used in literature to describe relational contracts (Wessel 2004, Kauffman and Stern 1988) and partnering (Eriksson 2007, Lazar 2000, Cheung et al. 2003, Wong et al. 2005).

Five important concepts are seen in the Prisoner's Dilemma illustration. First, altruism is seen in an iterative Prisoner's Dilemma with Boyd (1988) suggesting cooperation is altruistic because cooperators forego the temptation to defect, thereby placing the group's interests before their self-interests. Second, reciprocity is seen with Heide and Miner (1992) indicating the parties in an iterative Prisoner's Dilemma can either reward or punish the other party for their previous move. A player cooperates if the other player cooperated in the last game and defects if the other player defected (Richards 2001, Axelrod 1984). Third, cooperation is seen when the goal for both players is to achieve the best joint payoff. Fourth, opportunism is observed when a party focuses on self-interests and defects to maximize individual gain in the relationship. Fifth and finally, trust is seen as one-party seeking altruism and cooperation by trusting the other to reciprocate and not behave opportunistically. These five unity components illustrated in the Prisoner's Dilemma are addressed individually below.

The first component of unity is altruism, described by Margolis (1982) as a sense of social responsibility focusing on group interests rather than self-interests, reflecting a self-sacrificing behavior. Galston (1989) suggests a propensity for risk-taking may be related to the willingness to engage in altruistic acts, although reciprocity may balance some of the associated risks.

The second fundamental component of unity is reciprocity. Simmel (1898) describes unity as "the cohesion of elements produced by the reciprocal exercise of forces." He indicates every unity has destructive forces attacking it internally and externally that, if unopposed, would cause it to either dissolve into elements or transform into other groupings but countering these destructive forces are preservative reciprocal forces that hold the parts together and through this cohesion of the parts is the unity of the whole.

Linked to altruism in literature, reciprocity is the force that stabilizes altruistic cooperation and ensures cooperative relationships will be sustained (Axelrod 1984, Lado et al. 1997). MacNeil (1974a) states that altruistic benefits impose obligations of reciprocity in a relationship; for example, receiving a gift carries a compulsion to give a gift. MacNeil says this technique creates social bonds that Achrol (1997) calls the glue binding the entire network together. Reciprocity is linked to cooperation, with Axelrod (1984) saying reciprocity elicits cooperation.

The third component of unity is cooperation, described by Alter and Hage (1993) as a behavior component involving the willingness to work together and an attitude absent of selfishness. They say cooperation is a central and necessary condition for inter-organizational relationships. Organizational theorists such as Likert (1967) stress the importance of favorable attitudes, confidence, and trust in achieving coordinated action within an organization. Alter and Hage (1993) state this applies even more so to relationships between organizations.

Williamson (1975) addresses cooperation by indicating its different degrees along a continuum passing from transactions, such as those in organized commodity markets with minimal cooperation, through intermediate areas with linkages of traditional connection and goodwill, and finally to the complex and interlocking clusters, groups, and alliances that represent fully and formally developed cooperation. A disadvantage of unbounded cooperation is that it may lead to opportunism (Lado et al. 1997).

The fourth component of unity is opportunism, defined by Williamson (1975, 1985) as "self-interest seeking with guile," where guile is defined as "lying, stealing, cheating, and calculated efforts to mislead, distort, disguise, obfuscate, or otherwise confuse." Williamson describes the attendant use of guile as separating opportunism from standard self-interest-seeking

behavior. A party becomes vulnerable to opportunism when engaging in relationships, but reciprocity (Axelrod 1984) and trust (Lyons and Mehta 1997) can diminish partners' opportunism.

The fifth and final component of unity is trust, described by Lyons and Mehta (1997) as a two-party social relationship where each orients its behavior to the other's expectations. Trust is a substantive concept for the parties if at least one party is exposed to an element of "behavioral risk," making them vulnerable to opportunistic behavior. Lyons and Mehta (1997) use the work of Sako (1992) to indicate two types of behavioral risk that are facilitated by the presence of trust, and those are contractual risks and goodwill risks. A contractual risk is that an agreement—written or verbal, implicit or explicit—will be violated by a partner being untruthful or dishonest regarding some aspect of the contract. Goodwill risk is a risk that a partner will act in his narrow interest and against the joint interests of both parties should an unanticipated event arise that has not been specified in the contract because of the high costs of working through all conceivable eventualities or because an unimagined event happens. It leaves the exposed party uncertain whether their partner will either respond flexibly and cooperatively to a request to modify the original agreement or take the initiative to pursue a beneficial opportunity for self-interest.

Overall, trust contributes to unity in at least four ways. First, trust reduces uncertainty by providing cognitive and moral maps of expectation that guide people as they interact (Lado et al. 1997). Second, trust minimizes the transaction costs that would otherwise be incurred in building governance mechanisms to safeguard against opportunism (Hill 1990). Third, trust is an integrative mechanism that creates and sustains cooperation within and between organizations (Lado et al. 1997, Smith et al. 1995, Heide and Miner 1992). Fourth and finally, Lado et al.

(1997) indicate trust may induce reciprocity when there are mutual expectations of commitment between parties and serve to further embed and deepen the trust and cooperation between them.

5.3.3.3.3 Time

As one of four primal roots of contract, MacNeil (1974a, 1974b, 1980a) considers an awareness of time a crucial component of participants' attitudes in terms of their perceptions of past, present, and future. In a discrete transaction, parties are interested in "presentiating," bringing everything from the past and future into the present. In relationships, the parties are interested in "futurizing," where one plans and prepares for the future (MacNeil 1974a). Additional literature is developed in four sections to expand how participants view time differently. These four sections include relational time, temporal ordering, accessibility, and production.

5.3.3.3.3.1 Relational Time

Halinen and Törnroos (1995) introduce the concept of "relational time," suggesting that time should not be regarded from only one point of view but instead viewed horizontally regarding temporal modes such as the past and present and future and vertically regarding the specific cultural and contextual setting. Halinen and Törnroos describe that the relational notion of time has three attributes. First, time is bound to the past, present, and future. Second, time has a relation to the culture and space surrounding the interaction and is perceived differently within different cultures, organizations, and groups of people. And third, time has its context related to the human actors, their situation, and the problems solved through their interactions.

5.3.3.3.3.1.1 Horizontal time

Horizontal time is defined by a linear continuum from past to present to future. The past represents the time that has gone by captured in memories and interpretations of selected events

(Medlin 2004). The selection of these past events is often based on what is required to understand the present and the possibilities for the future (Mead 1932). Medlin indicates this has important implications because different people can interpret past events depending on many factors, one being their different viewpoints, as addressed in the vertical time discussion below.

Medlin defines the present as the period between two events, one past and the other anticipated, that changes the state of reality for at least one actor. Butler (1996) indicates we experience time in the present and fundamental to that experience is the knowledge we have of the past and how we use this knowledge to envision the future. Similarly, Medlin states the past and future can only be given meaning in the present, where the human mind is held with its memories of selected, interpreted events of the past and its intentions and expectations of potential alternative possibilities of the future.

The future is the time to come, and it is forever changing and unfolding as the present moves past (Medlin 2004). The future is full of possible alternatives, only one of which can become the present; alternative futures are discarded to make the present, then each present makes new alternative futures (Medlin 2004).

All events represented as past, present, and future are continually changing regarding these designations (Gale 1967). This progression of time is described in a study of time in economics by Winston (1982, Winston and Teichgraeber 1988) as running through a series of positions from the far past through the near past to the present and then from the present through the near future to the far future, crediting the idea to McTaggert and McTaggert (1927). This progression recognizes what was once an event in the far future will at every moment become an event in the nearer future until, at last, it will be present. Then it will become past and will always remain past, though it becomes further and further past at every moment.

Interaction can only occur in the moments making up the present. These interactions can be analyzed as a process of different moments identified in the horizontal dimension of time reflected in the past, present, and future (Medlin 2004). These moments are represented by specific events perceived as important by the actors. Identifying their temporal boundaries and managing interactions will be affected by social, organizational, and cultural influences and by different experiences and perceptions of time that are aspects of the vertical dimension of time addressed next.

5.3.3.3.3.1.2 Vertical time

Halinen and Törnroos (1995) note time is perceived differently within different cultures, organizations, and social contexts that constitute the vertical dimension of time. Ancona et al. (2001) and McGrath (1988) refer to an actor's perception of time as a characteristic of their "temporal orientation," indicating his approach to time by capturing not only how actors perceive time but also how they act regarding it. Temporal orientation embraces several elements. It includes temporal perception reflecting an individual's understanding and knowledge about time (McGrath 1988, Ancona et al. 2001) and their orientations to the past, present, and future and its relative importance (Ancona et al. 2001). And the length of an actor's time horizon represents how far into the future an individual typically looks or is capable of looking, which is particularly important in how an actor chooses to plan (Bluedorn and Denhardt 1988).

Addressing time and its influence in business decision-making, Halinen (1998) suggests that the business managers' concept of time affects their perception of business reality and their behavior regarding the perceived importance of problems and the solutions proposed to cope with them. Butler (1996) says decision processes are vital activities in the "present" timeframe connecting the past to the future and reflecting a cross-section of participants' lives.

Medlin (2004) indicates time is essential in understanding how the vertical aspect of time influences an actor's perception of the past, present, and future elements of horizontal time. Medlin recognizes variation in interpreting past results, and competing memories and perspectives contribute to a continuing difference between parties that are naturally brought to any moment of interaction, making any business relationship reflective of a metaphorical two-sided dance, two different perspectives of reality interacting in a relationship dynamic.

As stated earlier, Medlin (2004) defines the present as the period between two events, one past and the other anticipated, that will change the state of reality for at least one actor. One describes the present relative to the nature of the problem under study, and the present moves on when an event occurs, marking a change in future possibilities. This definition leads one to recognize some interactions will have long periods of the present, while others have a short duration present. This relative perspective of the "present" period allows disagreements over interaction to be understood and explained.

In considering the future, Butler (1996) says it is essential to understand how participants in an organization think of their futures and relate them to the past. He says this process of making choices by understanding forward from our understanding back gives us a better appreciation of how actors experience time. A significant aspect of the future is the extent to which there is congruence among participants in an organization over the desired future. Butler mentions the difficulty posed when one party's time is dependent upon the actions whose views of the possible futures are not congruent with their own, yet they have the power to impact those futures.

Medlin (2004) indicates that parties' futures in a relationship exist as expectations. Each present interaction occurs with a presumption of a future that will achieve the parties' intentions.

If not, there would be no need for continuing interaction. There are three implications for interactions associated with the unfolding and ever-changing future (Medlin 2004). First, new potential futures are possible with every new present and with no guarantee that any potential future will become the present; interaction requires a continued commitment to a shared intention because any disparity of intentions and thus commitment would likely lead to unintended results. Second, given variations in an organizational context, each actor brings a different perspective of the future to the interaction. Because each new present provides a different view of the future, the two firms can never move in exact harmony, thus making business relationships forever dynamic. Third, the continued renewal of futures places a massive task on human cognitive ability because each new present provides new futures that must be accommodated in choosing the next present. To overcome some of the complexity of interaction, Medlin (2004) says organizations resort to such things as intention, expectations, norms, exchange contexts, and networks.

Medlin (2004) says the different perspectives of time and the dynamics of interaction that result mean managers will always face continually changing relationships making managing a relationship a balancing act between different views of past, present, and future. He says management should continually bring the organizations' perspectives into complementary strategic alignment to create value in a relationship.

5.3.3.3.3.2 Temporal Ordering

Hassard (1991) refers to the work of Moore (1963) to identify synchronization, sequence, and rate as three elements of temporal ordering. These three elements are crucial in predicting when specific actions will occur relative to others, coordinating functionally segmented parts and activities, and distributing time, so activities consume it most efficiently. "Synchronization" is

used by Moore (1963) to describe activities that require either simultaneous actions by some participants or at least their presence at a particular time. Synchronization allows temporal coordination among functionally segmented parts and activities (Hassard 1991). Other activities require actions that follow one another in a prescribed order or "sequence" (Moore 1963). Zerubavel (1976) refers to a timetable consisting of blocks of time in which the basic structural units are "events." When sequential ordering is imposed on events, they are segregated temporally in terms of before and after. Zerubavel (1976) refers to "rate" as tempo or the pace of activity with actions that are too fast or slow, upsetting the synchronization and sequence (also, Hassard 1991).

These temporal structuring patterns can influence "private time" and "public time," the elements of time discussed next.

5.3.3.3.3.3 Accessibility

Zerubavel (1979) says time is a major dimension defining privacy and role commitments by characterizing a continuum of time expressed between private and public time poles that explain the structure of social accessibility and professional obligations. "Private time" is when one is socially inaccessible, working in isolation with their performance segregated from that of others. At the other end of the continuum, "public time" is the time in which an actor must be accessible to others. Between these two poles are varying degrees of accessibility.

5.3.3.3.3.4 Production

Koskela (1992) addresses the ideas of conversion and flow by applying manufacturing production techniques to construction. He associates "conversion" with value-adding activities that directly convert material or information to customer requirements, with its efficiency measured as a ratio of inputs to outputs. Any achievable innovation in production improves the

conversion efficiency. “Flow” is associated with non-value-adding activities that take time, resources, or space not directly contributing to the product. Flow improves by consolidating activities, reducing cycle time, minimizing the number of required steps, parts, and linkages, and decoupling linkages.

According to Koskela, the overall efficiency of production is attributable to the efficiency of performed conversion activities and the amount and efficiency of flow activities that bind the conversion activities together.

Additional information and concepts regarding the attitude of time and its illustration with construction participants are contained in Appendix C.

5.3.3.3.4 Trouble

Discrete transactions are not supposed to get into trouble because every conceivable contingency is planned, but with relationships, trouble is expected and is dealt with when it arises (MacNeil 1974a, 1980a). At the core of this concept of trouble is a problem requiring a solution. The participant’s perception of the problem and the mechanisms available to deal with the situation create the attitude, which is the focus here. Regardless of location along the contractual spectrum, all projects will encounter problems. When problems occur in a relational setting, they happen within the boundary defining the relationship; problems are internal to the organizational structure and can create trouble in the relationship. When problems occur in a discrete setting, they occur between the parties, at their boundaries, and are external instead of internal.

Trouble becomes a conflict as self-interests become the focus. As described by Merriam-Webster’s Dictionary (2006), conflict means “to clash; be antagonistic, incompatible, or contradictory; be in opposition; as, his interests conflict with mine.” When conflict is unable to

be resolved, it becomes a dispute which, according to Merriam-Webster, is "to argue or debate a question…in an attempt to prove and maintain one's own opinions or claims in opposition."

When dealing with problems, the focus can be on the contract or the relationship. Discrete transactions have a presentiated contract in which the future is brought to the present, all risks are allocated, and the entire transaction is planned (MacNeil 1974a). As a result, Macaulay (1991) indicates disputes during the life of a transaction are to be resolved by returning to the formal text of the contract document. Macaulay (2000) notes that the plan guides performance, and any problems that cannot be avoided by reference to it can be resolved by interpreting it. Other dispute resolution techniques like litigation are utilized when levels of conflict exceed the resolution capacity of bargaining and other exchange processes (MacNeil 1978). Since the dispute resolution is all that remains of the discrete transaction, MacNeil states the process is relatively clean and straightforward, like the discrete transaction itself. A "sharp in" by commencing suit and a "sharp out" by the judgment for defendant or collection of a money judgment by the plaintiff, but this type of resolution is often winner-takes-all typically destroying the relationship. Also, Macaulay (1977) notes litigation is expensive, which leads actors to use litigation to resolve disputes only when the present value of continuing the relationship is low while the anticipated return from litigation is relatively high. Therefore, legal options often occupy the background, governing the transaction only when all else fails and the party is willing to forgo the relationship (Gordon 1985).

In relationships, the contract is futurized, so parties negotiate a solution to problems that will preserve the relationship rather than relying on a complete contract that outlines ways to handle any potential problem. This approach to problem-solving makes the personal relationships between organizations important (Macaulay 1963) by permitting parties to adapt

and collaborate to best address specific situations instead of merely conforming to a standard approach set before commencing the project (Macaulay 1991).

Parties in continuing interdependent relationships will avoid disputes or settle them by relying on techniques outside of planning and the contract (Macaulay 1977). The value of the relationship leads all involved to seek to satisfy each party while downplaying potential disputes in the effort to keep the relationship alive (Macaulay 1985). Disputes are often settled without referencing the contract or possible legal sanctions, with contract planning and contract law being marginalized for important long-term continuing business relations (Macaulay 1963, 1985). Macaulay (1977) suggests the problem-solving process in relationships is akin to that of a marriage where provisions for third-party intervention to solve problems are inconsistent with the commitment to a marriage relationship. Participants tend to feel the same about the impact of overly detailed planning or third-party intervention in their long-term business relationships.

MacNeil (1978) indicates litigation does not work in a relational contract when the relationship is supposed to continue despite experiencing conflicts. According to Macaulay (1966), other-than-legal settlements of disputes often cost less, are reached faster, and "…produce compromise instead of victories, and leave parties happier than they would be if they had engaged in full-scale legal warfare." MacNeil (1978) notes that a relationship goal must always be its successful continuation after the conflict.

Gordon (1985) expresses a concern that power imbalances in relationships may influence aspects of its performance. The give-and-take needed in a cooperative business relationship could potentially turn into an antagonistic "horse trade" (Macaulay 1963), with one party forced to compromise too much in avoiding or resolving conflicts.

Conflict can have positive or negative outcomes with the resulting potential for "conflict aftermath" (Pondy 1967) or "conflict escalation" (Anstey 1999). Pondy suggests the aftermath of a conflict is a dynamic relational process that manifests itself in a sequence of conflict episodes. When and if the conflict is truly resolved, its resolution may form the foundation of a more cooperative relationship. However, simply suppressing the conflict may lead to continuing and potentially explosive conflicts in the future.

Anstey (1999) labels conflict escalation as another negative outcome in that as conflict grows, the number of contentious issues between the parties will as well. During this escalation, what was once concrete, specific demands develop into grandiose, all-encompassing demands of a generalized nature. Communication becomes unreliable or impoverished as available communication channels are ignored or used to abuse the other party. There is a shift away from problem-solving, persuasion, and conciliation toward increased reliance on strategies of power and the utilization of tactics of coercion, threat, and deception.

5.3.3.4 Classifying Attitudes in Current Construction Practices and Trends

Five project delivery methods are used to illustrate participant attitudes. These methods are design-bid-build, design-build, construction manager at-risk, partnering, and the firm.

Design-bid-build

In design-bid-build, the sequential ordering of each project phase provides "private time" to participants in carrying out their required tasks. When the conceptual phase is set to the "present" in the horizontal time dimension, the owner's primary concerns reflected on the vertical time dimension are typically the product, schedule, and cost. This demonstrates their attitude towards time includes both the near and far future. Various participants address these initial concerns in subsequent project phases. Sharing the owner's perspective of the far future,

the designer addresses concerns regarding the product and its lifecycle cost. In comparison, the contractor shares the owner's concerns of the near future and addresses the schedule and first-cost concerns.

Moving forward in time when the design phase is set to the "present" in the horizontal dimension, the designer's primary vertical dimension focus is on the utilization phase of the facility in the far future while giving less attention to the near future construction phase. As the owner's consultant responsible for the product that will last the facility's life, the designer naturally focuses on designing a safe, durable facility during his "private time" when he is isolated from other participants and before the design is made public. The designer advises the owner before costs have been determined about what design solutions are in his best interests for the facility. In this effort, the designer has little incentive to focus on constructability or invest time taking on the potential risks of developing innovative solutions. To do so would reflect altruistic behavior on the part of the designer because any benefits would accrue to either the contractor or owner in the subsequent phases.

A complete design resulting from the design phase is part of a presentiated contract guiding future actions and detailing how trouble will be handled. All aspects of trouble that can be anticipated will be planned. Still, some parts cannot be dealt with until they occur, like changes and unusually severe weather, so procedures are planned into the contract.

When the procurement phase is set to the present moment on the horizontal time scale, the design is available for bidding, resulting in many proposing contractors occupying the vertical time dimension. These actors are focused on the near future, developing an estimate of synchronization, sequence, and rate for delivering the work, which is reflected in a competitive bid for anticipated cost and schedule. The owner will also occupy the vertical dimension in

undertaking the evaluation of contractors' proposals to select the lowest, responsive bid. During this time, the designer responds to any questions concerning the design. The selected contractor then signs a presentiated contract that "moves time" forward.

When the construction phase is set to the present moment, the contractor is the primary actor occupying the vertical time tasked with executing the design developed in the recent past. Because the design is set, and with it, the attendant conversion activities are set as well, the only aspect of the project within the contractor's control is setting the pace of the work during what is mostly "private time" for the contractor. The contractor typically operates at a high-intensity rate because the more efficient he can be with construction, the more significant benefit he can receive. The contractor improves flow by reducing or eliminating waste, idle time, and rework. The contractor's involvement is mainly limited to the duration of construction. Naturally, it leads to his short-term perspective and attitude towards time which is to achieve the desired output as efficiently as possible. If a problem occurs, the contractor will offer or seek a timely solution requesting the owner issue a change order for compensation. The often adversarial nature of the relationships is reflected in this process. Each party focuses on self-interest, wants to resolve the problem quickly and return to the original contract as soon as possible.

When the utilization phase is set to the present moment, the owner is the primary actor performing any necessary maintenance after the initial warranty period. This project phase was considered during design, so the results should match initial expectations.

Design-build

In design-build, the project timeline is collapsed with certain phases synchronized. The conceptual phase is followed by procurement, then the synchronization of design and construction phases, and finally utilization.

When the conceptual phase is the present moment on the horizontal time scale, the vertical dimension is occupied by the owner who develops a partial scope typically describing the project output in general terms as part of a futurized contract but leaves the design-build team to generate the project input. The owner determines how he will select from the proposing design-build teams specifying these procedures in the RFP, including a selection criterion addressing his specific project requirements and those of his constituents.

In setting up the procurement process, the owner is establishing a structure connected to the attitudes of the design-build team. Often using a two-part proposal, the owner combines the evaluation of the technical content with its offered price. In selecting based partly on the low first cost, the owner focuses on the near future, meaning the design-build team will do the minimum amount of work required to meet the scope. To consider lifecycle aspects or do anything above the minimum which couldn't be appropriately captured in the technical content score would reflect uncompensated altruistic behavior by the design-build team. To consider lifecycle components, the owner must provide a benefit such as a monetary incentive or a selection criteria credit to reward above standard solutions or penalize substandard ones.

Some owners have rounds of proposal reviews allowing them to review and have more design set before entering a contract. This combats the concern that flexibility, when left for the design and construction phase, can create the potential for the design-build team to consider its self-interests, inadvertently creating consequences for the owner. Instead, the rounds of proposal reviews provide the parties the opportunity to barter with reciprocity. Since this occurs during the negotiation period when both the owner and potential design-build teams are present, each party can look out for their self-interests in bargaining for a balance of burdens and benefits.

Owners typically also specify procedures in the contract documents to deal with encountered problems should they occur. Despite all efforts to maintain the spirit of cooperation in relationships, there may be instances in which the parties cannot deal with the trouble themselves, so some owners choose to plan procedures for outside assistance such as arbitration or mediation.

Moving forward in time, when the procurement phase is the present moment, the vertical dimension is populated by proposing design-build teams made up of both contractors and designers and the owner's evaluation team. The futurized contract is available to the market for solicitation of proposals during procurement. The nature of the project can establish the organizational structure of the proposing design-build teams. A project requiring a more extensive technical solution will likely attract designer-led teams, while a standard project is typically more suitable for a contractor-led team. The owner can also focus the participant's attitudes on certain time elements through selection criteria targeting particular concerns. When the owner's more pressing concerns are related to construction, a contractor will likely lead, but when the owner focuses more on utilization in the far future, a designer will be more likely to lead.

Due to the synchronized design and construction phases, the designer will have less private time for the design than he typically would in the design-bid-build delivery approach. He will be working in an environment where the contractor is often the team leader and naturally focuses on flow while relying on the designer to provide designs needed for execution. Suppose the owner chooses to conduct multiple rounds of proposal submittals. In that case, the designer will be afforded more private time during the proposal process, which benefits the owner and the designer in solidifying design elements before entering the contract and beginning construction,

but this approach also creates concerns. One concern is extensive resources are being dedicated without the guarantee of being awarded the project. Another concern is that if the designer is presenting innovative ideas before being awarded the contract, these ideas could potentially be used by the owner on this or other projects in the future without compensating the designer. It should also be noted that if innovative solutions are expected, it is crucial that the owner's evaluation panel, who occupies a position in the vertical dimension, have the necessary knowledge to consider such solutions and that they are willing to accept the potential risk that may be involved in choosing an innovative solution.

Moving forward in time when the synchronized design and construction phase is the present moment, the contractor and designer occupy the same present. They exist as a group in the vertical dimension. By nature, the designer as the "planner" and the contractor as the "doer" have different attitudes and must find a way to maximize the usefulness of this difference in the delivery method. Because design-build involves bartering within the relationship to complete the contract, each action needed to specify obligations allows the participants to choose unity for the good of the group and the relationship or self-interests. When the participants choose unity, it is often because there are opportunities for reciprocity in the relationship. The participants have an expectation they will receive a benefit from the current action or an action in the future, or perhaps they have already benefited from altruism in the past. A concern in design-build is that synchronization often involves only design and construction members, so while there is the opportunity for reciprocity among the design-build team, this opportunity for reciprocity may not include the owner.

Another concern is that the participants may create spillover burdens for the owner in reaching unity as the design-build team. There is a concern that decision flexibility might create

consequences for the owner during utilization because the design-build team typically exits the project after construction, except for the designer who remains tied to the facility for its life. In some cases, the burden to the owner could be much higher than the benefit realized by the design-build team. One potential solution would be for the owner to include his maintenance team in the vertical dimension during the conceptual phase allowing their concerns to be voiced and interests addressed before their actual involvement during utilization. Another option is for the owner to make maintenance the responsibility of the design-build team, thus pairing the action and consequences, allowing the design-build team flexibility to make decisions but having to deal with the results of the decisions. Another option would be for the owner to create an incentive for the design-build team to consider the downstream consequences of their actions, such as a monetary benefit. Another potential solution would be for the owner to remain involved during the design and construction phases to provide their input as these decisions are being made.

Operating in this design-build environment may cause the engineer's perspective on time to change slightly. While the engineer will continue to focus on the future, it will likely be for safety and not necessarily the project lifecycle costs because he is working on a team selected by the owner, often based on low first cost. Construction also becomes a more significant focus for the engineer because adjustments due to conversion efficiencies become beneficial to his team. The benefits of this delivery method are realized when actors can work together to optimize both conversion and flow.

One such benefit is that the design-build method provides an opportunity for innovation. With a futurized contract in which the output is set, but the input is not yet specific, the engineer is now potentially compensated as a team member that benefits from the constructability of the

design and through design innovation by reducing the needed input to achieve the same output. Despite the benefit for the team, the engineer is still taking on higher risk, so innovative designs are still considered somewhat altruistic. Still, his willingness to develop an innovative design to optimize conversion or flow for the team reflects an attitude of unity.

When trouble occurs during synchronized phases, multiple participants are present who work together to devise a solution. Each with their self-interests, the designer and contractor can develop a solution to either exhibit unity or self-interest. Ideally, the parties choose unity which in some instances may mean one party is being altruistic by "giving" more, but in the spirit of unity, this should mean that in another instance, either prior or after this, there is reciprocity. This give-and-take approach requires cooperation and trust.

The synchronized design and construction phase presents a concern for engineers in dealing with instances of trouble and other actions of which he is part. As a team member, the engineer has contractual performance obligations, and as a professional, he has role obligations. These dual obligations are at play anytime actions are required, the role obligations are his professional duties independent of the team, and the performance obligations express unity within the group. The concern is if another party with a different perspective and different performance obligations is the leader, the engineer could feel pressured not only to maintain a pace that doesn't allow informed decision-making but also take on more risk than may be justified. While his role obligation as a fiduciary ensures he cannot be pressured to do anything unsafe, there may be a concern that he could potentially also use this as an opportunity to do less than expected to fulfill his performance obligations on the team. The engineer must always balance this split of opposing but concurrent commitments and attitudes.

When the utilization phase is the present moment, the owner and his maintenance team are the primary actors. The owner performs any maintenance necessary, but because this project phase is not typically part of the design-builder's responsibilities, there is the potential for their actions to push burdens into this phase. If the design-build team is focused only on the near future, the consequences of decisions made during construction for the sake of conversion and flow may be suffered by the owner during this phase.

Construction manager-at-risk

With construction manager-at-risk, the owner desires a presentiated contract but simultaneously wants the designer and contractor to work together in addressing both near and far future concerns. The project phases for this delivery method mirror those of design-bid-build with sequential conceptual, design, procurement, construction, and utilization phases. The difference occurs during the Design phase when the designer and contractor surrogate are synchronized; therefore, the discussion here is limited to the Design phase.

When the Design phase is the present moment on the horizontal time dimension, the designer and a construction advisor occupy the vertical dimension. With different perspectives regarding time, the contractor's involvement helps the designer consider more of the contractor's near future concerns, such as constructability. This input comes when both conversion and flow can be addressed in the design.

Partnering

With partnering, the owner desires both a presentiated contract and a futurized, relational approach to trouble. An adversarial relationship that may sometimes be seen during construction while using design-bid-build is replaced by an attitude of unity. Project phases for partnering

closely match the sequential phases of design-bid-build, with a difference occurring in the construction phase with the designer and contractor synchronized in dealing with trouble.

The designer and contractor occupy the vertical time dimension during the construction phase. The parties establish communication channels and avoid conflict by committing to shared goals and cooperation. When problems occur, the parties work together to create a solution. There is a concern that public agencies engaging in partnering may be so focused on dealing with issues to exclude litigation that tradeoffs may be entertained, leading to higher costs to the owner.

Firm

The project phases for this delivery method are like design-build with a conceptual phase typically followed by procurement, synchronized design and construction, and then utilization. The significant difference occurs in design and construction and in some instances utilization where participants within a single firm handle those associated tasks.

The firm occupies the vertical time dimension when the present moment is the synchronized design and construction phase. The design is often futurized, but the hierarchical structure means those in positions of authority assign the work as it is determined. Suppose the firm continues to be responsible during the utilization phase. In that case, their project involvement continues during this phase resulting in the firm having a perspective during design and construction to evaluate choices based on the best lifecycle decision. For example, a design decision that may result in the lowest first cost may be discarded if the more expensive option results in lower lifecycle costs or better performance. Their long-term involvement with a correspondingly long time horizon means both the owner's short and long-term concerns would be addressed.

There is a seamless, collaborative effort between the participants to solve problems as quickly as possible when there are problems. Although the design and construction professionals may have different opinions, as members of the same organization, they will solve problems by compromising or, when necessary, resolved by others higher in the organizational structure.

5.3.3.5 Conceptual Framework

MacNeil (1974a, 1980a) introduces "Attitudes" as a single concept with four parts, and although the parts were addressed separately in the literature, interactions among them will naturally occur. This section discusses these interactions by summarizing the individual concepts from literature and then examining how they interact.

5.3.3.5.1 Parts

"Awareness of Conflict of Interest" deals with the prevalence of "self-interest." In certain transactions, self-interests and individual goals dominate as actors maximize utility through an exchange. In more relational transactions, self-interests move to the background, as shared goals and group interests supersede secondary goals.

"Unity" has five fundamental elements: altruism, reciprocity, cooperation, opportunism, and trust. "Altruism" is an action benefiting another individual that carries no anticipation of reward. "Reciprocity" is an action followed by a reaction, for instance, giving and receiving. "Cooperation" is a joint action for a common purpose. "Opportunism" is an action motivated by self-interest, the lack of which is essential for unity. "Trust" is confidence in another individual. These five elements interact with each other. Altruism can occur in isolation, but it often happens in concert, expecting it will be reciprocated in some form, either through a similar action from the other party or through some benefit related to the action. Reciprocity not only balances altruism, but it is also fundamental to cooperation while reducing the likelihood of opportunism.

United for a collective effort, participants rely on goodwill rather than self-dealing, building trust over time. The result of these actions is unity.

There are five sets of concepts relevant to "time." First, presentiating and futurizing (MacNeil 1974a, 1974b, 1980a) pertain to moving time. "Presentiation" involves bringing the future into the present and planning for it as if it were present, thereby setting the future course. "Futurizing" leaves the future where it is, and any actions that might be taken during futurizing involve preparation for the potential futures.

Second, horizontal and vertical time (Halinen and Törnroos 1995) deal with our relationships to time. "Horizontal time" consists of the past, present, and future, which is described more specifically as far past, near past, present, near future, and far future (McTaggert and McTaggert 1927). "Vertical time" consists of the actors who relate to and perceive time differently based on organizational structure and culture.

Third, sequence, synchronization, and rate relate to temporal ordering and action (Moore 1963, Hassard 1991). "Sequence" requires steps that follow one another in a set order. "Synchronization" allows temporal coordination among parts or activities. "Rate" refers to the pace of activity.

Fourth, private and public time pertain to actor accessibility (Zerubavel 1979). During "private time," actors are socially inaccessible to others, while during "public time," actors are accessible.

Fifth, conversion and flow pertain to production (Koskela 1992). "Conversion" focuses on making activities more efficient. "Flow" focuses on reducing or eliminating activities. These activities can be value-adding activities that convert material or information toward the end-

product or non-value-adding actions which take time, resources, and space but do not contribute to the product.

Along the horizontal dimension of time, moments or events define the present and, in turn, the past and future. The sequencing of events in the horizontal dimension impacts the synchronization, or lack thereof, of actors. The vertical dimension allows individuals or groups of actors to be observed where their distinct culture and collected knowledge define them. The sequence or synchronization of events also influences the public and private time and creates circumstances that impact the performance rate and influence conversion and flow.

"Trouble" is a problem requiring action. The action can be pre-planned with participants anticipating and planning for potential trouble in the contract or dealing with trouble as it presents itself, relying on participants in the relationship to resolve trouble when it occurs. When trouble presents itself within a relational undertaking, there is a narrow window of time between when it arises and when it is resolved, in which intense bargaining occurs among the actors. Resolution is achieved when obligations are assigned. In this space between the problem and its solution, attitudes are manifested.

Trouble, when escalated to conflict, negatively impacts the parties. Series of conflicts over time can lead to "conflict aftermath" (Pondy 1967), with residual effects straining the relationship or "conflict escalation" (Anstey 1999) with a buildup of tension that can eventually lead to the demise of the relationship. Litigation can be used but often ruins the relationship between the parties, so best efforts are made to avoid legal action when preservation of the relationship is essential.

5.3.3.5.2 Interactions

One can place the four "Attitudes" into two categories. One category containing "time" and "trouble" reflects opportunities to manifest attitudes, and the other is made up of "self-interest" and "unity," representing the attitude themselves.

Attitudes are captured in the responses while "time" and "trouble" create the opportunities for response. Time and trouble are time-related elements differing in scale; "time" is an expansive notion, while "trouble" is a narrowly focused time segment. Time allows unfolding events, actions, and impacts to be observed and the involved participants to be identified. Time exists in the background of all activities but, in many cases, goes unnoticed until some event provides focus on a moment. Trouble is a focusing event raising the awareness of the importance and immediacy of needed action.

While attitudes naturally exist as part of each actor, these are typically not seen until demonstrated through events and actions. Self-interest and unity are two attitudes that can be manifested over time or when trouble occurs. These attitudes differ in motivation and are considered opposites if placed on a continuum. Self-interested participants at one pole focus solely on themselves and unity is evidenced in a participant at the other pole focusing on the group's well-being. Although these attitudes represent extremes, they do not occur in isolation, reflecting a range of possible combinations that may occur.

Time is a moldable and scalable concept. In general, time can be identified as past, present, and future; in particular, time can identify phases on a project and highlight instances of trouble. Attitudes can be manifested in actions over time or with an event like trouble requiring a solution. How participants respond with either self-interest or unity reflects their attitude. These

attitudes, exhibited in actors' behaviors, are described below for discrete and relational locations along the contractual spectrum and then illustrated with case study projects.

For a discrete transaction at the far end of the contractual spectrum where exchange occurs immediately, an attitude of self-interest naturally exists and is reflected in actions. If the exchange time is considered the present, two actors are observed, a seller and buyer, who each want to obtain the best deal. When considering the past and the events that led to this present moment, a participant specializing in creating a product for market exchange works in isolation paced at his rate. He will naturally maximize his utility or satisfaction through the sale upon entering the market. At the time of the exchange, there is no relationship between the participants and no expectation or plan to engage again in the future. The buyer will also be looking out for his interests, hoping to obtain the desired good or service as economically as possible.

The same attitude of self-interest continues for discrete transactions when exchange occurs in the near future, so a presentiated attitude towards time is added. Suppose the present is set to the segment of time leading up to the exchange while preparations are being made. In that case, one participant will specify all aspects of the transaction in a contractual agreement to protect his self-interests. This presentiated contractual agreement plans the future related to the exchange specifying all conceivable details about the product, contingencies for dealing with uncertainty, and plans for dealing with trouble. Any area that cannot be fully anticipated and planned is prepared for through stipulated processes to be followed.

When the present is the time of the agreement, the two parties will agree to the contract terms, the specified product for the agreed price delivered on the specified date. Once the contract is entered, the parties are bound by these obligations.

Moving time forward, if the present is a moment during execution when trouble is encountered, problems will be handled in a very rigid and predictable manner using the information contained within the four corners of the contract document. If a solution is not explicitly defined in the agreement, the parties negotiate with their self-interests in mind. If an agreement cannot be reached, legal action can be sought.

For relational transactions, parties focus less on the exchange and more on the relationship built and sustained based on unity. If the present is planning, the past is when participants' experiences and relationships with others influence their relationships and actions in the present. The past may have involved a relationship with an individual in the current relationship. Their past cooperation and interaction establish trust and a working relationship that continues. If the relationship is new, unity can naturally develop over time as the parties build trust and work together to deal with encountered problems, but some things can be done to help build unity; for instance, the parties can be co-located to facilitate communication and interaction.

During planning, participants can leave all aspects of the relationship unplanned, plan only certain parts of the relationship, or prepare for the future by establishing procedures for dealing with events such as trouble. Although futurizing allows the future to be dealt with as it arrives, the agreement often specifies some details about the two sides of the exchange to ensure the buyer gets the desired product and the seller is adequately compensated. If trouble is left to be dealt with when it occurs, the participants in the relationship will develop a solution at that time. Ideally, it will be handled in the spirit of unity through cooperation and reciprocity. Still, another option is to plan procedures for dispute resolution if or when participants are unable to resolve issues themselves, such as using arbitration or mediation. In some instances, participants

may determine high probability events and plan for trouble for these parts of the project, leaving less probable events to be dealt with when occurring.

If the execution phase is the present, parties in the relationship are synchronized and collaborating to produce an end-product. The relationship often focuses on common goals, reducing private time for the actors, may involve changes in rate, and focus on conversion and flow. Moments during execution provide opportunities for unity with participants engaged in give-and-take, reciprocal acts, and a mutual effort to concentrate on group interests.

When trouble occurs in synchronization, there are multiple participants working together to devise a solution. With the self-interests of the participants in the vertical dimension continuing to exist in the background, the answer to the problem provides them the opportunity to either exhibit unity or self-interest. Ideally, the parties choose unity, which may mean one party is being altruistic by "giving" more. Still, in the spirit of unity, this should mean that there was or will be reciprocity in another instance either before or after this one. This give-and-take approach fueled by cooperation, altruism, and reciprocity indicates that the participants' attitudes are unity. If problems cannot be resolved in the relationship, outside assistance can be used, but all efforts should be made to preserve the relationship.

5.3.3.6 Case Study Illustrations

Case study examples highlight elements of the conceptual frame illustrating attitudes. Two examples demonstrate conversion and flow resulting from the combined perspectives of participants when synchronized; two highlight trouble, one exhibiting self-interest and the other unity, and two examples highlight the reduction in private time available to design using design-build.

The owner's preliminary design for the I-85 reconstruction project required two interstate bridges to be built, including a right-hand merge of traffic into the inside "fast" lane of the interstate. The design-build team awarded the project reconfigured the design to build a single bridge on a minor highway over the interstate, eliminating the proposed interstate bridges and facilitating a safer left-hand entrance onto the interstate. The reconfigured solution reduced construction costs and time, reduced owner maintenance, and lowered long-term owner costs associated with plans to widen the interstate in the future.

This is an example of conversion efficiency. The designer was able to devise a better way of using resources by knowing the ultimate design intent of the project, and the attitudes of both the designer and contractor were contributing factors in the reconfigured design. The unique perspectives of each participant, the long-term view of the designer, and the short-term outlook of the contractor were balanced, and together they developed a solution that had positive downstream consequences for the owner and his constituents.

The I-77 project involved reconstruction using the existing median to widen the highway. Concerned over the traveling public's safety if construction trucks were to enter and exit the median via the interstate, the owner specified in the Request for Proposals (RFP) a requirement for nighttime construction, when the traffic volume would be lowest. Two of the proposing design-build teams constructed their proposals around the owner's request. However, the selected team proposed an innovative solution that allows day-time construction without the construction trucks interfering with traffic. They proposed an earthen ramp in the median up to an existing overpass bridge modified to have a construction lane to provide direct access to the site.

The earthen ramp was an innovative solution improving flow, allowing construction to occur during the day, reducing the time and cost of the project. The solution was possible because the engineer and contractor worked together to contribute their unique knowledge. The contractor, whose focus is on construction, time, and delivery cost, worked with an engineer who had the technical expertise and capability to evaluate and execute the idea. As a team member, the engineer was more aware of construction issues than perhaps he might have been if working in isolation and was also willing to dedicate more time to the design while taking on more risk to facilitate the innovative solution.

The I-10 Blackwater Bridge replacement was an emergency project that was fast-tracked due to structural damage caused by a hurricane. During construction, the design-build team encountered poor soils requiring them to extend the bridge approaches. The owner had provided existing soil data with the RFP, but the encountered poor soils occurred outside the area of the provided data. The design-build team requested a change order to compensate for the additional work, which the owner refused, believing the work was the design-build team's responsibility. Unable to reach a solution, the parties used the contractual dispute resolution procedures seeking assistance from a Dispute Review Board. The Dispute Review Board asked the parties to solve the problem jointly, but the parties could not agree. Subsequently, the Dispute Review Board issued a judgment in favor of the design-build team, which led to several other issues being taken to the Dispute Review Board for resolution.

This was an example in which trouble became conflict resulting in conflict escalation as the parties focusing on self-interests were unable to resolve issues. There was also conflict aftermath with the parties unable to cooperate in resolving future problems. The conflict and reliance on the outside party for its resolution ruined the relationship.

The I-77 contracting firm unexpectedly went bankrupt during the project. It was bought by another organization that replaced the firm's top management but left the rest of the organization and the project participants primarily intact. The owner indicated their relationships with the project participants were strong, and the project continued without significant impact. Unity was observed on this project when trouble was encountered, allowing the participants' relationship to survive a substantial change.

On the I-85 project, approximately 60% of the design was complete in the RFP. The owner indicated this amount of design was not ideal for the design-build delivery method. They planned to reduce the level on future projects. The designer's available private time changes when shifting from design-bid-build to design-build. Some owners that were early in the process of making this transition chose to complete a large portion of the design themselves, giving their designers additional private time to set elements of the plan before it was made public. This ultimately gave the owner more control but limited the innovation and flexibility available to the design-build team.

The I-15 owner specified in the RFP his right to conduct multiple rounds of proposal reviews. Two reviews were conducted, an initial round and a best and final offer. This extended proposal period afforded the design-build team's designers additional private time. Rather than completing more of the design during the delivery phase, which is primarily public time in concert with the contractor focusing on flow and input from other team members, the designers could perform more of their work before the start of construction.

5.3.3.7 Delphi Application

Everyday actions needed in relationships working with an incomplete contract and unexpected actions required to resolve trouble create the need for the "right team," as noted by a

Delphi panelist. This panelist didn't describe what constitutes the right team, but all panelists acknowledge its need, ranking it among the top five issues. This issue is used to illustrate the characteristics of the right team when utilizing the perspective of the conceptual framework developed for Attitudes.

First, the "right team" has the "right" actors. These are principal project participants acting for themselves and other stakeholders, acting on their behalf. These actors occupy the vertical dimension of time during involvement points along the horizontal dimension. The membership of the team will be dynamic throughout the project as the principal actors enter and exit, and participants with specialized knowledge, experience, and perspective are added and removed as needed.

Second, the "right team" is composed of actors well-suited for the environment in which they operate. This environment can involve sequential and synchronized phases and individual and collective actions. There is an expectation of "right conduct" by the actors. During "private time" when no one else is present for decision-making, the "right" actor would consider not only his self-interest but also the interests of others in the collective, making the best choice considering immediate and downstream consequences. During "public time" with the whole collective present, the "right" actor will give voice to his self-interest in the presence of all participants providing an opportunity to negotiate and bargain with each member as advocates for their self-interests in reaching an optimal solution based on present and future consequences of the action. In some instances, the solution may be an expression of altruism from some with the cooperative expectation of future reciprocity in some other instance.

The participants' attitudes of cooperation and trust are seen in the "right team" as the relationship develops in achieving unity. Opportunities for this development can be seen when

unexpected events arise, and participants are forced to adjust. The “right team” can adapt to dealing with the situation between the time trouble is realized and its resolution with the right team’s attitude being one of unity.

Third and finally, the “right team” has the “right” attitude. They can stabilize through unity between the two ends of the attitudinal spectrum—self-interest and altruism. This does not mean there will be a lack of self-interest, but simply that these self-interests will be balanced within the group. Participants will cooperate and at times express altruism, but mostly there will be reciprocity. When there are opportunities for the attitudes to be observed, the “right team” will exhibit unity in making the right decision for the group, whether operating individually or collectively.

5.3.3.8 Summary

This section focused on four Attitudes: awareness of conflict of interest, unity, time, and trouble. First, “awareness of conflict of interest” focuses on self-interests and whether these are the driving force behind participants’ actions. In discrete transactions, self-interests exist at the forefront of participants’ minds, each looking to maximize individual gain. In contrast, self-interests exist in the background in relational transactions, with the participants focusing on harmony.

Second, “unity” combines altruism, reciprocity, trust, cooperation, and lack of opportunism. Altruism is important in that participants work towards group interests rather than self-interests. Reciprocity balances altruism, helping through trust, sustaining cooperation, and reducing opportunism. Discrete transactions lack unity while relational transactions depend on it.

Third, participants’ attitude toward “time” is viewed relative to relational time, temporal ordering, accessibility, and production. The relational notion of time is a multidimensional view

that describes how actors perceive time and how they act regarding it. The vertical dimension helps to explain the intent, attitudes, and objectives of actors suggesting how their past affects their present actions and future expectations along the horizontal dimension. Temporal ordering is the sequence, synchronization, and rate of activities. Accessibility refers to public and private time where participants are at times accessible to others and at other times not. Production is conversion and flow, where conversion activities directly convert materials to products and flow activities metering the rate at which this occurs, both aspects of delivery. In discrete transactions, participants are interested in "presentiating" time while preferring to "futurize" in a relational transaction.

Fourth, "trouble" can either be planned for as is often done for discrete transactions or left to be dealt with in the future as usually done in relational transactions. Preparation in the form of procedures sometimes occurs in both instances, for discrete transactions when exact details cannot be foreseen and for relational contracts when outside assistance is required.

5.4 TIME

Throughout a project, there are noteworthy points in time, such as when participants become involved, contracts are entered, and products are delivered. These times can vary, and choices impact when they occur. Two concepts addressed in this section are: "Commencement, Duration, and Termination" and "Transferability."

5.4.1 Commencement, Duration, and Termination

5.4.1.1 MacNeil

MacNeil (1974a) originally addressed "Duration" and "Commencement and Termination" as two separate topics but later combined them into one "Commencement, Duration, and Termination" (MacNeil 1980a, 1981). MacNeil (1981) states that discrete

transactions start sharply, end sharply, and are short-lived, while relationships have no sharp beginning or end and have long durations.

Discrete transactions have “sharp in, sharp out” timing, commencing sharply by explicit agreement and terminating sharply by clear performance. This sharpness pertains to both the commencement and termination of the transaction and participation of the individuals, with the two usually coinciding. The duration of discrete contracts is often short, and the agreement is completed with minimum contact between the parties.

Relationships have “fuzzy in, fuzzy out” timing, often with a point of sharply focused consent. Yet, the relationships will tend to have a gradual and indistinct beginning and usually similarly diffuse ending. While a current agreement may have a distinct beginning, it often doesn’t represent a sharply defined beginning because the participants often have a preexisting relationship. The duration of a relationship is typically long, but differences in duration and member participation do exist.

5.4.1.2 Delphi Panel

The Delphi panel does not speak directly about commencement, duration, or termination, although concerns they do express can be linked to these ideas. For instance, one panelist asks, “how critical are contracts being in place to the scoping process?” The contract marks the point of consent and how soon this occurs during the scoping process impacts the sharpness of the “in” for the current project. A “detailed scope” as suggested by one panelist results in a sharper “in” for the design-build team while scope “flexibility” preferred by another panelist creates a fuzzier beginning with parties extending their design into the proposal period with no guarantee of being selected to deliver the project. When the panel was asked to initially rank the criticality of contracts during scoping, they provided a variable response: three “5’s,” three “3’s,” one “2,”

and one “1.” During the final ranking, those responding lowered their evaluation somewhat resulting in the fourth lowest ranking. Analysis of the data revealed the panelists providing the lowest factor ratings provided the highest rating for the owner leading the scoping process suggesting the panelists prefer delaying the contract while extending owner involvement during scoping.

Another question posed by a panelist, “who should lead the scoping process? Owner? A/E? Design-builder?” deals with the temporal boundary placement of the project phases and their participants. If the owner leads the scoping process, it will likely be a longer duration for the conceptual design phase that extends the owner’s involvement and more provided scope. In contrast, if led by a member of the design-build team, their participation will likely begin earlier in the project lifecycle.

Another panelist suggests, “long-term maintenance, if required, should be well scoped.” This reflects an aspect that impacts project termination and the duration of involvement for the design-build team. When the panel was asked to rate the importance of this concern initially, they provided six “5’s,” one “3,” and one “1.” In the final round, the two lowest values were raised, resulting in six “5’s” and two “4’s” placing the issue among the top ten. All the public sector engineers rated this factor “5,” and as members of the owners’ organizations would naturally be expected to show concern about the maintenance aspect of the project.

5.4.1.3 Literature

“Commencement, duration and termination” are time-related concepts defining moments and segments of time that temporal boundaries can capture. For instance, MacNeil (1974a) describes a discrete transaction as having clearly defined boundaries between being in or out of a commencing transaction and being finished or not of a terminating transaction.

Diamond et al. (2004) says the location and expression of temporal boundaries contribute to our understanding of organizational life. At the temporal boundary, relationships separate and connect, and the social structures of differentiation and integration emerge. Lawrence and Lorsch (1986) provide that differentiation results from functional separation and specialization. Still, the differentiated parts must be linked to be viable, much like a relay race where one functional professional group passes the baton to the next (Takeuchi and Nonaka 1986). Integration is seen when the unity of effort is achieved among various participants (Lawrence and Lorsch 1986), akin to a "rugby" approach with participants working together as a team (Takeuchi and Nonaka 1986).

It is essential to note MacNeil's particular view of time defined by "commencement, duration and termination" lacks a body of literature supplementing this view, despite a vast amount of literature related to time and lifecycle. For instance, literature on "stage gates" (Cooper 1994) speaks of sequential and overlapping phases; the links between the phases are gates established as project milestones for either a quality review or a go/no-go decision of continuing product development. There is reviewed literature dealing specifically with project phases (Krishnan et al. 1997), but it provides no connection between the phases or participants.

Important in achieving a deeper understanding of construction is the connection between when participants begin their project involvement and when project phases occur. It constitutes a relationship between functional and temporal differentiation and integration within temporal boundaries.

5.4.1.4 Classifying Commencement, Duration and Termination in Current Construction Practices and Trends

Temporal boundaries are a lens to view organizational structure and projects. This lens provides a perspective to observe the dynamics of different project delivery methods and helps explain the difficulties encountered in construction and the resulting movement occurring between methods. Five delivery methods along the contractual spectrum are utilized to illustrate these concepts beginning with design-bid-build, then moving to partnering, design-build, construction manager-at-risk before ending with the firm.

Design-bid-build

At the discrete end of the contractual spectrum, the phases of design-bid-build occur in sequence, creating functional and temporal differentiation with each phase being completed by a party specializing in that area before the next phase begins and each phase producing a deliverable for the next. During the design phase, the designer creates a complete design used for procurement. The owner executes the procurement phase resulting in a chosen contractor and an entered contract. The complete design provides a "sharp in" for the contractor who constructs the project during the construction phase. At the end of this phase, a complete facility is handed over to the owner providing a "sharp out" for the contractor. The owner and his maintenance team maintain the facility during the open-ended utilization phase.

One can take a closer look at the participants and their involvement in the project. An owner is tied to a project from its initial concept to the end of its useful life, and when the end occurs, it results in a fuzzy termination. This unclear termination is associated with the fuzziness in the design and utilization phases. The fuzziness of the utilization phase is linked to the uncertainty regarding maintenance and the design decisions made during the design phase. Still,

the fuzziness of both design and utilization is reduced in design-bid-build when the design phase has a sharp termination prior to construction and an owner working with the designer to translate his desires into complete plans for the facility. The termination of the design phase for a design-bid-build delivery method reflects a sharp boundary. However, the designer has a fuzzy termination with the project since he continues to be linked with it until the end of its life. Creating a complete design before construction gives the designer the power to control any design decision in relative isolation.

The construction phase defines a “sharp in” and “sharp out” for the contractor who ends his association with the project after construction and a short warranty period.

Partnering

Some owners began to move away from design-bid-build towards a more relational method like partnering to address problems encountered with design-bid-build such as the adversarial relationship between the designer and contractor caused in part by the separation of phases and some design concerns such as the possibility of overdesign and the limited focus on construction-related issues. Partnering maintains the sequential ordering of the project phases as in design-bid-build but incorporates temporal integration for the project participants during construction. The designer completes the design during the design phase, but his active participation and thus temporal boundary continues through the construction phase. The boundary movement allows the parties to adapt the design to encountered circumstances during construction.

Design-build

Early successes of partnering left owners wanting more of a relationship between the parties pushing the owners further along the contractual spectrum to the relational arrangement

of design-build where there are task and participant integration and overlapping design and construction phases. The contractor and designer are members of the same team, meaning by moving the temporal boundary, the contractor will be involved before construction begins with input during the design phase. A significant difference from design-bid-build is the overlapping of the design and construction phases, meaning the owner and designer no longer work together in an isolated phase to create a complete design before construction. Instead, the designer completes that portion of the design left flexible by the owner during the combined design and construction phase.

One concern about this integration is a prime contractor's potential influence over a subcontracted designer. As the team leader, a contractor can have power over the designer on design issues except for professional role obligations associated with matters of safety. This and other concerns related to the owner's difficulty with scoping are reasons for trying different methods like construction management-at-risk.

Construction manager-at-risk

Construction management-at-risk is a move back towards the discrete end of the contractual spectrum where project phases go back to being sequential but have some overlapping involvement of participants. The contractor's temporal boundary is moved earlier, but in contrast to design-build, where he is embedded in a relationship with the designer; his role here is advisory. The designer has authority over design, but construction knowledge is incorporated through the contractor's advice.

Firm

Some owners desiring relationships push to the firm at the far end of the contractual spectrum with few temporal boundaries. The firm is fully integrated as one enterprise, both

functionally and temporally, having the capability to design, build, and in some cases maintain the facility. This expansive temporal boundary captures much of the facility's lifecycle, preventing the potential of pushing spillover costs across temporal boundaries or onto other participants. There remain concerns that despite the temporal benefits regarding capturing spillover costs, there are functional concerns that should be kept in mind, such as the lack of a firm's policing powers. While a public agency can police its facilities and regulate such things as loads, this becomes a concern when the public agency is no longer in charge during utilization. Another potential concern is the pricing structure for toll road facilities. Is the firm allowed to set its fee structure, or will there be a means to control its return on investment? A public agency is also responsible to the public for safety; can the agency be sure the firm will have the same standards it has?

5.4.1.5 Conceptual Framework

"Commencement, duration, and termination" are temporal elements defining the beginning, length, and end of a project or activity. MacNeil (1974a, 1980a) refers to commencement as the "in" and termination as the "out" with descriptors of either "fuzzy" or "sharp" modifying the characterization of entries and exits of transactions or participants on the project. Discrete contracts are typically characterized by a "sharp in" and "sharp out" while relational contracts a more diffused "fuzzy in" and "fuzzy out."

Temporal boundaries provide a means of describing what is occurring during moments of time. These boundaries can indicate functional and temporal differentiation and integration, characterized as fuzzy or sharp. Discrete contracts are characterized by temporal and functional differentiation with project phases and activities timed in sequential order and participants providing specialized skills for the required tasks in isolation.

Relational contracts typically involve functional differentiation but temporal integration. The parties continue to specialize by contributing unique skills as with discrete contracts, but the relationship results in temporal integration with temporal boundaries moved and manipulated to integrate tasks allowing participants to work together as a team.

Temporal boundaries of relationships create two potential concerns. One concern is the unintended consequences of a potential hierarchical ordering of parties in exercising power and influence over project tasks and subordinate participants. This potential doesn't exist in discrete transactions where only one party participates at a time having full power over that phase. The party of the next phase has not and often cannot begin, and in some instances, may not even be known. This concern is detailed more fully in "Power, Hierarchy and Command." The second concern is the potential for a party with an exit characterized as a "sharp out" to either self-deal or inadvertently make decisions based on their short-term perspective, pushing burdens and costs into other temporal boundaries. This topic is addressed in greater detail in "Benefits and Burdens."

5.4.1.6 Case Study Illustrations

Three projects are used in illustrating these concepts, two projects highlight differences in decision-making by a designer and contractor who have different "outs," and a third project highlights an owner provided flexibility while protecting himself from potential negative impacts of decisions.

On the I-4 project, the contractor proposed reusing existing guardrail material for a new project installation, an approach that the team's designer vetoed. The contractor's "sharp out" exit from the project steers his decision to focus on the short-term cost and time savings of reusing the existing guardrail. The engineer's role obligations for safety and his associated

"fuzzy out" responsibilities for the project led him to oppose the idea, likely fearing the potential burden this could create for the owner and himself.

On the I-77 project, the owner left some flexibility in the owner stipulated design decisions, including that of the guardrail design, which was required only to meet state standards. The design-build contractor chose to place double lines of guardrail in the median that, while meeting the state standards, proved challenging to maintain for the owner. The contractor with a short-term perspective based on a "sharp out" at the end of construction chose a design with low first cost and valuable time saving while pushing the burdens associated with maintenance and lifecycle costs outside his temporal boundary to that of the owner.

The I-15 owner provided flexibility for the design-build team while stipulating his right to choose whether or not to purchase extended maintenance from the contractor at the end of project construction. As part of the design-build teams' proposals, they were to include an "add alternate" obligating them to maintain the facility for up to ten years if the owner chose to purchase it after evaluating the delivered facility. The owner ultimately decided not to buy it, believing the quality was such that the cost of any required maintenance would be less than the proposed cost. The owner found a unique way to balance the flexibility provided with the potential maintenance burden by extending the design-build team's temporal boundary into the utilization phase. This provided a potentially "fuzzy" exit boundary for the contractor instead of the typical sharp one, thus preventing decisions by the design-builder to spill burdens over a somewhat ill-defined temporal boundary.

5.4.1.7 Delphi Application

A Delphi panelist indicates the need for a "shared understanding of scope" that is often easier to achieve for discrete contracts than a relational one. With a discrete contract, the scope is

wholly defined by the owner and designer during the design phase and then provided to the contractor during the proposal phase creating a “sharp in” for the contract at commencement. This “shared understanding of scope” is typically more difficult for relational contracts because the scope is incomplete as the contract is entered—however, the timing of entering the contract during scoping influences how this understanding is achieved. The Delphi panel’s concern illustrates the different perspectives gained from utilizing the conceptual framework of temporal boundaries characterized as sharp or fuzzy applicable to commencement, duration, and termination of projects and activities.

Two possible approaches to achieving a shared understanding of relational contracts are to focus either on the scope or on the relationship. The first approach focuses on the scope. Owners uncomfortable with a mostly undefined scope or who want some parts of the design set before entering the contract may choose to create a nearly complete scope themselves, much like a discrete contract to establish a “sharp in” for the design-build team. Other owners wanting to provide an opportunity for the design-build team to capture the benefits of temporal integration in design may choose to have a large amount of the scope initially submitted in the proposal or conduct iterative rounds of proposal reviews. As more design is completed before award, a sharper “in” is created for contract commencement but at higher costs to the design-build team. They dedicate considerable resources to design without guaranteeing the contract, although some owners offset these costs with a stipend. With this approach, developing a “presentiated” scope tends to push the point of consent and the commencement of performance later into the project lifecycle.

The second approach to achieving a shared understanding focuses on the relationship. In the place of a complete design, clarity in the contract is based on a scope that either specifies an

outcome or procedures. When the outcome is specified, the owner uses performance specifications to describe the resulting functions of the delivered product. While the delivery phase may be undefined, the project termination is marked by a result that meets the specified outcome. When procedures are defined, the owner specifies what must be done in reaching a result of desirable project functions. When followed during delivery, these processes should lead to a product acceptable to the owner, creating a "sharper out" for performance. The flexibility provided in the scope often means the contract commencement is set earlier in the project lifecycle.

A more significant concern about a shared understanding of scope occurs with a wholly futurized project where the limited scope definition results in a "fuzzy in." This approach can be tough for public agents dealing with objective selection processes and strictly regulated appropriations because a shared understanding of the scope is more difficult to achieve, and a fixed price may be more difficult to determine. Also, the potential for pushing burdens can be great if, in the process of making design decisions, the design-build team inadvertently creates burdens for the owner.

Concerns about a design-build team's "sharp out" are addressed in a Delphi panelist's comment to "specify long-term maintenance." An option would be to adjust the temporal boundary of the design-build team where termination would not occur with the delivery of the facility for use but extend their involvement to include operation and maintenance to capture potential spillover burdens.

5.4.1.8 Summary

Commencement and termination can be described as a "sharp in" and "sharp out" applying to discrete transactions of short duration or a "fuzzy in" and "fuzzy out" to relationships

of longer durations. For discrete transactions, the sharpness applies to both the transaction and the involvement of the participants. For relational transactions, the fuzziness applies mainly to the participants rather than the transaction because there may be a moment that captures the commencement of the current agreement. This time perspective uses temporal boundaries that may cover the entire project timeframe or particular time segments that are studied and expanded to observe participants' temporal and functional differentiation and integration.

Project delivery methods are similar in that they are marked by concepts of commencements, terminations, and end of useful life; what differs are the temporal boundaries within this overall span. When specific parameters such as the phases and participants are manipulated, different contractual arrangements emerge. For discrete contracts, such as design-bid-build, owners and designers have "fuzzy outs" relative to utilization, and the design phase is managed through an isolated design phase before construction. This allows for a "sharp in" and "sharp out" for the contractor during the construction phase. This scenario changes with relational contracts such as design-build, where the fuzzy ins and outs dominate, although the owner can make choices reducing some of the fuzziness.

5.4.2 Transferability

5.4.2.1 MacNeil

Discrete and relational contracts have factors that facilitate and inhibit natural tendencies toward "transferability" (MacNeil 1974a, 1980a). Nothing hinders the transfer of either rights or obligations with discrete transactions except for the ultimate responsibility for performing. Non-primary relations and careful measuring facilitate ease of transfer. Other characteristics like the completeness and specificity of planning create no need for future cooperation; the absence of

sharing benefits and burdens means nothing stands in the way of complete transferability, except the ultimate liability for performing the transferred duties.

Relational contracts have many characteristics which work against simple transferability, like direct whole person relations that are heavily dependent on the identities of the other participants. Relational contracts also lack measurability of content, require trust and future cooperation in planning, and involve sharing benefits and burdens. The complicated transfer for relational contracts is tied to its existence within a "social matrix," the broad social background to which promises and contracts are attached. All contracts, even discrete ones, exist within a basic social matrix because an exchange is impossible outside society. Yet, the social matrix is particularly complex for contractual relations, completely embedded and intertwined in society.

5.4.2.2 Delphi Panel

Transferability was not a topic addressed explicitly by the Delphi panel, but because the research initially focused on the scope, all the comments were associated with some aspect of transfer. For instance, the Delphi panelists unanimously agree that a "Shared understanding of scope" is one of the most critical aspects of a project, but they differ on how the scope should be defined. Some panelists desire a "detailed" scope resulting in a more discrete exchange which MacNeil describes as easier to transfer. In contrast, others believe that scope should be flexible, facilitating a relationship but making the transfer inherently more complex.

Two comments under "Shared Understanding of Scope" are addressed more fully below relative to the developed consensus of the Delphi panel over multiple rounds. These comments are "cover all desired work requirements," and the "scope should not be overly prescriptive," each referring to the scope defined by the owner before transferring the project to the market. Yet, these two comments reflect positions at opposite ends of the contractual spectrum.

When initially asked to rate the importance of "cover all desired work requirements," the panel provided five "5's," two "3's," and one "1." In final ratings, the two "3's" were increased to "3.5" and "4," and one "5" was lowered to "4" resulting in four "5's," two "4's," one "3.5" and one "1." The highest values were provided by public sector engineers, the mid-range values provided by the architects, and the lowest supplied by a construction attorney. These ratings reflect the difficulty some public sector owners are experiencing with the transition to a project delivery method requiring less formal scoping. Overall, this critical factor ranked 27th out of 50.

When asked to rate the importance of the "scope should not be overly prescriptive," the panelists initially provided one "5," four "4's," one "3," one "2," and one "1" spanning the full range of possible scores. In the final ratings, the "1" was raised to "2" while all other ratings remained the same resulting in this factor being among the ten least important factors. These ratings also fell along professional lines, with the two lowest ratings provided by an architect and attorney and the highest ratings provided by engineers with the sole rating of "5" provided by a public sector engineer whose experience included the successful use of design-build on a large project where scope flexibility was a priority.

Other Delphi comments reflect different points of transfer for a design-build project. The first is the transfer to the market when the owner solicits proposals for the project. This transfer must include pertinent and sufficient information about the project to allow interested parties to develop their proposals. One panelist says the owner should "include soil surveys," while another panelist sharing from his experience says it is essential to "provide a clear understanding of what information can be relied on by the design-builder," a factor that when presented to the Delphi panel tied with four others as the most critical.

The second is the transfer to the selected team for delivery. Selection of the "Right team" for design-build often involves considering cost and additional factors. With the flexibility and relationship aspects of design-build creating greater "Reliance on someone," the panel indicates the importance of "trust between the owner and design-builder," the "technical competence of the designers and builders," and "evaluators [who] are competent, unbiased, and knowledgeable of the project's needs." During the time leading up to the second transfer, further progress can be made on the development of the scope, something that can be tailored for project needs, with one panelist indicating the owner should "specify expectations for the level of design drawings to be submitted with the tender offer." Owners desiring a contract closer to the discrete end of the contractual spectrum will request a greater level of completion, while owners wanting a relationship with more flexibility can request a lower level. The range of options available to owners is perhaps why one panelist asks, "When during the scoping process are contracts in place?"

The third is the transfer for use that occurs when a completed facility is turned over to the owner for utilization. Maintenance becomes the owner's responsibility for the facility's life unless otherwise agreed upon. A Delphi panelist indicates this aspect of the project should be addressed initially, saying, "long-term maintenance, if required, should be well-scoped."

5.4.2.3 Literature

Supplemental literature fleshes out MacNeil's description of factors inhibiting and facilitating transfers of discrete and relational contracts. The literature is organized around three major transfer points important to construction: transfer to the open market, transfer for performance, and transfer for use.

The first transfer is to the market, planned differently for discrete and relational contracts. For discrete transactions, everything connected to the transaction is "presentiated" into a precisely defined object of exchange containing specifically defined rights and obligations and a precise plan for every conceivable contingency (MacNeil 1974a, 1974b, 1980). This type of contract attempts to anticipate and dispose of all possible future problems and questions (MacNeil 2001). Brown and Dauer (1978), focusing on planning and structuring transactions to avoid disputes, describe this planning as identifying the end sought and planning backward.

Available literature highlights differences in transferability from a legal perspective. Gundlach (1996) identifies law's property and contract forms and their constitutive principles as legal equivalents of discrete and relational contracts. A discrete transaction is like a property exchange in three ways: it is presentiated, clearly defined, and what appears to be one thing, can be considered a multitude of things. Like the presentiation seen for discrete contracts, mandatory rules of property law require all information to be provided in the contract (Frankel 1993, Gundlach 1996). Property law requires much more in terms of the parties' agreement imposing stricter quantitative and qualitative conditions for enforcement than contract law (Frankel 1993). These requirements reflect the broad move in society to "propertize" tangibles and even intangibles such as legal relationships to create markets for them (Frankel 1993).

Like discrete contracts, property contracts are clearly defined, require actors to identify the object of exchange, and clearly define property rights, which both enhance the transferability of the property and clarify expectations (Gundlach 1996, Frankel 1993).

Lastly, property contracts are like discrete contracts in that what appears to be one thing can be considered a multitude of things. When MacNeil (for instance, MacNeil 1974a, 1980a, 1981, 2001) refers to discrete transactions, he typically refers to an exchange between two parties

interacting in the market, but underlying these activities often perceived as one exchange can be seen as a multitude of trades. For example, MacNeil (1981) describes a spot purchase of a specified quantity of coal in which a smelting operation purchases from a coal supplier in a market of many sellers. This transaction between two parties can be subdivided into multiple components. Each party is a bundle of employees, equipment, and other resources that could conceivably be unbundled and viewed separately. Nothing inhibits the assignability of rights or delegation of performance in this transaction as long as the original obligor remains liable on the contract (MacNeil 2001).

Clearly defined property rights enable parties to easily transfer their interests in property to others, in some cases transferring all rights while in others transferring only some (Gundlach 1996). These property rights can be partitioned, divided, and reallocated temporarily or permanently (Alchian 1977). In all cases, Frischmann and Lemley (2007) say both the design and allocation of rights matter, suggesting property rights should be assigned to the party best able to minimize costs and maximize benefits.

The nature of relational transactions and the information provided when entering the market is drastically different from discrete contracts. MacNeil (1974b) says presentiation plays a more minor role as one moves toward the relational end of the contractual spectrum, where more relational aspects are left for future determination. As a result, the well-defined factors making transfer relatively simple at the discrete end of the spectrum are replaced at the relational end by a relationship with an evolving future making transferability more difficult.

Relational transactions are “futurized” (MacNeil 1974a) by leaving the “future where it is; waiting to happen,” making planning for the future incomplete and lacking precision (MacNeil 1980a). Parties can prepare for the future but cannot conquer it. The object of

exchange is not easily measured initially. The parties never intend or expect to see the whole future of the relationship at any single time, viewing it as an ongoing integration of behavior growing and varying with events in a largely unforeseeable future (MacNeil 1974b, 1980). The close personal relationships, need for future cooperation, and significant duration of these relationships create "entangling strings" in a "relational web" that make transfer difficult (MacNeil 1974b).

Like the futurizing seen with relational contracts, contract law allows parties to design their agreement as they desire with "freedom of contract," a principle of contract law (Frankel 1993, Gundlach 1996). Gundlach (1996) says the law cannot be expected to anticipate the content of the infinite number of transactions that parties might engage in, so contract law furnishes parties the freedom and protection to establish their relations. Contract law places greater emphasis on relationships and the internal elements underlying the transfer and less on specific aspects of the transfer itself (Frankel 1993). This relational emphasis permits the law to be flexible, to change after the transfer with an increased reliance on extralegal devices for governing relationships: such as good faith expectations, customary industry practices, previous dealings between parties, and duties of loyalty and disclosure (Gundlach 1996).

While the two extremes of the contractual spectrum are emphasized above, the transactions can exist at any point along the spectrum, blending discrete and relational elements. Frankel (1993) indicates that property and contract laws overlap from a legal standpoint, with aspects of property law continuing as the movement toward relationships occurs along the spectrum. Wessel (2004) states that not all agreements can be neatly categorized at the poles but instead have varying levels of discrete or relational components.

The second element of transferring to the market indicates how the chosen participant will be selected. The utility theory principles show a decision-maker deliberately calculates and consistently makes choices that will result in his greatest possible amount of satisfaction by maximizing his utility (Harrison 1975). The choices concerning utility are often different for discrete and relational transactions. For discrete transactions with clearly defined property expressed during the proposal phase, the buyer typically uses a "monocriterion" approach, selecting based on a single measure such as price (Roy 2005).

For relational transactions, the futurized nature typically requires a "multi-criteria" approach using multiple measurements (Roy 2005). This basic concept is seen in the decision process of Benjamin Franklin (1986), who made decisions not looking at a situation in total, but looking at it in parts, a process he calls "moral algebra" consisting of establishing and weighing elemental pros and cons. According to Figueira et al. (2004), such a decision process is strongly related to comparing different points of view, which are roughly defined as criteria allowing decision-makers to assess similarities and differences and strengths and weaknesses of the alternatives while making their decisions.

Decision-makers employ multi-attribute utility theory in objectively evaluating tradeoffs and choosing from among alternatives (Antonsson and Otto 1995, Keeney and Raiffa 1976). Decision-makers give voice to their objectives and value system. When impacting others, they will incorporate their feelings, values, and utility preferences in making their assessment through an additive utility function (Roy 2005, Keeney and Raiffa 1976). Individual utility functions can be weighted based on importance, considering both quantitative and qualitative factors (Keeney and Raiffa 1976). Particularly relevant to this research are instances when multi-criteria utility theory is applied in design tradeoffs as Otto and Antonsson (1994) suggested with criteria

focusing on the end product and supplier selection (Sanayei et al. 2008) when focusing on choosing a contracting party.

Another aspect of transferability relevant to relational contracts is reliance, where the terms are left open to be settled or adjusted as the relationship proceeds (Jaffey 1998). The "open boundaries" of relationships that allow extensive information sharing (Gundlach 1996) create concern about the "assumption of responsibility" for the information made available to market participants during transfer (Jaffey 1998).

Following the "transfer to the market" is the second transfer point, "transfer for performance." The buyer had executed the selection process just before this transfer, determining the party that provides the greatest satisfaction and entering a contract for project delivery with them.

For a discrete transaction, the decision-maker often selects the party for transfer using a single criterion described by Figueira et al. (2004) as merging the multidimensional aspects of a decision into a single scale of measure as mentioned above. Despite the ease of this selection, Roy (2005) indicates monocriterion decision-making can have disadvantages in that it may: (1) lead to wrongly neglecting certain real-world aspects, (2) facilitate the setting up of fictitious equivalencies while having its fictionalized nature remaining invisible, and (3) tend to present features of one value system as being objective, while it's not. Once determined, the selected party in a discrete transaction enters a contract initiating performance that involves executing the performance described in the presentiated contract.

For a relational transaction, the decision-maker performs the utility assessment by selecting and transferring to the party best satisfying the multiple criteria. When using an "additive utility model, "the individual criteria" utility scores are aggregated to determine the

selection maximizing the overall utility (Keeney and Raiffa 1976). Roy (2005) says multi-criteria tend to avoid the dangers of using a mono-criterion. This is because multi-criteria allow one to mark out a broad spectrum of viewpoints that most likely align the decision process with those of the involved actors. A second reason is constructing a family of criteria preserves the original concrete meaning of the corresponding evaluations without any fictitious conversion equivalence. A third reason is that multi-criteria facilitates debate on each criterion's respective weighting in aiding the decision process.

Once selected, these parties enter a contract for performance in an evolving relationship to produce a result that becomes more specific over time. During this performance period, these relationships will involve tradeoffs which Zeleny (2009) suggests some participants will abhor because tradeoffs make decision-making harder, less transparent, and loaded with post-decision regret. Given the concerns associated with the transferability of relational contracts and this "post-decision dissonance" over tradeoffs, some owners develop ways to deal with the difficulty and uncertainty of these transfers by including specific contract stipulations. For instance, Smith (1991), who addresses the dynamic obligations of treaties, indicates the importance of establishing verification measures that can be incorporated to extend involvement beyond the point of promise.

After "transfer to the market" and "transfer for performance" is the third and final transfer point, the transfer of the finished product to the owner for use, "transfer for use." For discrete transactions, this is straightforward, with the property clearly defined before the transfer to the market in a presentiated contract. This result is expected to be provided to the owner after the performance period.

This “transfer for use” is different for relational transactions due to the futurized nature of the contract for performance. In relational transactions, the result is not fully defined initially in the contract. Instead, the owner selects the team who should provide the greatest satisfaction in the project performance and delivery. The concern is the selection process may not be able to capture everything, and what is not captured may be ultimately reflected in the resulting product transferred back to the owner for use. This unintended consequence includes the potential for spillover costs or benefits. Coase (1988) refers to spillover costs as an “externality.” He defines it as the effect of one person’s decision on someone who is not a party to that decision. Spillover costs arise where decisions made during performance negatively impact the asset after being transferred to the owner. These externalities are generally not adequately factored into a person’s decision about whether and how to engage in an activity and may distort participant coordination (Frishmann 2009). Ideally, the party entitled to the benefits of a decision should also be fully encumbered with its associated costs, thereby forcing them to factor both elements into their decisions (Frishmann and Lemley 2007).

5.4.2.4 Classifying Transferability in Current Construction Practices and Trends

The lifecycle of a construction project can be described by transfers and the work performed before these points to make them transferable. The three main transfers are the “transfer to the market,” “transfer for performance,” and “transfer for use” occurring between the four main project phases, which are pre-proposal, proposal, performance, and utilization where actions are taken and choices made by participants subsequently transferring the project to others. In this discussion, five construction delivery methods are illustrated using these concepts, with design-bid-build and design-build described in the most significant detail, only highlighting the difference between the other methods.

Design-bid-build

The design-bid-build delivery method has the design phase serve as the pre-proposal phase. The work to make the project transferable to the market begins with an owner identifying his needs and those of his constituents. Working with the owner, a designer develops a solution to meet those needs in 100% complete plans and specifications. During the design phase, an owner focuses on defining the product in a presentiated scope that will ultimately be transferred for use at project completion.

The owner provides this information and the selection criteria in an invitation for bids to market participants. This invitation and supporting documents represent the transfer to the market. The complete scope allows public owners, who must have an objective selection process, to select on a monocriterion of a low responsive bid from a responsible bidder.

During the proposal or bidding phase, the interested contractors develop bid proposals for the presentiated, owner-defined scope. The transfer for performance is marked by awarding the contract to the selected lowest, responsive bidder.

The performance phase is synonymous with the construction phase, during which the selected contractor produces the completed facility defined by the scope. During this phase, the owner confirms that the created product is as described in the initial bargain and accepts the facility for use once completed.

The transfer for use in discrete contracts is relatively straightforward because of the events leading up to it. The contractor delivers the facility defined in the project documents, which initiates the utilization phase with constituents gaining access to the facility and the owner responsible for maintenance.

Design-build

The design-build project delivery method operates the transfer points differently. The pre-proposal phase is the conceptual design phase, with the owner developing criteria for team selection and an initial futurized scope. This initial scope is transferred to the market where proposing design-build teams seeking the award further develop it during the proposal phase. In some instances, owners are unclear about their initial expectations hoping the design-build team defines it during the proposal phase leading some owners to require a nearly complete design in their proposals or multiple rounds of design submittals and reviews to produce a finished product plan before award. Such an extensive design effort creates a burden for design-build teams as they dedicate significant resources without a guarantee of being awarded the contract.

The owner uses the earlier defined criteria in selecting the design-build team considered the best fit for the project and subsequently entering a contract with them to deliver the facility. If the scope were completed as part of the proposal phase, the contract would be a presentiated, discrete-type contract. Alternatively, if the scope remains incomplete at contract award, it will be a futurized, relational one. The contract marks the transfer for performance where the design-build team obtains the rights specified in the contract, and the owner retains all residual rights.

The performance phase reflects when the design-build team completes the remaining design, left incomplete at the award, and the construction to deliver a completed facility.

The facility is turned over to the owner with “transfer for use.” Concerns over potential spillover burdens as designs are completed by the design-build team during performance cause some owners to extend the involvement of the design-build team for operations and maintenance during utilization.

Partnering

The partnering delivery method mirrors that of design-bid-build, except that the parties agree to a cooperative relationship during the performance in solving construction-related problems.

Construction manager-at-risk

The construction manager-at-risk delivery method also mirrors design-bid-build, except that a construction manager contributes construction knowledge during the design phase before its transfer to the market.

Firm

Delivering a project by a firm is like a design-build relational contract except for the relationships between functional actors existing within a single organization, and typically less information is provided with transfers to market and performance.

5.4.2.5 Conceptual Framework

A construction project involves at least three main transfer points: “transfer to the market,” “transfer for performance,” and “transfer for use.” These points are preceded by phases that produce the deliverable for transfer: “transfer to the market” is preceded by the pre-proposal phase, “transfer for performance” is preceded by the proposal phase, and “transfer for use” is preceded by the delivery phase and followed by the utilization phase.

During the pre-proposal phase, the owner defines the scope and selection criteria. The scope will be presentiated, futurized, or some combination of the two, often developed with the help of designers. The selection criteria will be either a single criterion such as low price or multiple criteria reflecting the value systems of the owner and other stakeholders. The developed information is provided to interested proposers as the owner enters the market.

The transfer to the market occurs when the owner solicits offers for the described scope of work and begins the proposal phase with offerors responding in a proposal form. These proposals look to satisfy the criteria identified by the owner, varying from a simple price for a presentiated scope to design work and team qualifications in addition to a price in responding to a futurized scope. For this futurized scope, the owner may require a certain level of design or reserve the right for multiple rounds of proposal submissions and reviews, allowing the design to develop to the desired degree. The owner evaluates a builder or team on the identified mono- or multi-criteria and then enters a discrete or relational contract with the selected party.

The transfer for performance occurs at the contract award, with the selected party acquiring the specified rights and beginning the delivery process. The performance phase segments the work necessary to deliver a completed facility. The builder determines the means and methods for performing the work required to produce the product defined in the complete scope. If performance was made flexible through a futurized scope, parties in the relationship work together to complete the design and construct the facility.

The transfer for use begins the utilization phase marking the return with full owner's rights and responsibilities in the completed facility. However, this transfer might vary. In some instances, the delivery team continues their involvement in operation and maintenance activities because the owner wants a hands-off approach to facility ownership or perhaps over concerns about spillover costs from short-sighted decisions during the performance.

Generally, these options can be aggregated to represent discrete and relational contracts. Discrete transactions like design-bid-build are completely defined before transfer with the presentiated contract akin to a property contract with clearly defined rights and obligations; all conceivable aspects of the transaction are made known. Transferability of this type of exchange

occurs with relative ease; a seller easily transfers to a buyer, or an owner easily transfers rights to another or even multiple parties. The initial transfer is a transfer to the market soliciting responses with contract specifics and selection method that often involves a mono-criterion such as low cost. Upon selection, a discrete contract is entered. The project is transferred to the contracting party, who assumes the allocated rights under the contract and performs the necessary work to deliver the described product. Upon completion, the product or facility is transferred back to the owner for use.

The transferability for relationships like design-build is more complicated than discrete exchanges. Relational contracts are typically only partially defined before transfer. The process is akin to contract law, with the freedom of contract allowing parties to structure their agreement as they see fit. A futurized contract focuses on achieving an outcome, and the transferability of this type of exchange is challenging with its incomplete contract and the need for extensive interaction to complete. The initial transfer to the market specifies the desired outcome and criteria for selection as potential relational parties are solicited. Upon selection, a relational contract is entered, and while lacking clearly defined obligations, the parties rely on relational norms such as good faith, goodwill, and cooperation. The relationship evolves with the product becoming more defined over time during the performance phase. The completed product or facility is transferred back to the owner for utilization and maintenance. There can be concerns about product quality when it is partially defined by a party with only temporary ties to the project. In some instances, adjustments are made to account for this concern with the transfer back to the owner pushed further into the future by continuing the involvement of the constructing party for at least a short period for a warranty or, in some instances, longer if an extended period of maintenance is agreed upon in the contract.

5.4.2.6 Case Study Illustrations

Transferability within a conceptual framework is illustrated using several case study projects. The I-15 project demonstrates deliberate choices made by the owner before each transfer. Additional projects are highlighted for difficulties associated with particular transfers; the I-10 owner provided insufficient soil data, the I-85 owner provided incorrect traffic data in their solicitation, and the I-77 owner entered a futurized contract with inadequate descriptors to assure the desired product upon turnover.

The I-15 owner chose to leave large portions of the project flexible and other parts the owner defined in detail during the conceptual phase. The detailed parts were either in areas the owner was concerned about the timeliness and provided the complete designs for these long-lead items or in areas they wanted to be delivered in a particular way detailing it with prescriptive specifications. To economize for the proposing design-build teams, the owner decided to provide a detailed geotechnical investigation with the Request for Proposal (RFP) so that each group could rely on it and not perform their own studies during the proposal phase.

The owner also reserved the right for multiple rounds of proposal reviews which they invoked during the proposal phase, conducting one additional proposal review. Another such right was that the owner could choose whether or not to purchase an extended warranty before transferring the facility for use. The owner, concerned over the potential for low product quality given the flexibility provided to the design-build team, required the proposing design-build teams to submit an add alternate for an extended warranty with their proposals.

The RFP described the selection process that involved a large evaluation team and established selection criteria. Once selected and the contract awarded, the owner would remain involved during performance using “over-the-shoulder” design reviews and partnering. At the

end of the performance phase, the owner evaluated the delivered product quality, determining the warranty's cost would exceed the costs of any repairs that might be needed during the extended warranty period. The owner decided not to purchase the warranty.

Other projects are used to highlight choices made by owners encountering transfer-related difficulties on their projects. The I-10 Blackwater Bridge project was an emergency project requiring quick replacement due to hurricane-related structural damage. The owner chose to use the design-build method for the first time to shorten delivery time. Working within a compressed schedule, the owner developed a design-build contract based on their existing design-bid-build format, providing the proposing design-build teams with the available geotechnical data to expedite their proposals. The parties had different expectations attached to the data. While the design-build team felt the contract supported their reliance on the information, the owner believed the design-build contract's relational elements suggested the parties cooperatively deal with any encountered problems. The supplied geotechnical data proved insufficient to identify poor soils in a particular area. There was a subsequent disagreement over the responsibility for the cost of redesign and reconstruction, requiring a Dispute Review Board intervention that ruled the owner must compensate the design-build team for making the necessary changes.

The I-85 project had a similar problem but a better resolution. The project owner provided traffic data that was to be relied on by the design-build teams in their proposed designs. The data later was determined to be wrong, forcing the design-build team to change their acceleration-deceleration lane. The owner took responsibility for the incorrect data provided with the transfer, compensating the design-build team for the necessary changes.

The I-77 owner transferred the project using a futurized contract that gave the design-build team flexibility in guardrail design, resulting in a double line of guardrail in the median that proved difficult for the owner to maintain during utilization. This project was transferred for performance, lacking components necessary for a satisfactory result such as selection criteria to capture specific maintenance concerns, stakeholder representation during selection, rights during design for owner input on the final product, or a means to extend the design-build team's responsibilities to include operations and maintenance.

5.4.2.7 Delphi Application

The Delphi panel, as is the industry, is concerned about a "Shared Understanding of Scope," "Reliance," and other issues that can be classified under "Transferability." The developed framework is applied to illustrate its usefulness for addressing the concern of a "shared understanding of scope" and its influence on the multiple transfers that occur in construction.

First, discrete transactions have a defined end-product provided by the owner in the lead up to transfer to the market. Some Delphi panelists prefer this complete design even for relationships as suggested by one comment saying, "provide a detailed scope," in that it allows a shared understanding to be easily achieved, allowing the owner to establish a single criterion, low cost, as the mechanism for selection when transferring the project to the market.

The proposal phase involves the proposing teams determining a price to deliver the described product in this approach. The contractor with the lowest price is deemed the "right" contractor, assuming they are also considered to be responsible. Like a property exchange, both sides of the agreement are clearly defined in the contract, a complete scope by the owner and a

fixed price by the contractor. The transfer for performance occurs when the contract is entered with the lowest, responsive bidder.

The performance phase involves the contractor producing the described product. The owner includes an inspector to assure the product is constructed as specified, and the final transfer is straightforward due to the nature of the earlier transfers. The contractor transfers the finished product, as defined earlier by the owner, back to them for their use.

This approach to defining product scope can also be used for portions of design-build projects the owner wants to specify, moving it closer to the discrete end of the contractual spectrum as more of any project is defined.

Second, relational transactions have the owner looking forward during the pre-proposal phase to two subsequent transfers in determining how to prepare the project for transfer to the market. The owner must consider the "transfer for use" in determining how he will scope the project. The owner may describe the desired outcome using performance specifications or specify procedures with prescriptive specifications to establish the desired product, serve as the basis on which promises are made, and reflect the shared understanding of what will be achieved. The owner may also choose to have some remedy or warranty as part of the scoping agreement. The owner must also consider the "transfer for performance" in determining how he will objectively "pick the right team" for the relationship. Input from "stakeholders" can be used to develop selection criteria that include a combination of team and project-related factors.

After receiving and reviewing proposals, the owner selects a team and enters a contract marking the "transfer for performance." The contract may remain futurized for some portions of the project, not based on detailed product descriptions but established promises for the relationship on one side and an agreement for payment on the other. The design will continue for

the futurized portions of the project. For some owners, the choices made during the performance will be a concern leading them to continue their involvement as decisions are made. Other owners might include protective measures in the agreement after the "transfer for use."

At the end of delivery, the project is transferred for use either as the final transfer to the owner or for an extended maintenance period where the facility is being used but is maintained by the design-build team.

Relational projects can vary in structure, with some additional choices highlighted below. Some design-build projects located in the middle of the spectrum combine features of discrete and relational projects. With the option to begin like a relationship but morph into a discrete-type arrangement before transfer for performance, initial planning occurs like a relationship with the owner describing the conceptual scope and how he will select the design-build team, but also informing the proposing teams in the RFP of his intention to mostly complete formalized scoping before contract award. An example of this is the owner stipulating "the level of design required with the tender offer," as one Delphi panelist recommends. He may specify his right to conduct multiple rounds of proposal submittals and reviews. This approach may occur when owners want to review and approve proposed innovative solutions. Also, as selection criteria are developed, the number and weighting of the criteria often tend to be more heavily in favor of product-related factors. And because the design-build team will, in essence, develop both sides of the bargain, there will typically be a two-part evaluation process in which the technical solution will be compared against the offered price.

The proposal phase involves a negotiation process in which the design-build team creates a design for satisfying the owner's requirements and develops a price to deliver the product. This process is comparable to a manufacturer developing a product, and the buyer decides whether or

not the product meets his needs and to buy at the offered price. Here, the owner uses the selection criteria to evaluate the presented designs objectively and picks the "right" product offered at the right price. The project is transferred for performance when an agreement is entered, and if the design is complete, the agreement will be a discrete contract.

With relational projects involving firms at the far relational end of the spectrum, the selection criteria focus heavily on team-related factors. Additionally, the owner must consider how a price can be determined when the scope is incomplete at contracting, which is a pressing concern for public agencies dealing with appropriations. Because some variable pay will typically be desired, the potential options could include cost-plus or some measure of an all-in unit price determined in advance. If a unit price system is chosen, pricing will occur as the actual quantities are defined as the design is created. If the cost-plus option was selected, the owner who is likely still involved in the process makes decisions about what he wants in the final design, with the owner paying based on his design preferences.

5.4.2.8 Summary

MacNeil (1974a, 1980a) identifies "Transferability" as a characteristic of discrete and relational contracts and focuses on differences in the two exchange styles. In construction, transfers occur at multiple points during the project lifecycle, with the three main transfers being "transfer to the market," "transfer for performance," and "transfer for use." With the "transfer to the market," the owner defines what he desires through some combination of presentiated and futurized scope and selects from the market participants using either a mono-criteria or multi-criteria selection process.

With the “transfer for performance,” the owner selects a builder or team based on the defined criteria and enters a discrete or relational contract. The selected party performs the work necessary to deliver a finished product.

With the “transfer for use,” the facility is transferred back to the owner for utilization. Unless otherwise agreed, the owner becomes responsible for operations and maintenance for the facility’s life.

5.5 PLANNING

Planning is preparing for action, and what occurs during planning can vary regarding both the amount and type of planning. The concepts in this section can be grouped into two categories, one providing characteristics of the plan—“Planning,” “Future Cooperation,” and “Measurement and Specificity”—and the other providing elements of the plan—“Obligations” and “Benefits and Burdens.”

5.5.1 Planning

5.5.1.1 MacNeil

MacNeil (1974a, 1980a, 1981) compares “planning” for discrete and relational contracts using six factors: substance-process, completeness-specificity, tacit assumptions, participation, post-commencement planning, and bindingness.

First, “substance-process” is the primary focus of planning. Planning for a discrete transaction focuses on the substance of the exchange—the price and the good or service—while planning the process of the exchange deals with handling occurrences of trouble in the transaction. Planning for a relationship focuses on the substance of the exchange if the relationship can be transactionized when planning occurs, but if it can’t, then planning will focus

on how the relationship is to operate. In this case, planning is both constitutional and procedural, providing a framework for additional planning in the future.

Second, "completeness-specificity" for discrete transactions is complete and specific, encompassing everything except unforeseen contingencies. Planning for relationships is typically incomplete, with specific and complete planning occurring only for those portions that are transactional at the time planning occurs. All other planning involves an element of tentativeness with specificity and completeness not possible or even desirable. However, planning of structures and processes can be complete and specific in a constitutional sense, not in a day-to-day operational sense.

Third, "tacit assumptions" are not involved in discrete transactions other than the assumption that a social matrix exists to prevent theft and enforce promises. In relationships, tacit assumptions are common. These assumptions range from general ones like trust to highly specific ones about trade usage. Tacit assumptions are a significant aspect of planning, with mutual assumptions serving the same function as expressed mutual consent.

Fourth, "participation" in discrete contracts involves unilateral planning by one of the parties. While contractual relations often involve mutual participation, most of the planning occurs through joint effort after the commencement of the relationship. Most relational planning is either bilateral or negotiated but may be unilateral in some instances through hierarchical command.

Fifth, "post-commencement planning" for discrete contracts is unnecessary because of the complete and specific planning performed before the commencement of the transaction. It only occurs in discrete contracts when unforeseen events make adjustments necessary. For

relational contracts, planning continues after the formation of the relationship and can vary from general to specific.

Sixth and finally is “bindingness.” Planning is intended to be entirely binding for discrete transactions. In relationships, some planning may be binding. Still, most plans remain flexible, subject to change with circumstances either by negotiation and agreement or by an exercise of unilateral power if planning occurs by hierarchical command.

5.5.1.2 Delphi Panel

The Delphi panelists address planning with comments grouped under “Shared Understanding of Scope,” which is a comment provided by a panelist and the label used to categorize other additional comments. When asked to rate “Shared Understanding of Scope,” the panelists unanimously agreed on its importance by all providing values of “5” in both the initial and final rounds leading to tying with four others as most critical. However, panelists differ on achieving a shared understanding, some saying, “provide a detailed scope” and “cover all desired work requirements.” In contrast, others say the “scope should not be overly prescriptive” and “the owner should let go of the controls and allow the design-build team the flexibility to provide their best and most innovative product.” The conflicting nature of these comments, while initially puzzling, becomes apparent when placed at opposite ends of a contractual spectrum reflecting different approaches to planning.

Comments of “provide a detailed scope” and “the owner should let go of the controls” represent different levels of “completeness and specificity” of planning. When the comment “provide a detailed scope” was initially presented to the Delphi panel for rating, it received four “5’s,” one “4,” two “3’s” and one “1.” In later rounds, both rankings of “3’s” were raised to “4” and one “5” was lowered to “4” resulting in three “5’s,” four “4’s” and one “1,” tying with two

other factors at 28th out of the 50 critical factors. A closer look was taken of the panelist providing the single low outlying ranking. This panelist had a decided preference for a flexible scope. He consistently offered ratings of "1" for all factors associated with detailed scoping, factors such as "the scope should encompass all disciplines and activities" and "the scope should cover all desired work requirements." While he provided ratings of "5" for all factors associated with flexible scoping, factors such as "be clear about what the project is to accomplish" and "outline performance expectations for the design-builder."

When the comment "the owner should let go of the controls and allow the design-build team the flexibility to provide their best and most innovative product" was presented to the Delphi panel for rating, it initially received one "5," five "4's" and two "3's." In the final round, three panelists remained consistent with their ratings, two adjusted their ratings by one point, one up and the other down, and three did not provide final ratings leaving the results at one "5," two "4's" and two "3's" placing it 33rd on the overall list. An analysis yielded no noticeable pattern in the ratings. All were in the mid to upper range of the scale and had no evidence of clustering based on their professions or organization, with members of owner organizations represented in all three values.

Analysis of the complete list of factors did not show a consensus regarding a preference for planning at one end of the contractual spectrum or the other. The highest-ranked factor that pertained to a detailed or flexible scope was "outline performance expectations for the design-builder," which placed eighth overall, indicating a preference towards flexibility. Other related comments that are clustered nearby do not imply that same preference. "Use performance style specifications," considered a relational approach to planning tied with "provide a detailed scope," a more discrete approach. Other comments spanning the spectrum like "encompass all

disciplines and activities," "avoid gaps and overlaps," and "the owner should let go of the controls" were ranked 31 through 33, respectively.

The Delphi concerns seem primarily focused on whether planning results in a detailed or flexible scope, which are concerns directly linked to the completeness and specificity of planning. The five other attributes identified by MacNeil were not directly addressed but inferred in the comments. For instance, "meetings at the jobsite when the location of the design team is separate from the construction team" are procedures for post-commencement planning. Another example, "long-term maintenance, if required, should be well scoped," eliminates the need for tacit assumptions about maintenance. Still another instance, "specify expectations for the level of design drawings for tender offer" reflects mutual participation in planning pre-commencement. And the question "who typically leads the scoping process? Owner? A/E? Design-Builder?" addresses the organizational structure during pre- and post-commencement planning. In another instance, a Delphi comment suggests "the design-build firm should have the flexibility to modify the preliminary design and still meet the scope and requirements of the RFP without sacrificing safety and life cost of the final product" indicates the scope should not be binding.

5.5.1.3 Literature

"Planning" is expanded below with supplemental literature in two areas: "presentiating" and "futurizing." Planning is the coordination of exchange yielding either presentiated contracts for discrete exchanges or futurized contracts for relational exchanges. These reflect the two extremes on the contractual spectrum, although many contracts involve combinations of the two types of planning. The archival literature typically addresses the "substance-process" aspect of planning, leaving largely untended the influence of MacNeil's five other areas of planning.

5.5.1.3.1 Presentiating

The goal of parties planning a discrete contract is to "presentiate" by bringing all the future into the present, where it is arranged to provide 100 percent complete, binding planning (MacNeil 1974a, 1974b, 1980a). The object of exchange is specified in the contract, and to the extent possible, every conceivable contingency is entirely and precisely planned. Rights are bargained for in the present, and all obligations are clearly expressed at contract formation.

Presentiation yields what Wessel (2004) describes as a "four-corners" agreement in applying MacNeil's relational contract theory to treaties. All aspects of the future are captured within the four corners of the contract document. This agreement leaves no room for tacit assumptions, requires no post-commencement planning, and binds the parties from the moment of mutual assent (MacNeil 1974a, 1980a). Wessel (2004) refers to discrete contracts as "end-game" and "static" agreements.

The discrete contract process molds the future and structures interaction through a current transaction establishing legally binding expectations of the parties and solutions if these expectations are not met (Brown 1956). It is impossible to address all possible future eventualities through unilateral planning before entering a discrete contractual agreement. As a result, some solutions will be in the form of the processes described next for relational contracts.

5.5.1.3.2 Futurizing

Planning a relational contract that is "futurized" can best be described as planning a constitution (Goldberg 1976, Hadfield 1990, Gifford 1991, Vanberg 1994). The approach used for discrete transactions no longer works because many issues are unknown, causing the emphasis to shift from a detailed agreement to a relational commitment with structures and processes for the future (Goldberg 1976). Vanberg (1994) provides an illustrative example of a

group of corporate actors forming an organization by establishing a constitution to define the joint enterprise's terms and give the procedural foundation on which organizational action will be based.

Mirroring Corwin's (1936) description, a constitution is both a "symbol" because it protects rights and powers and an "instrument" because it can impart a desired shape to events in the future. Constitutions representing relationships can be thought of in two parts: the part which establishes and protects rights much like the Bill of Rights (Amar 1991) and the part which establishes processes for going forward. First are the enumerated rights. Just as the United States Constitution specifies rights for individual citizens and branches of government, so too would a constitution accomplish this for the parties to a relationship. Second are processes for the future which can be compared to the structure and processes established in the United States Constitution for the government and for any changes to the Constitution itself (Amar 1991). For relationships, such procedures may be established for things like dispute resolution, adjustment to unexpected factors that arise during the relationship, and decision-making (Goldberg 1976, Vanberg 1994). For example, Vanberg (1994) says it is vital to consider how the organizational decision-making process will be structured. The constitutional perspective draws attention to two different aspects of the issue. One aspect is to whom the constitution assigns rights to take part in organizational decisions. And the other aspect is whose interests are considered by those authorized to make organizational decisions. These interests may belong to members of the organization or to external parties, who the decision-makers must consider even if these parties have no actual constitutional rights in the decision-making process.

Relational contract planning as a constitution focuses on "process" and impacts the other five planning factors. This type of planning lacks the "completeness and specificity" of a

traditional contract but instead establishes frameworks for cooperation and adaptation for "post-commencement" planning. Because relational contracts lack rigid specificity, they are referred to as "incomplete contracts" (Hart and Moore 1999, Williamson 1975). These contracts do not address every potential state of the future because to do so is impossible because all circumstances cannot be foreseen, would involve a high "transaction cost" (Williamson 1975), or be undesirable because it can jeopardize the relationship by signaling a lack of trust (Macaulay 1963). Too much "bindingness" in the contract also reduces the parties' ability to cooperate (Hauser and Roitinger 2004). As to "tacit assumption," it is often believed that parties retain all existing rights with mutual "participation" in planning, but when the parties are combined into a relationship, this may no longer be the case for specific power structures. This situation should be considered and addressed during planning.

It should be acknowledged that futurized contracts may present a challenge for some participants, particularly those previously involved with complete contracts owing to the influences of "structural inertia." "Structural inertia" is a force on organizational structures that can prevent or slow change (Hannan and Freeman 1984), causing parties to remain stuck in their existing structure and bringing aspects of their old culture with them to the new system (Schaefer 1998).

5.5.1.4 Classifying Planning in Current Construction Practices and Trends

Planning is described below for five project delivery methods beginning at the discrete end of the contractual spectrum with design-bid-build and ending at the far relational end with the firm while following the industry's movements between forms.

Design-bid-build

Design-bid-build is an example of a discrete contract in which all conceivable aspects of the project are planned and presentiated in the contract. The owner and designer unilaterally develop the contract creating a 100% complete design to define the substance of the exchange and anticipate and plan for all potential problems. In this method, procedures are prepared to deal with the parts of the project that cannot be thoroughly planned, limiting post-commencement planning to only situations such as changes and unforeseen conditions. The result is a complete and specific contract that is totally binding and void of the need for tacit assumptions. Throughout delivery, the focus is on executing the plan with any problems that arise dealt with by following established procedures and returning the project to the original plan as quickly as possible.

There were two aspects of planning in the discrete form that contributed to the owners' desires to use more relational delivery methods. One is the lack of contractor input in the planning process, and the other is a concern about overdesign. Both aspects stem from unilateral planning. As the industry began to shift along the spectrum to more relational arrangements, the first derivative method was partnering.

Partnering

Planning for partnering is similar to planning for design-bid-build except for the post-commencement planning occurring within the relationships. During construction, the parties establish a relationship allowing any encountered problems to be worked out cooperatively. Although this method facilitates mutual planning, it was only for areas where omissions or errors occurred and didn't adequately address owners' desires regarding the other aspects of planning.

Design-build

Owners desiring for more of a relationship during planning began to push further along the contractual spectrum in the relational direction to design-build. The relationship component meant contractor input could be incorporated into the design with fewer tendencies toward overdesign.

With design-build, the initial planning results in a futurized contract with planning to continue in the relationship. The owner develops a partial scope and then enters a contract with a design-build team who completes the planning during delivery. As members of the same team, the designer and contractor collaborate in completing the design and constructing the project.

Those using design-build seemed to experience difficulties in three planning-related areas: the partial scope concerns some owners regarding unknown project deliverables, structural inertia makes scoping difficult for some owners with deeply engrained design-bid-build mindsets, and the organizational structure of design-build unduly influencing project planning. There were assumptions that all parties would retain their role-related rights regarding this last issue. Still, team dynamics might sometimes suggest the prime contractor held all rights, including the ability to influence the subcontracted designer, creating difficult relationships due to naturally differing perspectives of the parties. This influence was not an issue with other delivery methods because the designer performed complete planning before selecting the contractor. In light of the knowledge provided in the literature, it seems apparent the rights component of design-build contracts is deficient in this area. Some owners began to move back along the spectrum to construction manager at-risk, perhaps without realizing why they were moving back or making design-build adjustments to deal with this difficulty. They moved towards what was familiar to them.

Construction manager at-risk

Construction manager at-risk involves complete planning much like design-bid-build but allows construction knowledge to be incorporated into planning. The designer remains in charge of the design, with the contractor having an uncompensated advisory role.

Firm

Some owners embraced a relationship at the far relational pole with a firm where design-build planning produces a futurized contract that the firm completes. This type of relationship avoids some pitfalls of design-build because all individuals are contained in-house with established organizational procedures and a hierarchical structure for planning. Those in positions of command plan the work and then assign it for execution.

5.5.1.5 Conceptual Framework

Planning leads to either a presentiated or futurized contract or some combination of the two defined by six factors: substance-process, completeness-specificity, tacit assumptions, participation, post-commencement planning, and bindingness.

A presentiated contract contains a complete scope detailing the object to be exchanged and any conceivable aspects of the interaction between parties. In these contracts, rights and obligations are clearly defined and solutions scripted for any anticipated trouble. There are no expectations beyond what is specified, so tacit assumptions play no part in the transaction. Once agreed on, the contract terms are binding for both parties and serve to guide their actions in the future. The completeness of the pre-commencement planning makes post-commencement planning unnecessary.

A futurized contract contains an incomplete scope that will be jointly completed in post-commencement planning. The contract can vary in specificity, often resembling a constitution by

specifying rights and procedures for conducting the relationship. The incompleteness creates reliance on tacit assumptions resulting in conditions being subject to change with circumstances, thus limiting total bindingness other than the ultimate commitment to the relationship.

5.5.1.6 Case Study Illustrations

The six planning attributes are illustrated below using case study projects. Planning is typically thought of as producing a presentiated contract for a discrete transaction or a futurized contract for a relationship. Still, many contracts exist along a spectrum between these two extremes making it difficult to classify as purely one or the other, so too are the case study projects. The projects are all design-build which can be classified as a relational contract, but not all planning was relational. The successful implementation of design-build on the I-15 project is primarily due to its planning. The project serves as the primary example, with additional projects highlighting different decisions leading to different outcomes. “Substance-process” is highlighted with the permitting process on the Knightdale Connector. “Completeness-specificity” is illustrated by the high level of owner design on the I-85 project. “Tacit assumptions” and “post-commencement planning” are shown with the I-77 guardrail. “Mutual participation” and “post-commencement planning” are emphasized with the guardrail on the I-4 project. And “bindingness” is highlighted with the reconfigured design of the I-85 project.

During initial planning, the I-15 project owner dealt with parts of the project differently by futurizing large portions while presentiating others. As a time-sensitive project, there were long-lead items that the owner decided to complete the design before the award to assure its planning process would not impact project completion. Other parts of the project were left flexible. Still, as a measure of protection, the owner incorporated a process giving him the option to extend the involvement of the design-build team for a prolonged warranty period. The RFP

required the proposing design-build teams to include the warranty as an add-alternate, specifying procedures for the purchase of the warranty, including an evaluation and decision process at the end of construction, along with the methods to implement if the warranty was added. The owner also specified procedures establishing his right to continue involvement during the delivery phase by "over-the-shoulder" design reviews and a partnering process.

As planning continued during construction, other decisions influenced the project. A Memorandum of Understanding was created during the partnering process, establishing a means to allow the design-build team to propose changes to the original contract documents or its own proposed plans. These changes could be approved without processing a change order if the owner agreed the proposed changes were at least equal-or-better than what was included in the original proposal. The design-build team also co-located team members to facilitate their interaction.

This project demonstrates planning can occur differently for different parts of the project. There were presentiated portions that exhibited attributes associated with discrete planning. The owner developed plans through unilateral planning reflecting a complete design using prescriptive specifications. The focus here was on the exchange object, relying on no tacit assumptions, with the plans intending to be completely binding requiring no post-commencement planning.

The owner planned procedures into the contract for futurized portions of the project. Absent the completeness and specificity of a complete design; the owner stipulated procedures into the agreement that would allow an assessment of the quality of the end-product before the owner would decide whether to extend the warranty. The owner specified in this agreement the rights and processes for the relationship reflecting a "relational constitution." These processes

structured and facilitated mutual participation in post-commencement planning, including "over-the-shoulder" reviews, partnering, and co-locating the design-build team.

The owner's intention with presentiated plans was to allow the design-build team to begin construction immediately using completed designs; however, the design-build team had difficulty incorporating some pre-existing plans into their designs, so the parties agreed to allow changes, thus making these presentiated elements not entirely binding and requiring post-commencement planning to complete.

Substance-process

The Knightdale Connector project owner assigned permit responsibility to the design-build team for the first time. The permits had been obtained initially in conjunction with an adjoining project, and the design-build team was to seek any necessary permit modifications due to their design. The owner specified the process to be followed by the design-build team that would include requiring the owner's approval. In performing this task, the owner assigned the permitting responsibility to the design-build team structuring the process to preserve the owner's right to be involved in this aspect of post-commencement planning.

Completeness-specificity

Although the I-15 owner presentiated portions of that project for particular reasons, other owners are completing large portions of the overall design because they have little or no experience with design-build projects. For example, the I-85 project owner relied heavily on prescriptive specifications, indicating that approximately 60% of the completed design was included in the RFP. This significant pre-commencement planning is evidence of the structural inertia associated with transitioning to a new project delivery method while relying on experiential patterns obtained by performing the complete, specific, and unilateral planning

related to a discrete contract. The owner recognized this amount of design is not ideal for the design-build delivery method and plans to reduce the level on future projects.

Tacit assumptions and post-commencement planning

The I-77 project owner futurized the planning of the guardrail, including relying on tacit assumptions that didn't align with the thinking and actions of the design-build team during post-commencement planning. The owner didn't specify procedures or rights to remain involved during decision-making, and consequently, the provided guardrail, although meeting scope, was challenging to maintain.

Mutual participation and post-commencement planning

The I-4 guardrail design was left flexible, leading the contractor to suggest reusing the existing guardrail in portions of the new work. The designer disagreed with this decision. Complicating matters, this was the first time either had worked with design-build and the first time working together. The post-commencement planning was made difficult by the organizational structure that didn't clearly delineate the parties' rights, thus hindering mutual participation. The contractor was the prime for the project, and there were those suggesting the engineer had a difficult time adjusting to working with a contractor, which was perhaps a reflection of structural inertia on their part.

Bindingness

The I-85 project owner proposed reconstructing a facility in its existing configuration. Using the flexibility provided by a futurized contract, the design-build team adjusted the design to eliminate a bridge and merge traffic using a safer traffic pattern. The lack of bindingness of the contract coupled with a relationship between the parties produced a better product, reduced

completion time, lowered first costs, annual maintenance costs, and dropped estimated costs for future expansion.

5.5.1.7 Delphi Application

A Delphi panelist says to “use performance specifications” for design-build. This answers a broader unasked relational question: How might an owner plan a project from beginning to end to receive the desired product? Using performance specifications is one option, but other options exist besides that of a wholly futurized contract for an owner choosing to use design-build. The owner can break the project into parts dealing with each differently based on its needs. The owner can separate and specify those parts he wants to be completed in a certain way. Those parts which are to remain flexible for design, but the owner wishes to retain approval authority can be made part of the proposal submission and review process before contract formation. The parts the owner is willing to leave flexible after the contract commences can be planned by the design-build team following the procedures specified by the owner. Presentiate, require parts presentiated before starting the contract, and leave parts to be determined after commencing the contract. These are options leading to a result that requires different planning. The options can exist on the same project with the approach tailored to the needs of the individual parts.

The owner specifies those parts desired to be completed in a particular way within the contract, either using a complete design, the required use of standard drawings, or in such a manner there could be no other solution. In doing this, the owner must recognize the lost opportunity for possible innovation unless he is willing to negotiate the bindingness of his plan.

There may be other parts the owner wants to give the design-build team flexibility to allow innovation but wants to approve the design solutions before the contract. In such instances, the owner can require the designs to be dealt with during iterative rounds of proposal

negotiations. These submitted, reviewed, and approved plans become the basis of the bargain and are binding on both parties.

While the owner indicates his right to approve innovative designs during multiple rounds of reviews, he should recognize the design-build team might seek the same benefit in pre-approval of an innovative solution that may constitute a large portion of their bid. This situation could occur for parts the owner left flexible or those he specified, thus providing the design-build team comfort in having the approval of a design option while providing the owner comfort knowing the design-build team can propose adjustments if they see an opportunity.

The owner may be willing to leave other parts of the project flexible for the design-build team to complete after the contract award. These should be parts of the project in which the choices have limited variability in solutions or areas in which the owner is comfortable "letting go of the controls," as one Delphi panelist suggests. The owner can influence how the post-commencement planning for these parts will occur by either specifying an outcome using performance specifications or processes to be used by the design-build team to achieve the outcome. Additionally, the owner may plan a remedy for added protection, such as an extended warranty.

The owner makes the above choices before issuing the RFP. Each option results in planning occurring in different ways along the project timeline and by different members of the project team. Before the RFP, the owner is the sole participant determining how to plan the project, with some parts complete and specific focusing on the substance of the exchange, others requiring mutual participation during the proposal phase, and others requiring post-commencement planning where the owner focuses on planning processes while also relying on tacit assumptions. The time after issuing the RFP will be a time of mutual participation, with

negotiations for some parts culminating in a binding agreement for those that are complete and specific and on processes for those that aren't. After the contract is awarded, some parts will be completed as planned, while others requiring post-commencement planning will depend on the processes previously established by the owner or involve mutual participation. All paths merge at the end of the delivery phase with a finished product provided to the owner.

An additional concern of the Delphi panel was who should lead the design-build scoping process. Although the panel was inclined to think one particular party should be chosen, it is evident with the application of the conceptual framework that it is not necessary to pick just one party but allow each party to oversee the portion of the project for which they are directly responsible. This can be addressed through enumerated rights stipulated in the contract if necessary.

5.5.1.8 Summary

Planning for a discrete exchange yields a presentiated contract, while a relational exchange yields a futurized contract. The planning for these exchanges differs in six ways (MacNeil 1974a, 1980a): substance-process, completeness and specificity, tacit assumptions, post-commencement planning, participation, and bindingness. The focus of planning for a discrete contract is the substance of the exchange, while for a relational contract, the focus is on processes for the relationship. Discrete contracts are complete and specific, while relational contracts are intentionally incomplete and non-specific. The planning for discrete contracts leaves no room for tacit assumptions, but such assumptions are relied on as an element of planning for relational contracts. Discrete contracts require no post-commencement planning, unlike relational contracts that do. Planning for discrete contracts is unilateral, while it's often a joint effort requiring mutual participation for relational contracts. Finally, discrete contracts are

intended to be completely binding, while relational contracts are non-binding, with parts tentatively planned and subject to change throughout the relationship.

Planning for discrete and relational contracts can be summarized as planning either a "four-corners" agreement or a "constitution." For a discrete contract, the object of the exchange and all rights and obligations are entirely specified, with planning performed for all foreseeable circumstances and specified procedures prepared for any potentially unforeseen events. For a relationship, rights and procedures are established to guide the future while waiting for it to occur.

5.5.2 Future Cooperation

5.5.2.1 MacNeil

The factor was initially labeled "Future Cooperation Required in Post-Commencement Planning and Performance" and later shortened to simply "Future cooperation" (MacNeil 1980a). MacNeil (1974a, 1980a, 1981) addresses the need for future cooperation in performance and post-commencement planning for discrete and relational contracts. A discrete contract requires limited future cooperation with each party producing either the money or the commodity to be exchanged as agreed in the initially complete contract. Relational contracts depend on cooperation for carrying out the planned performance and for planning future activities that require a joint effort, the exercise of choices, and often adjustments.

5.5.2.2 Delphi Panel

"Future Cooperation" is reflected in many comments of the Delphi panelists, although not directly mentioned. The extent to which future cooperation is needed depends on how the scope is initially defined. A "detailed scope" requires less cooperation in further planning than a scope where the "owner let[s] go of the controls." In addition to other similar comments under

"Shared Understanding of Scope," there are comments important for seamless cooperation that are categorized in "Right Team" and "Power." One panelist says "pick the right team" without elaborating, although one can assume in this context that would mean the individuals have the skills and abilities to relationally collaborate, continue mutual planning, and execute the plan through cooperative performance. Another panelist suggests team cooperation be structured, saying, "if the location of the design team is separate from construction, it is important to have meetings at the jobsite" and additionally specifying "…who must attend the jobsite meetings." Another panelist concerned about the organizational team structure and recognizing a decision about "Power" impacts cooperation in the relationship asks, "who typically leads the scoping process? Owner? A/E? Design-Builder?"

Other comments refer to the nature of cooperation with "Reliance on Someone" focusing on cooperation through the relationship and "Reliance on Something" focusing on cooperation through documents. One "Reliance on Someone" Delphi comment suggests there should be "trust between the owner's team and the design-build team." When this comment was initially rated, the Delphi panel provided five "5's," one "4," and one "3" and remained consistent in the final rating placing the factor among the top half, although three panelists didn't respond in the final round. The panelist providing the lowest rating of "3" is the sole private-sector engineer on the panel, suggesting his role may provide a unique perspective on the need for future cooperation.

A companion category to "Reliance on Someone" is "Reliance on Something." In a discrete transaction, that something is often the contract. At the same time, in a relational design-build setting, this might also pertain to included documents like "soil surveys" requiring the owners to "provide a clear understanding of what information can be relied on by the design-

builder." This reliance would also indicate the nature of future cooperation when shared documents prove unreliable during the performance. One panelist recommends that some issues be addressed explicitly in the contract saying, "to identify who is responsible for unforeseen soil conditions outside of the areas where borings were provided."

The initial rating of the comment to "include soil surveys" in the scope received two "5's," four "4's," one "3" and one "1," and the final rating received one "5," one "4.5," four "4's," one "3," and one "1" placing the factor in the bottom half of the list. The construction attorney provided the lowest rating suggesting a unique professional perspective relative to future cooperation. His preference for minimal scoping is apparent when considering his other ratings suggesting less reliance on "things" and a greater reliance on cooperation within the relationship.

5.5.2.3 Literature

"Future cooperation" is supplemented with archival literature that addresses the need for cooperation, illustrates the exchange environment with a theoretical model, and indicates essential elements that must exist or be controlled to facilitate cooperation.

Pre-commencement planning ranges from complete to minimal and sets up the nature and extent of cooperation needed for post-commencement planning and performance. Complete pre-commencement planning covers everything except improbable events or those that can't be thoroughly planned until occurring, thus leaving a minimal need for future cooperation. Alternatively, if the transaction is initially unplanned, the parties expect to continue planning during the relationship creating an extensive need for future cooperation.

Cooperation and the overall exchange environment can be illustrated with Game Theory using the "Prisoner's Dilemma" (e.g., Axelrod 1984, Rappaport and Chammah 1965), where

players in a competitive environment can choose to either compete or cooperate. A player maximizes his gain individually if he decides to compete, but the players will be better off collectively if all decide to cooperate. A player engaging in a never-to-be-repeated game is best to compete; if they expect to engage again with the same parties in the future, referred to as an "Iterative Prisoner's Dilemma" by Wessel (2004), it is best to choose to cooperate. This latter scenario of iterative games applies to relational contracts, while the previous one-off game applies to discrete contracts.

Discrete contracts reflect a zero-sum game in that each player focuses only on self-interests, and any gains directly result from your opponent's loss. The desire to maximize individual goals leads players to compete, fostering an adversarial environment with little consideration for the other player.

Relational contracts reflect a win-win mindset, with participants focusing on the group and the shared, common goals driving parties to cooperate (Crowley and Karim 1995). However, the potential for a player choosing to defect and self-deal remains a possibility. To mitigate this potential, one might seek to enlarge the "shadow of the future" by raising the expectation of continuing exchange and future interactions (Axelrod 1984).

Freeman (1992) suggests the reliance on stipulated procedures for dealing with an unknown future in planning a contract parallel that of the U.S. Constitution, which defines the roles, power, and procedures of the government and the fundamental rights of citizens.

Other contracts or parts of contracts might leave the future largely unplanned and can be described as "outline maps" of "territories-to-be" that are completed in the future through cooperation (MacNeil 1975). The details of a contract are replaced by goodwill, negotiation, reciprocity, and give-and-take (Macaulay 1963).

Cooperation to occur and be sustained requires trust and control over both power and conflicts. A party to a transaction must trust the other party to refrain from opportunistic behavior and respond cooperatively to unforeseen events (Lyons and Mehta 1997). Also, unbalanced power and unresolved problems can lead to conflict that can quickly shift cooperation into competition. These issues must be managed either in the relationship or resolved with procedures planned in the contract (Tjosvold and Johnson 1983).

5.5.2.4 Classifying Future Cooperation in Current Construction Practices and Trends

The concepts of "future cooperation" are described below, beginning at the discrete end of the contractual spectrum and following the chronology of shifts in industry usage, including design-bid-build, partnering, design-build, construction manager-at-risk, and the firm.

Design-bid-build

Design-bid-build delivery is competitive, with each party focusing on their self-interests, and any required cooperation is planned into the contract. Functional and temporal separation of the participants results in the designer and contractor performing their tasks in isolation, with the designer completing the contract and handing it "over the wall" to the contractor who produces the described product. The interaction between parties is limited to contract changes and other unanticipated events that are not fully scripted in the contract but are dealt with by planned procedures that reflect the extent of necessary cooperation. The parties follow the established processes for these situations then return to the original plan for continued performance.

Partnering

The adversarial environment created by the competitive nature of design-bid-build led to participants desiring more cooperation. Partnering offers this cooperative atmosphere during implementation. Parties agree to solve problems during construction cooperatively instead of

strictly relying on formal or legal channels. The concern arises when the need to cooperate during partnering becomes a “horse trade” when parties seek to satisfy the other at virtually any cost to maintain a positive image of the delivery method.

Design-build

The success of partnering led to desiring a relational component earlier in the project. This desire caused a resurgence of design-build. The owner develops a partial scope to be completed by the design-build team cooperating during post-commencement planning to design and construct the facility. A challenge facing this approach is when competition between functions enters this cooperative process; for example, when team leaders use their position of power to influence the performance and role obligations of the other party. As a result of responding to this challenge, some parties began to push back along the spectrum toward construction manager-at-risk.

Construction manager-at-risk

With construction manager-at-risk, the contractor serves in a supportive advisory role to the designer during design development, thereby eliminating the opportunity for the relationship to become competitive. Only limited future cooperation is required for performance since a complete design is developed pre-commencement.

Firm

Some owners chose to push to the far relational end of the spectrum with the firm in which full cooperation is fostered as most functions are being performed in-house. The firm employs members with a long-term history of working together and can use the firm’s hierarchical organizational structure to assure cooperation between individuals.

5.5.2.5 Conceptual Framework

Cooperation can be achieved through either planned procedures or relationships. Planned procedures foster cooperation when events that couldn't be thoroughly planned must be dealt with as they occur. The parties merely execute the procedures as per plan when such circumstances arise.

Relationships encourage cooperation through trust, industry norms, give-and-take, and good faith. They can naturally strengthen over time, particularly in long-term relationships between parties. Team building activities can facilitate cooperation, such as team meetings, house publications, intramural sports teams, and jointly celebrating special events, e.g., births, birthdays, graduations, promotions, etc. Relationships benefit from wholly and quickly addressing problems in a cooperative rather than a competitive spirit.

5.5.2.6 Case Study Illustrations

Two case study projects highlight the need for "future cooperation" in relationships, one in which cooperation was achieved and the other in which it wasn't.

The I-15 project is an example of successful cooperation. The owner and the design-build team made critical decisions directly influencing the need for and the structure of future cooperation. The owner made three critical decisions. First, the owner thoroughly planned certain portions of the project that required future cooperation only for performance. Second, the owner divided the risks in a way that some would require cooperation and some wouldn't. Third, the owner planned procedures for cooperation during post-commencement planning and construction by allowing the owner's team to be involved as design continued to facilitate easier resolution of problems during the performance.

The design-builder made two critical decisions regarding future cooperation. The design-builder co-located the parties into an office called “the Hub.” They provided team-building activities such as attending sporting events, celebrating holidays, and project milestones. These decisions were made to build the relationship and foster cooperation among the team, who didn’t have a pre-existing relationship.

The I-10 Blackwater Bridge project is an example of cooperation dissolving into a competition when an unexpected event occurs. The fact the parties held different expectations regarding cooperation became evident during the delivery. The owner believed any challenges encountered on the project would be handled through negotiations and cooperation within the relationship, but the design-build team viewed the contract as complete, including procedures provided for necessary cooperation concerning unexpected events.

During construction, the design-build team encountered poor soils in an area removed from where the owner took the soil borings and provided them during the proposal phase. These soils required a portion of the facility to be redesigned and reconstructed. Unable to agree on either who was responsible or to work together to reach an equitable solution, the parties resorted to the Dispute Review Board, the conflict resolution provisions in the contract. The Board ruled in favor of the design-build team. This issue and the resulting conflict aftermath destroyed the relationship between the parties, who had to seek the assistance of the Dispute Review Board on subsequent matters. The parties were unable to restore cooperation after the initial conflict, and the self-interest element of competition emerged as each party began to look out for themselves.

5.5.2.7 Delphi Application

Participants realize “future cooperation” is required for design-build but have concerns about how it will occur. The owner is concerned about whether another party will beneficially

cooperate in completing an incomplete contract. Designers or contractors are concerned with expectations associated with cooperation during the performance or within relationships. These concerns are reflected in the Delphi panel comment that "parties understand what is expected of them." As suggested by the conceptual framework, expectations for cooperation are expressed either through procedures or within relationships.

For a discrete contract, expectations for cooperation are detailed in the contract, and parts of the project that can't be entirely determined at the time of contracting are resolved through defined procedures.

For relational contracts, cooperation occurs pre- or post-commencement within the relationship. Owners providing flexibility during the proposal phase will seek pre-commencement cooperation with clear expectations established in the RFP, specifying "expectations for the level of design drawings for tender offer" as indicated by one Delphi panelist and making clear their intentions to conduct multiple rounds of proposal reviews. These expectations may include procedures for how the process will occur and should be accompanied by their cooperation in providing "knowledgeable" evaluators, as suggested by the Delphi panel. The proposing teams expect cooperation will mainly occur during this phase. Any proposed innovative designs submitted in the selected proposal will have secured both the owner's approval and cooperation with its implementation during delivery.

Owners providing flexibility during delivery requires post-commencement planning and cooperation. While this approach may present the most significant concern for some owners, the relationship doesn't have to be completely unstructured. Specified procedures can plan cooperation, such as using "job-site meetings" as recommended by a Delphi panelist or "over-the-shoulder" design reviews as seen in a case study project. Procedures can facilitate

relationships by stipulating co-location. Cooperation can also be left to occur organically in relationships with the parties operating in alignment with industry norms and good faith.

5.5.2.8 Summary

MacNeil describes “future cooperation” as required for performance with discrete contracts and post-commencement planning and performance with relational contracts. In a construction context, cooperation occurs through planned procedures or within relationships. For discrete exchanges such as design-bid-build, cooperation is an extension of a highly structured transaction. The parties presentiate every aspect of the future exchange in the contract allowing an arms-length relationship with cooperation only required to the extent adjustments to the original plans are needed.

For relational exchanges such as design-build, an incomplete contract requires additional planning through a joint, cooperative effort. Cooperation can vary from implementing structured procedures specified in the contract to unstructured negotiations occurring in the relationship. Procedures may focus on processes to reach a solution or develop the relationship to employ cooperation by relying on trust, established practice norms, and compromise.

5.5.3 Measurement and Specificity

5.5.3.1 MacNeil

The factor that was initially labeled “Measurability and Actual Measurement of Exchange and Other Factors” (MacNeil 1974a) and later simplified to “Measurement and Specificity” (MacNeil 1980a, 1981) takes up the manner that exchange components at two ends of the contractual spectrum are stipulated relative to planning, measurement, and specificity. During initial planning, discrete contracts are measured, and the exchange elements’ specificity is usually achieved in the form of money on one side and something easily monetized on the

other before the contract agreement. While during initial planning for contractual relations, much remains immeasurable and nonspecific, leaving amounts and relative values to be vague within the relationship and obligations arising from it to be diffuse and unmeasurable. The elements that will be made specific during the performance are not specific at the start of the relationship, thus leading to the increased importance of relational norms like trust and reliance.

5.5.3.2 Delphi Panel

The Delphi panel addresses "Measurement and Specificity" in categories such as "Shared Understanding of Scope," "Expectations," "Reliance on Someone," and "Reliance on Something." Comments under "Shared Understanding of Scope" include "provide a detailed scope" and "cover all desired work requirements," along with others like use "performance specifications" and "the scope should not be overly prescriptive." Those comments that initially seem contradictory can be placed at the two ends of the contractual spectrum in which panelists express different approaches to measurement and specificity during planning. The Delphi comment that the owner should "specify expectations for the level of design required with the tender offer" and the question "when during scoping should contracts be in place?" pertain to the level of measurement and specificity achieved before the contract is entered and help align the "expectations" of participants. The concern that the "scope matches the available budget" placed in the "Reliance on Something" category addresses reasonable expectations regarding the two sides of the exchange, the deliverable and the monetized value. While the comment there should be "trust between the owner and design-builder" falls within "Reliance on Someone" and is a relational component needed when measurement and specificity occur during performance.

Two of the above comments that one should use "performance specifications" and "scope matches the available budget" pertain to measurement and specificity at the relational end of the

spectrum. Performance specifications focus on outcomes, allowing more flexibility than the detailed product descriptions of prescriptive specifications. While all exchanges involve aligning the two sides of the bargain, this can be more challenging when the scope is not fully defined when entering the contract. When the Delphi panel initially rated the importance of using "performance specifications," the panelists provided two "5's," three "4's," two "3's," and one "2" staying broadly consistent during the final round with one panelist increasing his "2" to a "4," thereby placing the relative ranking of the factor in the middle of the overall list. The two lowest initial rankings stand out on closer inspection because of the panelists' experience. The public-sector engineer who initially provided the "2" was perhaps influenced by a large project where his department used a mix of prescriptive, performance, and hybrid specifications with great success. Another panelist who rated this concern a "3" was from a DOT in which design-build was new. Their goal was to use only performance specifications indicating this would involve a cultural shift that would take time.

When asked to rate the importance of "scope matches the available budget," the panelists initially responded with five "5's" and three "4's." During final ratings, two increased their initial ratings of "4" to "5's," and one lowered his initial "5" to a "4," resulting in six "5's" and two "4's" which placed this among the top ten in the overall list. The panelists agreed on the importance of aligning expectations. Some owners have concerns about what they are buying because they no longer completely measure and specify the scope during planning.

5.5.3.3 Literature

"Measurement and specificity" is an agreement between parties about the quantity and quality of the exchange deliverables communicated through a "boundary object" that is fully

developed during planning or performance. Supplemental literature is used to expand on the concept of the boundary object expressed in either a "presentiated" or "futurized" contract.

"Boundary objects" sit at an interface coordinating participants' perspectives within different organizational settings (Star and Griesemer 1989, Wenger 1998). These objects can have both technical and social aspects (Bresnen 2010) and, in the context of measurement and specificity, have primarily two forms: a presentiated complete contract or a futurized incomplete contract.

"Measurement and specificity" being fully developed during planning results in a presentiated contract that serves as the boundary object in which all details are made present and fixed, with clear performance expectations established in the "four corners" of the contract (MacNeil 1974b, Poppo and Zenger 2002). The "transaction costs" in using this type of contract are high due to the expense of planning for all eventualities (Williamson 1985).

"Measurement and specificity" that is not fully developed until performance imply the boundary object is futurized, leaving "…the future where it is; waiting to happen" (MacNeil 1980a), which requires parties to rely on relational norms like trust and cooperation. Futurized contracts provide a fluid option for contracting under conditions of uncertainty by replacing the precise definition of a discrete contract with an agreement open to adaptation and change as the exchange evolves and the relationship unfolds (Salbu and Brahm 1994). The distinct difference in measurement and specificity of relational and discrete transactions leads to concerns about the "meeting of the minds," which is graphically illustrated in Medlin's (2003) model included earlier in Figure 4.1. In this figure, the discrete contract is depicted with a small vertical space indicating little or no chance the parties will have differences in their understandings of the

transaction. In contrast, the relationship shown with the larger vertical space is indicative of a more significant potential for differences in understanding.

5.5.3.4 Classifying Measurement and Specificity in Current Construction Practices and Trends

"Measurement and Specificity" is illustrated by showing how projects are measured and specified using five project delivery methods.

Design-bid-build

Design-bid-build involves complete measurement and specificity in a presentiated contract. All possible occurrences are anticipated and planned, resulting in high transaction costs and limited but scripted participant interactions. The owner and designer define one side of the exchange during planning with the proposing contractors monetizing the other side in their bids. The owner then enters a contract with the selected contractor who creates the predefined deliverable during the performance, transferring it to the owner upon completion.

Partnering

Like design-bid-build, partnering uses a presentiated contract, adding a relational component during the performance. The parties establish a relationship to deal with any problems encountered during delivery. The relationship is often structured using a supplemental boundary object, often termed a "partnering charter," to adjust performance requirements if necessary. Consequently, measurement and specificity may not be complete until the end of the project.

Design-build

Design-build uses a futurized contract with the owner partially describing the intended scope by providing enough detail for the design-build teams to develop a proposal. Typically

incomplete, the contract between the owner and design-build team allows owners to dispense with much of the overhead associated with presentiated contracts, relying instead on the relationship between the parties to deal with encountered events. “Measurement and specificity” activities continue during the performance as the design-build team finalizes the product design with the parties cooperating to deal with the faced circumstances.

Construction manager-at-risk

Construction manager-at-risk allows measurement and specificity in a presentiated contract with a contractor sharing construction knowledge for potential incorporation in the design during planning. It differs from design-build as the design is completed during planning, and the designer remains in full control of the design as the contractor participates in an advisory role.

Firm

The firm is another option at the relational end of the spectrum where measurement and specificity activities are incomplete in the boundary object resulting in a futurized contract completed during the performance as individuals in positions of authority make decisions about the deliverable.

5.5.3.5 Conceptual Framework

“Measurement and specificity” requires communicating through a boundary object the deliverable by measure, description, and performance using either a presentiated or futurized contract. Despite having the same needs at the beginning and ending bracketing points of a project, how and when measurement and specificity occur for the project differs based on its location along the contractual spectrum, sometimes happening during the planning and at other times during the performance.

For discrete contracts, measurement and specificity occur in the boundary object during planning. A presentiated contract defines both sides of the bargain. On one side is the deliverable and related obligations that are clearly and completely defined in both measure and description, and on the other side is the measured cost. Because all potential future occurrences are addressed, the transaction costs are high, yet any encountered problem can be resolved by resorting to the contract documents. The deliverable defined in the boundary object is created during the performance and transferred to the owner for use upon completion.

An owner choosing a relational contract will want to arrive at the same ending point as in a discrete contract, but the route is different. Instead of measurement and specificity occurring during planning, the owner provides flexibility for it to happen in the relationship. This means the boundary object is likely incomplete at the time of the agreement but has enough information to establish both sides of the bargain. On one side, the deliverable is described in terms of performance with enough information to develop the other side, either a monetized value or a means to arrive at the value. Measurement and specificity continue during the performance and, in some instances, are not complete until the end of the process. Once completed, the deliverable is transferred to the owner for use.

Construction owners concerned about a futurized boundary object have options about when and how measurement and specificity will occur to protect themselves from potentially undesirable decisions by the design-builder. One option is for the measurement and specificity of some or all parts of the proposed deliverable to be required during the proposal phase and subsequently presentiated in the resulting contract. Another option is to provide guidelines in the boundary object for how measurement and specificity will occur during performance. For instance, there might be procedures that must be followed or stakeholders who must be present.

Or an owner wanting to provide maximum flexibility in a futurized contract can establish some remedy such as a warranty if the measurement and specificity of the deliverable don't meet expectations.

5.5.3.6 Case Study Illustrations

The conceptual framework for "Measurement and Specificity" is illustrated using five case study examples. The first project highlights measurement and specificity occurring at different times during the project lifecycle by different participants. The second project shows undesirable results from the measurement and specificity of a futurized contract. The third project illustrates better than expected results from a futurized contract. And the fourth and fifth projects highlight the difficulty associated with measurement and specificity during the planning when there is a high degree of uncertainty.

The I-15 project used a variety of scoping methods. The owner completed some of the scope himself, required some to be completed by the design-build team during the proposal phase, allowed some to be completed by the design-build team during delivery with the owner remaining involved through an "over-the-shoulder" review procedure, and reserved the right to add an extended warranty covering some work at the end of construction. Measurement and specificity occurred at different times on this project resulting in a boundary object with both presentiated and futurized elements. Parts of the scope measured and specified by the owner during planning were presentiated in the boundary object. The design-build team measured and specified other parts, and the owner vetted the decision during the proposal phase. Other areas remained futurized in the contract that the design-build team would measure and specify during the performance. The owner incorporated procedures that allowed his team members to stay involved during design, including an option to add a warranty as a final measure of protection.

The I-77 owner gave the design-build team flexibility to design the guardrail, only requiring that they follow state standards. The provided guardrail didn't meet the owner's expectations due to difficulties maintaining the median with the guardrails in place. The guardrail design was futurized in the boundary object while only specifying the minimum standards to follow for measurement and specificity. Although the specified code addressed safety concerns, it was insufficient to capture and satisfy the owner's maintenance concerns.

The I-85 owner developed a preliminary design for roadway reconstruction using its original configuration that, in one location, involved a right-hand merge into the fast lane of the interstate, reflecting a safety concern for the traveling public. The design-build team's reconfigured design created a traditional left-hand merge that provided a safer facility and eliminated an interstate bridge. This reconfigured layout reduced the time and cost of construction, the expected lifecycle costs for maintenance, and the estimated costs for the planned future widening of the interstate. This project exemplifies the benefit of a futurized boundary object. The owner developed a partially complete design during planning by describing the deliverable and communicating the intent, but the design-build team provided measurement and specificity to the exchange, which proved beneficial to the owner, traveling public, and the design-build team.

On the final two projects, both owners removed portions of the work from the design-build contract. On the I-4 Reconstruction project, the utility work was so uncertain the owner believed a design-build team would add a large contingency amount to their bid if required to perform that work. On the St. George Island Bridge project, the oyster relocation was work that was unfamiliar to the design-build team but critically important to the owner and his constituents. In both of the above instances, the owners felt it was in their best interests to

complete these portions of work themselves because it was difficult to measure and specify before the performance. Even if possible, it would have involved high transaction costs. These concerns led the owners to use the boundary object to separate the work from the overall deliverable.

5.5.3.7 Delphi Application

A Delphi panelist mentions the need for a "shared understanding of scope" that must be reached when the contract is entered. Still, it can be reached in different ways based on how and when measurement and specificity occur in the contract.

For a discrete contract, a shared understanding is easily achieved because measurement and specificity of both sides of the bargain occur in the boundary object; the owner defines the scope, and the price is determined by the contractor with all aspects of the parties' interactions planned.

For relational contracts, rather than having everything scripted and a shared understanding based on clearly defined tasks, the measurement and specificity occur at different times throughout the project, requiring trust and cooperation and the parties to have a mutual understanding as issues that arise are dealt with contemporaneously. For some relationships, the scope is not wholly defined during planning, but measurement and specificity of both sides of the bargain occur during the proposal phase before the contract. In doing this, an owner can "specify expectations for the level of design drawings for tender offer," as one Delphi panelist recommends. Or the owner can use rounds of proposal reviews in requiring the design-build team to fashion both sides of the bargain acceptably. Although this process can result in a presentiated contract, it involves a high cost for the proposing design-build teams.

For other relationships, a futurized boundary object leaves the scope flexible with measurement and specificity occurring during the performance. In these instances, the owner must specify a minimum scope so that a price can be determined in establishing both sides of the bargain. With a futurized contract in which measurement and specificity don't occur until the performance, the question becomes: "On what basis do the parties go to contract?" The answer essentially boils down to contractual promises that may be in the form of specified "oughts," procedures, and outcomes to be supplemented by other implicit industrial norms and a collaborative relationship as the parties strive to complete the contract. For example, certain codes may be specified to govern the performance, or the owner may define procedures giving them the right to remain involved as measurement and specificity occur. The owner can also specify performance standards that must be met or an end-of-phase remedy for protection. It is important to note that if the owner selects the design-build team, at least in part, based on low first cost, then decisions will likely be impacted as measurement and specificity occur because what can be accommodated within the budget often means using the minimum standard as the guidelines.

Owners should be aware that they don't have to choose to deliver their entire project in only one way. To meet their needs on a particular project, some owners may divide their projects into parts and deal with each piece differently. For parts the owner wants to ensure are completed as he desires, the measurement and specificity can occur during the planning and be presentiated in the boundary object. The measurement and specificity can be left to the design-build team during the proposal or performance phases for other parts where the owner is willing to provide flexibility.

5.5.3.8 Summary

"Measurement and specificity" occurs differently for different types of contracts. In discrete contracts, measurement and specificity happen during planning and is communicated through the boundary object that defines both sides of the bargain and all aspects of the transaction in a presentiated contract. In relational contracts, measurement and specificity typically occur during the performance. A futurized contract is a primary boundary object supplemented by many other implicit and explicit boundary-related objects.

5.5.4 Obligations

5.5.4.1 MacNeil

MacNeil (1980a) states obligations differ based on their location along a three-pole contractual spectrum anchored by a single discrete contract pole at one end and two dissimilar relational poles at the opposite ends, one a primitive contractual relationship and the other a modern relationship. Primitive contractual relationships occur in communities with a relatively stable independent economy with little specialization and experiencing no fundamental changes; modern contractual relations are intricately connected with a larger society of great complexity involving extremely elaborate specializations and constant change (MacNeil 1980a).

Three parameters distinguish differences in an undertaken obligation: sources of content, sources of obligation, and specificity (MacNeil 1974a, 1980a). With a discrete contract, the sources of content are the expressed promises of the parties, the sources of obligation are from the promise-enforcing social matrix, and the separation of the sources of content from sources of obligation leads to high specificity.

With a primitive relationship, both the sources of content and sources of obligation come from the relationship by way of slowly evolving patterns of custom and law with only modest input from individual promises. These obligations tend to be diffuse and ill-defined.

A modern contractual relationship combines styles of obligations associated with both discrete transactions and primitive relationships. The sources of content for the obligations are both the promises of the parties and those arising from within the relationship. The sources of obligation arise from both the relationship and the social matrix that enforces promises and provides the structure for carrying out the relationship. The obligations tend to be both specific and general.

The spectrum that links the discrete contract and modern relationship pole is closely aligned with MacNeil's (1974a) earlier work, where he distinguishes obligations using a single axis with a transactional and relational pole, attributing obligations at the relational pole with both transactional and relational elements.

MacNeil's (1980a) work is applicable in a construction setting by providing the perspective needed to address different "kinds of obligations" while establishing the obligational parameters necessary to understand them.

5.5.4.2 Delphi Panel

The Delphi panelists do not specifically mention obligations, but many of their comments reflect the aspects of obligations addressed by Prof. MacNeil. For example, when viewed through the lens of obligations, it is evident that comments like "identify special project requirements" and "identify responsibility for unforeseen conditions outside of the areas where borings were provided" refer to the content of obligations contained in the promises.

Comments like “if there is a sub-consultant designer, the sub-consultant should report only to the prime design consultant and not the design-build contractor” and the question “who typically leads the scoping process? Owner? A/E? Design-Builder?” are sources of obligations, aspects of the relationship, and references to the social matrix that can both create and enforce obligations.

Finally, MacNeil’s (1974a) indication that the specificity of obligations tends to reflect planning which means comments like “provide a detailed scope” and the “scope should not be overly prescriptive” also reflect how the obligations are expressed in the contract with some panelists preferring specificity and others flexibility.

As a sample of the Delphi rankings on this topic, consider two comments that can be categorized under sources of content “identify special project requirements” and “identify responsibility for unforeseen conditions outside of the areas where borings were provided.” The Delphi panel initially rated the comment “identify special project requirements” with all “5’s” except one “4” provided by an architectural engineer that subsequently raised his rating to “4.5,” perhaps being influenced by the other panelists’ feedback but stopping shy of declaring it of the highest importance. This observed hesitance in rating the comment a “5” coincides with the architectural engineer’s experience with a design-build success where an active user group worked through several critical design options alongside the design-build team suggesting the content of the obligations was allowed to develop within the relationship.

The Delphi panel initially rated the importance of “identify responsibility for unforeseen conditions outside of the areas where borings were provided” with seven rankings of “5” and one “3.” In the final ratings, the architectural engineer who initially provided the “3” raised it to “4,” while a public-sector engineer lowered his initial “5” to a “4,” resulting ultimately in six “5’s”

and two “4’s,” tied with four other factors as tenth among 50. Although still high, it seems important to take a closer look at the two lowest ratings of “4.” The rating from the public-sector engineer is slightly puzzling given others within the same profession rated this “5,” which seems fitting given their roles as owners potentially responsible for unforeseen conditions. Neither panelist providing a “4” mentioned bad experiences with this issue, although other panelists did.

5.5.4.3 Literature

Black et al. (1990) define an obligation as “a legal duty, by which a person is bound to do or not do a certain thing.” MacNeil (1974a, 1980a) says undertaken obligations differ in three ways: sources of content, sources of obligations, and specificity. “Sources of content” refers to the origin of the substance of the obligation, and there are two primary sources: the contract or the relationship. Contracts establish obligations through “genuinely expressed, communicated and exchanged promises” (MacNeil 1974a). Often seen in discrete exchanges, the contract typically details roles and responsibilities to be performed, stipulates procedures for monitoring and penalties for noncompliance, and specifies outcomes or outputs to be delivered (Poppo and Zenger 2002). Relationships establish content through a mixture of promises and tacit agreements, much like a marriage. Leckey (2002) indicates the obligations and exchanges for marriage can’t be set out completely at its beginning, and the initial commitments don’t exhaust everything the parties might expect to occur within the relationship. Noting the lack of explicit detail in a marriage relationship, Leckey (2002) says that beyond the gaps in promises, much of a marriage relationship is likely to be what MacNeil (1974a, 1980a) calls non-promissory, in which obligations arise not from the parties’ promises but from the relationship itself.

“Sources of obligation” refers to the place from which the duty is generated and enforced. These sources are elements of a social matrix or structure supporting the exchange within which

MacNeil (1974a) says all exchanges exist. Sources of obligation differ depending on whether the contract is presentiated, supported mainly by courts, or futurized relying on norms and intent. Courts are a promise-enforcing source external to the transaction itself (MacNeil 1974a, 1980a) and are the primary source of obligation for discrete contracts. Gordon (1985) says that individuals bound by traditional contracts have no obligations to each other except those created by the rules of the state or their promises. Further, he states the outcomes of contract law flow from the parties' promises, their allocations of performance obligations, and risks at the time of contract. Hart (1995) declares that courts merely enforce the contract as it stands because a complete contract specifies the parties' obligations in every eventuality. Hart (1961) says legal rules generally only require external behavior and are indifferent to the motives, intentions, or other internal aspects of conduct definitive for relational elements of the social matrix. Norms are a source of internal support and can range from general standards of right behavior considered by MacNeil (1974a) as "oughts" to more specific industry-related standards. Scott (2000) says norms in relationships often tend to govern behavior rather than legal rules. MacNeil (1980a) describes norms as binding exchange partners by acting as governance blueprints to guide, control, and regulate proper and acceptable behavior. This is a sentiment echoed by Gundlach and Achrol (1993), who describe norms as providing a frame of reference, order, and standards. Another author, Kimel (2007), describes relationships as having the propensity to generate norms, define and inform expectations, and facilitate cooperation over and above, and potentially instead of what can be gleaned from the expressed terms of the contract and what is provided by the bare legal norms and mechanisms that underlie and support contracts.

Lastly, there is the intent. For discrete contracts, the expressed terms of the contract are the foundations of intent that allow the parties to communicate both to themselves and the courts

the precise content they wish as obligations in their agreement (Kraus and Scott 2009). For relational contracts, Fried (2006) says it is easy to overstate the importance of the agreement both as a source of content and source of obligation by suggesting agreements should be interpreted in terms of the parties' real intent in promising. Kraus and Scott (2009) state intent is vital in determining what meaning to attach to the terms of the agreement, what default terms are implied in the agreement, and whether or not the obligations of the parties are conditioned on unstated assumptions.

"Specificity" is the degree of detail used in expressing obligations. MacNeil (1974a, 1980a) says specificity tends to parallel planning. When planning is "presentiated," all information is brought into the present (MacNeil 1974a), and the contract serves as the means of fixing the obligations of the parties (Salbu 1997). Such contracts are described by Ayres and Gertner (1992) as obligationally complete with the parties' obligations fully specified for all future states. When planning is futurized, things are left to happen in the future (MacNeil 1974a), with obligations evolving. This type of contract is referred to as an "incomplete contract" (Ayres and Gertner 1992; Scott and Triantis 2005; Williamson 1985). Although incomplete, these contracts may be specific concerning processes; obligations are written in rules and procedures that must be followed as the obligations are customized and detailed within the relationship (Dwyer et al. 1987).

In addition to MacNeil's obligation parameters, there are three types of obligations identified in the literature that are particularly applicable to construction. These are performance, role, and constructive obligations. MacNeil's (1980a) placement of obligations on a spectrum along with their defining parameters is reflected in these three types of obligations. The axis spanning from the discrete to modern relationship poles can describe performance obligations

that range from presentiated to futurized and exist within a complex society where specialization also establishes a need for role obligations. The third type of obligation is constructive obligations; these obligations are futurized, and an example of a primitive relationship MacNeil (1980a) defines on a second axis where obligations develop within the relationship.

Performance obligations are duties associated with delivering a good or rendering a service; these obligations can be both presentiated, representing a "static" obligation, or futurized, signifying a "dynamic" obligation. A static obligation is transactional in that these are unambiguously expressed at the time of agreement (Wessel 2004) and are typically seen in discrete contracts where parties reduce all requirements down to specific performance obligations (Goetz and Scott 1981). A "dynamic obligation" is relational in that the agreement is structured to create evolving commitments (Smith 1991). These relational obligations are duties the parties undertake as they arise over time, becoming specific after entering the contract. Goetz and Scott (1981) elaborate on these by describing relational contracts as creating unique, interdependent relationships in which the combination of uncertainty and complexity prevents the specifying of precise performance obligations.

Role obligations are duties or responsibilities that one has as an occupant of a social role (Hardimon 1994) that stem from specialization. This kind of obligation can be both presentiated with the specified rights and duties organized around an institutionally specified function or futurized as seen with fiduciary obligations. This parallels Hardimon's (1994) description of a role obligation as a requirement attached to an institutional role whose content is fixed by the function of the role and whose normative force flows from the role. Role obligations can stem from professional obligations, norms, and contractual promises. Those arising from a profession are in some cases based on and held to an oath of office. Doctors, lawyers, architects/engineers,

and other professional services providers must exercise the degree of care, skill, and knowledge required within their profession (Jervis and Levin 1988). A role obligation is reflected in fiduciary obligations, with duties of the obligator going beyond mere honesty and fairness; these duties obligate him to act to further the beneficiary's best interests (DeMott 1988). Role obligations can also be established by detailing roles and responsibilities through contractual promises (Poppo and Zenger 2002). This creates a concern for certain participants described by Hardimon (1994) that have both contractual role obligations and fiduciary duties. For example, Brown and Dauer (1978) indicate a lawyer faces a professional paradox that while serving his institutional function in the administration of the law, the lawyer is simultaneously privately retained by one side, having an accompanying obligation to act in the best interests of that client.

Constructive obligations, referred to as "gap-fillers" (Patterson 1942), are obligations that are made specific to fill gaps in the contract by using expectations, intent, and norms. A constructive obligation is an evolving foundational area of contracts in assisting industry and law in filling gaps in incomplete contracts as the need arises (Scott 2003). Scott and Leslie (1988) indicate that the traditional "four corners" rule applies in discrete contracts in which the trier-of-fact examines the written document. If the document is found to be complete, no inquiry is necessary beyond the four corners of the written agreement. For relational contracts, Gudel (1998) indicates classical contract law cannot be applied because it attempts to locate the entire content of the parties' agreement and their obligation to one another in the initial moment of agreement. Instead, Campbell et al. (2003) describe the determination of contractual obligations as a task of interpretation, or more realistically, of construction where the investigation cannot be limited to the straightforward reading of the express terms of the contract but must also include the implicit understandings and expectations of the parties. Zeller (2003) says the totality of a

relationship exists in the intent of parties that may be both subjectively and objectively exhibited. It is in that vein that Scott and Leslie (1988) say a written agreement should be examined in the context of the surrounding circumstances, going beyond the plain meaning of the text to examine evidence outside the contract to ascertain the parties' actual intention, relying on customs, usages, and other norms of general application. Gundlach and Achrol (1993) say recognition of the limitations of contracts for guiding long-term exchanges contributed to the attempt for the law to implement alternative mechanisms of governance. For instance, Gundlach and Achrol say the law is beginning to recognize business customs and other normative aspects of exchange in the planning and formation of exchanges in which gap-filler provisions allow contracts without explicit terms to rely on practices and customs developed in their trade or industry to settle these terms at a later point in time. Goetz and Scott (1985) say customs and trade usages establish general patterns reflective of collective wisdom. These patterns are models and temporal precursors to a possible formal legal recognition. Those patterns that gain acceptance within a particular market will ultimately emerge as additions to the array of existing norms. Also, Campbell et al. (2003) say the legally imposed obligations will, over time, become part of what is implicitly understood by the contracting parties as these manifest into the customs and expectations of the contracting community.

5.5.4.4 Classifying Obligations in Current Construction Practices and Trends

Construction project delivery methods are used to illustrate the six concepts identified for obligations. These concepts include the three attributes or parameters: sources of content, sources of obligation, and specificity, and the three different types of obligations: performance, role, and constructive obligations.

Design-bid-build

Located at the discrete end of the spectrum, design-bid-build is a project delivery method that follows sequential project phases that separate the participants and their activities. This method is based on a high level of specificity of obligations in which each participant has well-defined performance and role obligations. The source of content for the obligations is the contract used to communicate between the parties and, if necessary, to the courts. These courts are the source of obligation that can be used to enforce the agreement and settle disputes. There is often a reliance on other content sources, such as codes and guidelines typically referenced in the contract. Still, even in the absence of being explicitly expressed, specific industry standards like a life safety code and professional standards for an engineer are implicitly attached to the project. Constructive obligations are only used to resolve areas not adequately dealt with in the initial authoring of the contract.

Construction manager-at-risk

Construction manager-at-risk is a project delivery method that may be positioned on the contractual spectrum slightly removed in the relational direction from the discrete end. Construction manager-at-risk is a project delivery method where the contractor provides construction input in an advisory role during the design and only has contractual performance obligations for delivery if later competitively selected. Unlike design-bid-build, a contractor is involved earlier in the project lifecycle allowing him to contribute construction phase knowledge to the design/contract, which will serve as the principal source of content for obligations. If the contractor is selected for construction, he will have role and performance obligations associated with the delivery and the added benefit of familiarity with these obligations.

Partnering

Next is partnering, a project delivery method with the parties agreeing to cooperate to solve problems during the construction phase. This delivery method has obligational elements resembling both discrete and relational contracts. Like design-bid-build, the contract has a high degree of specificity and is the primary source of the content of the obligations. Unlike design-bid-build, the contract is supplemented with a partnering charter which establishes a relationship between the parties during construction and serves as additional sources of content and obligation. While partnering, the parties are free to cooperate and compromise to solve problems facing the relationship. As a feature of this method, they are not strictly bound to what is indicated within the "four-corners" of the contract nor required to go through formal change procedures or seek external legal support when problems are encountered.

Design-build

Even more relational than partnering is design-build. Design-build is a project delivery method in which the design and construction phases overlap, and the designer and contractor are members of the same team. Design-build differs from design-bid-build in all six aspects of obligations. With design-build, there is an expectation that many obligations will not be made specific initially. Scope of work that is only partially defined results in less reliance on the contract as a source of content and greater reliance on the relationship. The specificity initially lacking in the contract will occur during delivery as the design progresses, with role and performance obligations becoming specific as contractual gaps are filled with constructive obligations derived from intent and expectations associated with outcome. The source of obligations also shifts as the relationship becomes a primary means by which the parties fulfill their obligations as the relationship develops over time and typically continues past the project

completion. Codes, standard drawings, and other industry standards also serve as sources of content. Sources of obligations take on a relational bent as courts and other third-party interventions, like mediation or arbitration, remain in the background and are considered a last resort.

Firm

At the far relational end of the spectrum is the firm, a project delivery method in which the participants are members of an organization with a hierarchical structure that influences aspects of the obligations. All three attributes of the obligations are like design-build but even more relational. The source of content is the relationship relying heavily on intent to gap-fill an incomplete contract. The source of obligation is the relationship and an established hierarchy that assigns work and solves problems. This hierarchy is a significant obligational difference between the firm and design-build.

5.5.4.5 Conceptual Framework

The conceptual framework describes the three kinds of "Obligations"—performance, role, and constructive—using the three attributes by which they can be better understood—the source of content, source of obligation, and specificity. Performance obligations are duties about the work to be done and have attributes that vary with location along the contractual spectrum. At the discrete end of the spectrum, the source of content of performance obligations is the contract, where obligations are "static;" At the relational end, the source is the relationship, where obligations are "dynamic." In-between locations on the spectrum often have a combination of the two. The source of the obligations varies as well from external sources like courts that enforce and interpret the contractual promises at the discrete end, through to internal sources like norms and intent used to both enforce and generate the obligations at the relational

end. Performance obligations can either be specified initially or become specific over time which often corresponds with movement along the spectrum from the discrete to relational end, respectively.

Role obligations are duties associated with a profession having attributes like the sources of content and specificity varying with positions along the spectrum, while the sources of obligation tend to remain consistent across projects. The source of content of role obligations is either in the contract with its presentiated responsibilities defined initially at the discrete end of the spectrum or in the relationship with futurized responsibilities determined over time at the relational end. The source of the obligation can be courts that enforce the contract or other elements of the social matrix like a professional norm, an oath of office, or fiduciary obligations that govern beyond any individual project and even in the absence of being mentioned in the contract. Role obligations may or may not be specific at any point, with some explicitly expressed and others implicitly applied.

Constructive obligations are duties specified to fill gaps that are often a feature of incomplete contracts or used to correct mistakes in a complete contract; this type of obligation has attributes reflective of both discrete and relational transactions. Sources of content may be defined by intent or implied in either the contract or relationship through tacit assumptions, norms, or expectations. Sources of obligation can be courts to interpret and infer or industry norms, long-term relationships, and other aspects from the social matrix that guide how contractual gaps should be filled and provide the structure for ensuring they are. The obligations become specific as they are assumed by a participant, assigned by an authority figure, or allocated by a third party as the project progresses.

5.5.4.6 Case Study Illustrations

The three types of obligations are demonstrated using case study projects. There are two examples of performance obligations, one dealing with the timing of specificity and one with unmet expectations. There are three examples of role obligations, each highlighting a decision involving conflicts with performance obligations. And, there are three examples of constructive obligations in which each is specified using a different mechanism.

Performance Obligations

Two examples are used to highlight performance obligations. In the first example, performance obligations are made specific at different points during the project. In the second, performance obligations not specified in the agreement were not completed as expected.

On the I-15 project, some requirements were specified in the RFP, others during the proposal process, and still others during delivery. Requirements in the RFP were specified by the owner as complete designs using prescriptive specifications. Requirements specified during the proposal phase were included in the design-build team's proposal and incorporated into the contract. These performance obligations, those specified by the owner in the RFP and others specified by the design-build team during the proposal phase, reflect static obligations with the sources of content being the contract.

Requirements specified during design were left flexible in the contract. The owner established a process for over-the-shoulder design reviews during delivery in which members of his team could be involved as the design developed. He also incorporated an option for an extended warranty for additional protection from unfavorable design decisions. The obligations that remained flexible in the contract were dynamic obligations that became specified during delivery as the design progressed. The source of content of these performance obligations was

the relationship. The source of obligation for the design-build team was the specified procedures established by the owner in the contract. The warranty represented the potential for additional performance obligations assigned to the design-build team, which was to be determined by the owner at the end of construction.

On the I-4 reconstruction project, the owner anticipated that significant contingencies might be added by proposing design-build teams if they were required to perform particular utility work due to its associated uncertainty. The owner removed the utility work from the design-build contract to avoid this expense, choosing instead to perform it himself. He failed to complete this work on time, impacting the start of construction for the design-build team. The ensuing lack of negotiation to accommodate the design-build team for the delay damaged the relationship. In this example, the owner's performance obligations were not fully specified in the contract. The contract was not a sufficient source of content for the static obligation of the owner on an isolated portion of the work. Despite the intent associated with the owner's removal of the utility work from the contract and the expectation by the design-build team of timely performance by the owner, the owner was unable to fulfill his implicit performance obligations, and the relationship did not serve as a sufficient source of obligation.

Role Obligations

Focus now shifts to role obligations, with performance obligations playing a part in three examples by highlighting different decisions involving competing role and performance obligations. In the first decision, the role obligation controlled; in the second, the performance obligation ruled; and in the third, the two were balanced.

On the I-4 project, the contractor wanted to reuse the existing guardrail because of the associated cost and time savings, but the engineer rejected the idea. The underlying relationships

on the project were complex. The designer and contractor had previously worked together, and both used design-build previously, although the team members assigned to this project had done neither. The designer was a sub on this project.

The contractor's proposal to reuse the existing guardrail left the I-4 designer with a decision involving his performance obligation as a design-build team member and his role obligation as an engineer. The source of content for the designer's performance obligation was his subcontract for project design. Still, his fiduciary duty as an engineer was a source of obligation associated with his role obligation. Although the contractor's solution may have met the basic requirements for safety, it was not ideal for the long-term needs of the project as judged by the engineer. An additional source of obligation from the social matrix that could have been a factor was an existing long-term working relationship between the engineer and owner. Despite being on the contractor's team and under contract with him, the designer opposed the contractor's solution deciding to go with what he felt "ought" to be done. It's important to note that the organizational structure complicated the conflict between performance and role obligations. The designer making the decision, seemingly in the owner's best interest, was also protected by the owner by stipulating in the contract, a source of content for obligations, that no changes could be made to the design-build team without the owner's approval. As a result, the contractor could not merely replace the designer for disagreeing with his design solution.

The I-77 project left parts of the design flexible, including the guardrail required only to meet State standards. The guardrail provided by the design-build team met this scoping requirement but would be difficult for the owner to maintain. This situation is an example of an incomplete contract in which the performance obligations for the guardrail were not specific. During design, the performance obligation was specified as a constructive obligation generated

using an industry-standard as the source of obligation. The guardrail chosen by the design-build team and agreed to as safe by the engineer fell short of meeting the lifecycle concerns of maintenance and what the owner thought "ought" to have been done on the project. In this instance, the engineer seemed to limit his role obligation with the owner to that of safety while giving greater weight to his contractual performance and role obligations with the contractor with whom he had a design subcontract.

The I-77 project owner was concerned about the traveling public's safety during construction due to the lane widening in the median and anticipating construction trucks entering and exiting the median via the interstate. This concern led the owner to stipulate nighttime only construction as a requirement in the Request for Proposals. The winning design-build team proposed an innovative solution that would allow construction to occur during the day by having construction traffic enter and exit the median using a temporary earthen ramp from an existing bridge near the site. The design-build team included a design specialist to ensure the ramp's safety and prevent damage to the existing structure. This example highlights a designer balancing his performance obligation in designing a safe ramp for use during construction with his role obligation to prevent long-term damage to the existing bridge.

Constructive Obligations

The final three projects highlight three different ways constructive obligations may be made specific: intent and expectations, industry standards, and third-party intervention.

Time was a significant concern on the I-15 project leading the owner to make certain decisions like providing a complete geotechnical investigation report to all proposing design-build teams. The owner did not offer any solutions based on this report leaving this aspect of the project flexible for the design-build team. In an area with high settlement potential, the selected

design-build team used multiple innovative solutions to accelerate, reduce, or eliminate settlement allowing the project to be completed within the available timeframe. As an incomplete portion of the I-15 contract, the design-build team based their approach on the intent and expectations established by the owner regarding time, even though the owner did not specify any geotechnical solutions. The owner left this aspect of the performance obligations incomplete but protected himself from potentially bad design decisions with the option for the extended warranty.

On the I-77 project mentioned earlier, the design-build team provided a product that, despite meeting the industry standard referenced as a source of content, left the owner dissatisfied. The constructive obligations associated with this standard did not adequately address considerations of the lifecycle maintenance cost but instead focused on the product's functional attributes.

On the emergency I-10 Blackwater Bridge replacement, the owner faced time constraints that resulted in the first-time use of design-build, reduced the amount of available time for developing the RFP and proposals, and led the owner to provide available soil data concerning the site. Due to the short timeframe, the design-build contract resembled an earlier design-bid-build contract used as a cut-and-paste reference. Still, the owner assumed the relationships would be different because it was a design-build project. During construction, the design-build team encountered soil issues outside the areas where data was provided, requiring them to redesign and reconstruct a portion of the bridge approaches. The design-build team submitted a change order, but the parties could not agree on who was responsible for the changes. They then used the Dispute Review Board procedures established in the contract, with the Board ultimately viewing the contract as complete and ruling in favor of the design-build team. The owner subsequently

began administering the contract as written, leading to three additional uses of the Dispute Review Board.

The design-build team had viewed the contract as the source of content of the obligations because of its similarities with a design-bid-build contract and assumed the owner would be obligated for any issues related to their reliance on owner-supplied data. The owner's intent and expectations were that things would be naturally different because the project was design-build. The owner believed the contract was not a source of content that would establish static obligations, but rather the parties were entering a relationship with dynamic obligations that would evolve as the parties cooperated and renegotiated during the project. When the soil issue was encountered, the parties could not solve it themselves. They sought external support from the social matrix to allocate the unassigned obligations with the Dispute Review Board interpreting the contract as having established static obligations. This use of external support for gap-filling led to the deterioration of the relationship. After the ruling, the owner began viewing the agreement as containing static performance obligations, choosing to enforce the document as written.

5.5.4.7 Delphi Application

A Delphi panelist says there should be a "clear allocation of responsibilities." These responsibilities would be obligations allocated in the contract. But it is difficult to recommend this occur in every situation because the obligations will not or cannot be initially allocated in many relationships. This section uses the conceptual framework first to address why this is likely a concern for the panelist and then provide options for allocating responsibilities.

The Delphi comment reflects a concern about the differences in specificity of responsibilities in transitioning from design-bid-build to design-build. With design-bid-build, the

contract is the primary source of content of obligations in clearly defining responsibilities as performance and role obligations with constructive obligations used to make modifications when errors or omissions occur. The specificity of the obligations leaves parties with a clear understanding of what must be done to achieve the end result; and, if necessary, allows courts as the source of the obligation to enforce the agreement easily. These circumstances result from sequential project phases that separate the participants and their activities, allowing each participant to conduct their portion of work independently. An engineer works out the design details in isolation before it is packaged in the contract. The specificity of the presentiated design means the contractor has a clear idea of the obligations when developing the bid. These obligations will change only if a change order is issued modifying the contract.

When the project phases overlap with design-build, the temporal change in sequencing will impact what the contract entails and when and how the parties perform their work. The contract is initially incomplete, allowing the designer and contractor to work together to deliver the project. The source of content of the obligations is no longer mostly the contract but also includes the relationship in which the obligations become specific. The lack of specificity and the inclusion of dynamic performance obligations leave the parties relying on the role and constructive obligations using things like industry norms and codes to fill the gaps in the partially defined scope.

The design-build method not only involves a new process for specifying obligations, but the structure of the delivery method creates a concern for designers who have role obligations that may conflict with their performance obligations. This conflict leaves an engineer always faced with balancing his role and performance obligations. As a professional and fiduciary, the engineer has an additional source of obligation attached to any project he is involved in. This

role obligation is easily managed in a sequential system because the engineer works in isolation and completes his work before the start of construction and the involvement of a contractor. This rigid sequential synchronization of involvement is no longer the case with the design-build delivery method. One of its hallmarks is the opportunity to have construction knowledge incorporated into the design. This situation creates a double-edged sword for the designer performing portions of his work during delivery while engaged as a subcontractor with associated performance obligations in his contract with the prime contractor. The extent of the concern becomes more evident when considering the engineer's role obligations will extend throughout the facility's life, far beyond the contractor's time horizon, which ends shortly after construction.

There are concerns over how far the engineer can and will extend his role obligation relative to performance obligations. The role obligation must control for matters of safety, but beyond that, it is difficult to determine where the line is drawn for decisions related to the owner and the facility's life. With design-bid-build, the designer is the owner's agent, and while that is no longer part of his role in design-build, its influence may continue impacting the design-build delivery method due to the effects of structural inertia.

There are numerous options available to address the Delphi panelist's comment about the clear allocation of responsibilities, and three examples are provided here. One option is for the owner to allocate all responsibilities by providing a complete contract, much like a discrete project. The source of content of the obligations would be the contract in which performance and role obligations are specified and easily enforced by courts as an external source of obligations. A second more relational option would be for the owner to provide an incomplete contract relying on certain role and constructive obligations to establish a baseline for performance. At a

minimum, the engineer's role obligations conforming to established industry codes and safety requirements would be used to fill the gaps. Rather than initially allocated, the parties assume obligations as the project progresses, with negotiations occurring within the relationship when necessary. A third intermediate option would involve creating more fixed boundaries around the participants and their activities, with the owner specifying obligations for certain parts of the project. The contract would serve as a source of content for these obligations, along with the created relationship also serving as a source of content for additional obligations. In this resulting mixture of external and internal sources of obligations, specificity would range from specific to not specific for different parts of the same project.

Before concluding, it is worth mentioning that perhaps in the future other elements of the social matrix will develop. For instance, a guiding lifecycle code could be developed as more consideration is given to lifecycle issues. And, despite third-party intervention often being undesirable in a relationship as a source of obligation, more third-party help in the form of making mediation or arbitration decisions public as contract gaps are filled and thereby establishing a legacy for future projects.

5.5.4.8 Summary

Three kinds of obligations important to construction—performance, role, and constructive obligations—can be better understood using MacNeil's attributes of how obligations differ in their source of content, source of obligation, and specificity. Performance obligations are duties necessary for achieving an end result. The sources of content may be the contract or the relationship. The sources of obligation may be courts enforcing contractual promises and can play this role within relationships as well, although relationships often serve as their own source of obligation. Specificity can vary for performance obligations from specific to non-specific.

Role obligations are duties related to the functions of participants that arise from expressed promises or implied norms. The source of content may be the agreement or a professional standard. The source of obligation is either the contract or the social matrix from which norms and professional requirements develop. These obligations may be initially specific or become specific during the relationship.

Constructive obligations are duties fashioned from intent and norms to fill gaps. The source of content may be the contract drawing from established intent and expectations or the relationship through which obligations are made specific. The source of obligation is the social matrix in which certain norms and expectations become standard. Specificity occurs as these obligations are determined.

5.5.5 Sharing and Dividing Benefits and Burdens

5.5.5.1 MacNeil

Labeled initially "Incidence of Benefits and Burdens" (MacNeil 1974a), but later changed to "Sharing and Dividing Benefits and Burdens," MacNeil (1980a) suggests some relations share benefits and burdens undivided while others, such as in a discrete scenario, divide them sharply where "…each party has his benefits, all his, and his burdens, also all his."

MacNeil says that sharply dividing or sharing benefits and burdens parallels the use and non-use of measurement and specificity in contractual relations. In well-measured and specified discrete transactions, the contract typically shifts or assigns the total incidence of particular benefits and burdens to one party with no sharing (MacNeil 1974a). In less measured and specified relational transactions, it is common to have undivided sharing of benefits and burdens within the relationship. However, it is possible to include certain partitioned aspects of the effort

measured, specified, and divided between the parties within these transactions (MacNeil 1974a, 1980a).

5.5.5.2 Delphi Panel

The Delphi panelists address the sharing and dividing of burdens but use different terminology than MacNeil while ignoring the benefits side of the exchange. Examples of panelists recognizing the need to address burdens include comments such as “transfer risks to the party best able to manage the risks” and “identify potential unforeseen conditions.” Another comment, obviously sharing from his experience, mentions “identify responsibility for unforeseen conditions outside of the areas where borings were provided.” Still, another comment says, “include expectations for project specific insurance.” All these statements indicate a need to adequately identify and allocate the possible burdens in the effort. These seem to focus only on one side of the benefit-burden bargain and are in keeping with, possibly the result of, the Delphi panel’s original organizing theme, which was to develop a list of critical success factors for design-build scoping. This focus seemed to have steered towards preventing adverse project outcomes while drawing from their experiences; it seems the panelists note the positive steps taken to avoid trouble on their “successful” projects and relay lessons learned from their “failed” projects.

Two of the above comments that refer to the need to identify and assign certain risks within the contract illustrate the developed consensus of the Delphi panel over multiple rounds. One comment was “transfer risks to the party best able to manage the risks.” The panel initially ranked this comment with five “5’s” and three “4’s.” In later rounds, one panelist, an architect, raised his ranking from a “4” to “5,” while two engineers, one from the private sector and the other from the public sector, remained consistent with “4’s.” The ranking of the public sector

engineer is particularly interesting because he provided this comment as a lesson learned when his department chose not to shift a high-risk aspect of a project to the contractor. This panelist also offered the two comments mentioned earlier about "unforeseen conditions," ranking both as "5's," perhaps seeing the negative impacts from that past project as more impactful or more front-of-mind than the positive outcome on the other project. The final result of six "5's" and two "4's" tied with six others as the tenth most important. One of those six is the comment addressed next.

When initially ranking the comment "identify responsibility for unforeseen conditions outside of the areas were borings where provided," the panelists provided seven rankings of "5" and one "3." In the final ratings, the architectural engineer who initially offered the "3" raised it to "4;" a public sector engineer lowered his initial "5" to "4." As the only architectural engineer on the panel, his initially low rating could indicate his unique perspective, while his moderation of the rating to a "4" could reflect the iterative Delphi process demonstrating the influence of feedback from other panelists' ratings in developing a consensus. Another consideration is that when asked about past projects, neither he nor the engineer who provided the equivalent rating indicated negative experiences related to unforeseen circumstances as some of the other panelists did, perhaps resulting in this not being as great of a concern for them. The final result of six "5's" and two "4's" resulted in a tie with the above comment and five others as the tenth most important comments.

5.5.5.3 Literature

"Benefits and Burdens" is expanded below with supplemental literature in four topic areas: bargains, boundaries, risks, and externalities. Benefits and burdens are an aspect of a bargain that is either solidified through a contract's promises or dealt with in the future within a

relationship. Boundaries depict how benefits and burdens will be handled with boundary objects often used to communicate the assignment of benefits and burdens across the boundaries. Risks are a specific type of burden concerning the uncertainty of a future outcome. Externalities occur when benefits and burdens are pushed over a boundary.

5.5.5.3.1 Bargains

Benefits and burdens are one aspect of a bargain often solidified through a contract. In the bargain theory of contracts, a contract is described as an exchange by at least two parties of present promises to render future performance (Narasimhan 1986). Fried (1981) states a feature of a promise is that it creates reliance such that "the ordinary man will recognize at once: a promise is made to someone; it gives the promisee a right to expect, to call for its performance…".

Additional bargaining will be required for some contracts. Bargaining is defined by Dwyer et al. (1987) as a process in which parties rearrange their mutual distributions of obligations, benefits, and burdens. In relationships such as partnering in which participants have both common and secondary goals and trade-offs between these goals are negotiated (Crowley and Karim 1995), there is an expectation of reciprocity. Each party assumes it will earn a benefit because of its behavior in the relationship and expects the other party to reciprocate (Diathesopoulos 2010).

5.5.5.3.2 Boundaries

Boundaries depict how benefits and burdens will be handled. A boundary is "a physical, arbitrary, or imaginary line of demarcation acting as a barrier to segregate one's territory and define the limits of a common culture and jurisdiction" (Crowley and Karim 1995).

Organizations and their subsystems are distinguished from their environments by boundaries (Alderfer 1976).

Boundaries can be characterized as flexible or rigid and permeable or impermeable (Crowley and Karim 1995). Flexible boundaries can be repositioned, allowing an organization to decentralize, reorganize, or restructure its resources according to specific objectives; rigid boundaries are well-defined and challenging to reposition (Crowley and Karim 1995). Permeable boundaries allow communication and interaction through the boundaries to facilitate the exchange of ideas and information, while impermeable boundaries restrict this type of exchange (Crowley and Karim 1995).

A "boundary object" (Star and Griesemer 1989) is used at a boundary interface as a communication device (Koskinen and Mäkinen 2009). This artifact serves as a coordinator of perspectives and as a point of mediation and negotiation around the intent to help people from different organizations build a shared understanding (Koskinen and Mäkinen 2009).

5.5.5.3.3 Risk

Organizations are continually faced with various situations involving unknown, unexpected, undesirable, and unpredictable factors, creating a need for risk management (Akintoye and MacLeod 1997). Risk management methods include risk transfer, risk reduction, or risk retention (Akintoye and MacLeod 1997). Risk transfer is an option for certain foreseeable risks. Scott (1987) indicates there is a potential gain to all involved parties if they can assign the entire risk to the party best able to influence the risk, then allow that party to control processes and other aspects of its performance as well as take cost-effective precautions to reduce the probability of variations. Risk reduction techniques are an option to reduce the potential impact or likelihood of occurrence. These techniques can involve alternative strategies, a redesign, or a

more detailed and in-depth investigation (Akintoye and MacLeod 1997). Risk retention is an option when risk prevention or transfer is impossible or not economical (Akintoye and MacLeod 1997).

5.5.5.3.4 Externalities

"Externalities" are burdens or benefits pushed outside a participant's boundary to either the environment or another participant (for example, Frischmann 2009, Mundt 1993, Demsetz 1967). One externality is spillover burdens, where actions of an organization have harmful effects on others. Spillover burdens often result in spillover costs in that an expense is realized by one party because of another's activity without payment or compensation (Coase 1960, Frischmann and Lemley 2007). One remedy for capturing externalities is to internalize the spillovers by merging the party creating the spillovers with the party on which they are imposed (Heller 1972). Coase (1960) suggests capturing and containing the adverse effects of situations within a single firm if by handling the situation using multiple parties would require a lengthy and detailed contract to describe what the parties have agreed to do or not do.

Spillover benefits are incidental extras resulting from a decision made by one party that spills over a boundary to others (Frischmann and Lemley 2007). Spillover benefits can be induced through incentives that link the providers' performance with associated benefits from the relationship (Heller 1972, Diathesopoulos 2010).

5.5.5.4 Classifying Benefits and Burdens in Current Construction Practices and Trends

These concepts identified in the literature are illustrated using five project delivery methods: Design-Bid-Build, Partnering, Design-Build, Construction Manager-at-Risk, and the Firm.

Design-bid-build

Design-bid-build is at the discrete end of the continuum, with participants communicating across rigid, impermeable boundaries through a contract that serves as a boundary object. Under this method, the contract encompasses the entirety of the bargain with all benefits, burdens, and conceivable risks identified and assigned within a participant boundary, along with specifying the procedures for areas that can't be thoroughly planned. Externalities are seen as errors or omissions in the contract. Any required extra work will occur with the benefits and burdens incrementally adjusted in a negotiated change order.

Partnering

Partnering began to be used to address the adversarial nature of design-bid-build. This method is a shift along the continuum in the relational direction where the boundaries are thinned out during construction allowing communication for problem-solving. A complete contract remains the primary boundary object, but it's supplemented by a partnering charter that serves as an additional boundary object. The partnering charter seeks to establish a cooperative relationship between the parties during construction that can often lead to flexibility in the original bargain. Encountered problems are negotiated cooperatively between the parties. Externalities may arise while partnering from self-dealing on secondary goals. For example, the contractor may trade on the owner's desire for a completed project in which there are no unresolved changes or claims for higher profits achieved through excessive payments on changed work.

Design-build

The success of partnering led some owners to desire a more significant relational component available in design-build. Participants foster relationships in design-build through

flexible, permeable boundaries. The contract is no longer the primary means of communication, nor does it capture the totality of the bargain. Initially incomplete, contracts are completed through interaction across the thinned, permeable boundaries during the performance. Some high-risk items, along with their benefits and burdens, may be partitioned and subsequently either assigned to individual parties or planned for with procedures. Other events are dealt with in the relationship as they are encountered. The incomplete scope creates a concern that externalities may result from either stakeholders' voices not being given sway during decision-making or that short-term decisions based on low first cost or time constraints considerations may leave downstream burdens for the owner. Also contributing to the possibility of externalities is the organizational structure of design-build. The designer is no longer an agent of the owner as typical in design-bid-build but is often now a subcontractor to the builder, resulting in less control over the design when dealing with areas not directly related to safety. This last issue is believed to be one of the reasons some owners are moving back along the continuum to a construction manager-at-risk project delivery method.

Construction manager-at-risk

Construction manager-at-risk is positioned on the contractual spectrum between design-bid-build and design-build and possesses many of the characteristics of both. Like design-bid-build, a complete contract serves as the boundary object; but unlike design-bid-build, the typical thick boundaries between the designer and contractor are thinned during the design phase allowing the incorporation of construction knowledge into the design. The designer benefits from enhanced knowledge of field processes, while the contractor benefits from incorporating preferred construction techniques. If ultimately selected to perform the contract, the contractor benefits from familiarity with the design and an established relationship with the designer, which

could ease any potential difficulties between the parties that might be encountered during the performance. If the contractor is not selected, then its incurred expenditure of cost and time will benefit the owner without compensating for the burden. This situation reflects a significant externality in this delivery method.

Firm

The firm occupies the most relational position on the continuum where designers and builders are within the same organizational entity. This method relieves the project owners of the burdens associated with other delivery methods. There is no need for the owner to incur the expense of developing a complete contract, be burdened with externalities linked to a flawed boundary object, suffer from potential externalities of an incomplete contract, or deal with unsuitable organizational structures where designers work for the contractors. Firms are defined by flexible, highly permeable boundaries. The boundary object facilitates communication between the participants from its hierarchical structure, not a contract. This structure allows work to be assigned as it's determined, and risks and other benefits and burdens are dealt with as they are encountered. Externalities are typically reduced by merging the participants within a single organizational boundary. However, it does not eliminate all possibilities that burdens may be pushed outside the firm's boundary to others.

A continuum of construction project delivery methods from discrete contracts like design-bid-build to relational ones like the firm illustrates concepts that distinguish methods by morphing boundaries and boundary objects along with the handling of risks, benefits and burdens, and externalities. Boundaries change from being rigid and impermeable to flexible and permeable during either certain phases or for the project's entirety. Boundary objects change from a complete contract serving as the primary communication device to one that is incomplete

and augmented by additional boundary objects and relational interactions. Risks and benefits and burdens go from being specified and assigned in the initial bargain together with the necessary planned procedures to being dealt with as they occur within the relationship. Externalities go from arising as mistakes occur in the boundary object to pushing burdens outside relationships that aren't inclusive of all critical stakeholders.

5.5.5.5 Conceptual Framework

Benefits and burdens are part of a bargained exchange that may be divided, shared, allocated, and traded, with each bargain distinguished by boundaries, boundary objects, risks, and externalities. A divided bargain is an exchange in which benefits and burdens are identified and assigned to participants in the contract. Boundaries are rigid and impermeable, with the contract serving as the boundary object to communicate across them. Benefits, burdens, and risks are anticipated and planned through adding contingencies as a compensating benefit to parties incurring burdens or assuming risks. The complete boundary object details the bargain, thus reducing the likelihood of externalities. The arms-length nature of this impersonal exchange may result in burdens being pushed over participants' boundaries when encountering unplanned problems.

A shared bargain is an exchange in which benefits and burdens are negotiated within the relationship. Boundaries are flexible and permeable, facilitating communication and collaboration among the participants. The contract is often only one of many boundary objects and is typically incomplete initially to be completed by the participants during the performance. Similarly, benefits, burdens, and risks are usually negotiated within the relationship when these are encountered with participants expecting give-and-take and reciprocity in their dealings. Externalities are a concern when the decision-making process decouples the benefits and

burdens, allowing a participant to capture a benefit while pushing the burden outside its boundary.

An allocated bargain is an exchange in which benefits and burdens are negotiated during the proposal phase and agreed to in the contract. Rather than prescribing a design solution, the owner presents his problem to the market, allowing proposers to develop solutions in a competitive setting. The initially incomplete bargain is completed through rounds of proposal reviews into the terms of an agreed contract that serves as a boundary object at the boundaries. This type of bargain allows potential benefits and burdens, anticipated risks, and possible externalities to be considered and dealt with in the boundary object while all participants are actively involved.

A traded bargain is an exchange in which benefits and burdens are both known and consented to by all or unknown and likely not agreed to by the other party. Both types of these traded bargains, constituting bilateral and unilateral bargains, occur during the performance. The first type of traded bargain is known to the parties arising bilaterally. It is similar to a divided bargain with potential benefits and burdens typically identified by the parties before contracting and also similar to a shared bargain where exact events cannot be anticipated, so procedures are included in the contract to deal with them as they occur. Unlike a divided bargain, the trade that happens during performance results in adjustments to the original bargain. Impermeable boundaries are thinned during the performance to help negotiate the trade. This is seen with certain divided bargains with procedures planned into the boundary object for equitably dealing with change orders or unforeseen conditions during the performance, removing the potential and need for added contingency. There are risks when a trade occurs during the performance because

the owner is negotiating with only one contractor compared to many in a competitive setting before contracting. Externalities are typically not a concern with the bilaterally agreed trade.

The second type of trade that occurs unilaterally is not known by all parties, and it can directly impact the end product, other participants, and the environment. This type of traded bargain has the potential to occur in all scenarios: with rigid or flexible boundaries, permeable or impermeable ones, and with complete or incomplete boundary objects. This traded bargain occurs when benefits and burdens are uncoupled. With a spillover burden, the benefit is captured while the burden is pushed elsewhere, either to the environment or another's boundary. The possibility for these externalities is a particular risk in instances where the boundary object is incomplete, stakeholders are not present during decision-making, participants' perspectives and length of involvement differ, or a complete boundary object is flawed. There is also a potential for spillover benefits where a burden taken on by one participant creates an uncompensated benefit for another.

Bargains are often used in combination. Divided bargains are typically used for discrete contracts but may be combined with shared bargains that establish contractual procedures to negotiate equitable solutions for certain unplanned events encountered during construction. Shared bargains are typically used for relational contracts but may be combined with divided bargains for certain contractually delegated elements. While the parties share the same objectives, goals, and outcomes, there can be unique contributions, obligations, and burdens borne by each of them individually.

To summarize, benefits and burdens are part of a bargained exchange that may be divided, shared, allocated, or traded. Each bargain can be defined using boundaries, boundary objects, risks, and externalities. A divided bargain assigns benefits, burdens, and risks to

participants in well-defined boundaries using a complete boundary object that attempts to prevent externalities. A shared bargain deals with benefits, burdens, and risks within a relationship through negotiations between participants who have permeable boundaries. Externalities are possible when one participant decides on an issue without the other's involvement. An allocated bargain ultimately assigns benefits, burdens, and risks in the boundary object. The participants have permeable boundaries allowing them to negotiate the assignment during the proposal phase, ideally preventing externalities. A traded bargain pushes benefits, burdens, or encountered risks over a participant's boundary, compensated or not, to another participant or the environment.

5.5.5.6 Case Study Illustrations

Case study projects illustrate the four types of bargains. There are three examples of divided bargains with owners partitioning and allocating project requirements to various participants within the contract. Three examples illustrate shared bargains involving different expectations concerning the nature of the bargain and established procedures for the relationship. Two examples show allocated bargains with the design-build teams presenting design solutions for approval before contracting. Finally, four examples demonstrate traded bargains and include a negotiated burden on one project, a burden pushed onto the owner on another, and implemented measures to prevent externalities on the other two.

5.5.5.6.1 Divided Bargain

Three case study examples highlight a divided bargain. In the first, a risk matrix is used to assign foreseeable risks, and in the other two, risky project requirements are removed from the contracts leading to significantly different outcomes.

The I-15 project uses a risk matrix to identify potential risks, assessing their probability and impact. Risks with high likelihood and impact are dealt with using specific mitigation measures such as assigning these project risks to who can best manage them. This approach reflects a divided bargain where certain risks and their associated benefits and burdens are separated, assigned, and contained within well-defined boundaries between the contracting parties. This rigid delegation is communicated between participants in the construction contract serving as a "boundary object."

The St. George Island Bridge project crosses the Apalachicola Bay, home to 90% of Florida's oyster harvest. Concerns about the potential oyster bed impact prompted the owner to make four adjustments to the project plan: (1) The work to relocate the oyster beds in the vicinity of the project was retained by the owner and not included in the design-build contract, given the typical design-build team would be unfamiliar with this type of work. (2) Oyster relocation was coordinated and carried out by the owner using experienced local oystermen. (3) A consultant was hired to assist in reducing oyster crop impacts and work with permitting agencies. (4) Criteria for design-build team selection included a heavy emphasis on the oyster reef and environmental protections leading to the selected team proposing fewer, larger diameter piles used previously by the contractor to reduce disturbance to the bay bottom.

This divided bargain utilizes well-defined boundaries and boundary objects to good effect. The owner retained the oyster relocation work within his responsibilities, allowing them to control a portion of the project that is particularly important to his constituents while minimizing the potential for choices that might have led to externalities in operation. In the owner retaining this work, the design-build team was relieved of the burden of undertaking uncertain, unfamiliar work that would have resulted in higher bids with a large contingency for

the owner. The owner communicated to potential design-build teams the importance of the environmental concerns in the project requirements through the selection criteria detailed in the RFP (Request for Proposal), which served as a boundary object. Also, the owner augmented his capacity for the oyster work by adding a consultant and the oystermen within his boundary to assist with the owner's retained oyster work. The thin, permeable boundaries between the contractor and designer within a design-build project delivery facilitated designs incorporating the contractor's experience and capability with the proposed fewer large diameter piles to reduce oyster impacts.

The I-4 project had extensive conflicts with existing utilities. The owner chose to self-perform the utility work, believing that otherwise, the design-build teams would increase their bids to incorporate it by 200 to 300%. Subsequently, the owner was unsuccessful in providing timely delivery of this work, which significantly impacted the design-build team's work. This example illustrates a planned divided bargain failing to maintain the integrity of the bargain during the performance. The bargain was structured with the owner committing to self-perform the highly uncertain utility work in exchange for the benefit of paying actual costs while stripping the bids of possible contingencies. The design-build team relied on this division of work communicated in the RFP when submitting the winning proposal by likely assuming the owner would and could perform the utility work as promised without impact. The owner failed in this effort. The owner benefited from paying the actual cost but created an uncompensated time-delay burden for the design-build team, which constitutes an externality. This burden was intended to be contained within the owner's boundary but leaked over to the design-build team's boundary straining the relationship. There was no contractual provision to handle this situation, and the parties failed to negotiate an equitable solution. The boundary object used to divide the

bargain was not complete in this regard. And, it lacked the relationship to facilitate communication across the boundary to renegotiate in situations when a shared bargain is realized.

5.5.5.6.2 Shared Bargain

Three examples highlight a shared bargain. In the first, unforeseen soil conditions reveal the participants' different perspectives on the type of bargain they entered. The same project was used for both the second and third examples. These examples are of a risk matrix facilitating the sharing of risks and a partnering process establishing a relationship for problem-solving.

Existing structural damage exacerbated by a hurricane resulted in the need to replace the I-10 Blackwater Bridge quickly. The emergency nature of this project had two significant impacts: (1) the Florida Department of Transportation chose the design-build project delivery method for the first time on a major bridge project, and (2) the timeframe was condensed for all aspects of the project including both RFP and proposal development. To alleviate some of the time pressure, the owner provided existing soil data which the design-build team relied on for their design. During construction, poor soils were encountered outside areas where boring data was provided, resulting in the need to redesign and reconstruct a portion of the structure. The design-build team requested compensation for the effort in the form of a change order, but the parties could not agree on a solution. Based on their interpretation of the contract, the design-build team believed that this change was the owner's responsibility. Using the design-build method, the owner thought that the parties were establishing a working relationship where events would naturally occur differently. Ultimately, the Dispute Review Board was used to settle the issue. After an additional attempt at negotiations between the parties was unsuccessful, the Board ruled in favor of the design-build team based on the Board's interpretation of the underlying

contract. After the ruling, the owner also began to interpret the contract as written, resulting in the need for three additional Dispute Review Board rulings. This problem highlights that the parties did not share the same understanding of the bargain, the owner saw it as shared, and the design-builder saw it as divided. This misunderstanding is partially due to using a flawed contract that was cut-and-pasted from a traditional design-bid-build contract template. Although as a boundary object, the contract is typically used as a communication device, the owner never expected to have it engaged but instead planned to rely on the spirit rather than the letter of the agreement. At the same time, the design-builder interpreted the agreement literally, resulting in miscommunication about the reliability of owner-supplied information. The difference in perspective was revealed when the design-builder requested a change order due to the encountered poor soils, as he traditionally would with design-bid-build. After the parties could not agree, the Dispute Review Board ruled in favor of the design-build team based on the contract. After this occurred, the owner also began to administer the contract as if it were a complete boundary object that reflected a detailed description of the agreement by adjusting pay based on the actual work performed. This action resulted in additional assistance being required from the Dispute Review Board.

Along with identifying certain risks that should be divided, the I-15 risk matrix identified some risks that could be shared. Details that could be anticipated were planned, but other details were left to be dealt with in the future. For example, if hazardous materials were encountered, the owner would pay the contractor on a unit price basis. This reflects a shared bargain where specific risks are negotiated within the relationship between contracting parties having permeable boundaries. This sharing of burdens was communicated in the contract as a boundary object reflecting the planned portions of the project.

In the I-15 RFP, the owner recommended using partnering. The selected design-build team committed to common goals, objectives, and problem resolution using a partnering charter to create a tiered partnering process from operating to management levels. A partnering process, established through a partnering charter serving as an additional boundary object, facilitated a relationship by thinning the boundaries between the participants, making them thinnest at the lowest working levels but leaving them more structured at the higher decision-making levels.

5.5.5.6.3 Allocated Bargain

Two examples highlight an allocated bargain. In both instances, design-build teams whose bids are based on adjustments to the preliminary design present their solutions for approval during the proposal phase.

Safety during construction was a primary concern of the I-77 owner, given the widening was occurring in an existing median of a high-volume interstate requiring the entering and exiting of construction trucks via the interstate. This led the owner to specify in the RFP that construction would be restricted to nighttime hours. The selected design-build team proposed an innovative solution to construct a temporary earthen ramp for construction traffic in the median up to an existing bridge, thus allowing daytime construction. This innovative solution lowered costs, reduced delivery time, and improved construction safety. The design-build team included a design specialist to ensure the ramp would be safe for construction while preventing damage to the existing structure. A significant change to the owner's construction stipulation and a basis for the bid, the design-build team sought owner approval before entering the agreement. A risk and potential externality for the owner was the possible damage to the existing bridge. The connecting roadway was addressed with the inclusion of the design expert as a member of the

design-build team. The reduction in cost and time were externalities in the form of spillover benefits for the public.

One location in the I-85 preliminary design involved a right-hand merge of traffic onto the fast lane of the interstate, raising concerns over traffic safety. The design-build team addressed this concern in their proposal with a reconfigured, traditional left-hand merge that solves the safety issue for the traveling public. This winning solution also substituted a new smaller bridge over the interstate to replace the proposed interstate bridge reducing cost and project duration while lowering lifecycle maintenance costs and future interstate expansion costs. The thin, permeable boundaries of the participants and the flexibility provided by an incomplete design as a boundary object allowed the design-build team to propose a reconfigured, safer plan resulting in the externality of a spillover benefit to the owner and public.

5.5.5.6.4 Traded Bargain

Two types of traded bargains are highlighted, one trade is known, and the other is unknown. The first type of traded bargain is typically seen with discrete contracts. All aspects of the bargain cannot be divided before entering the contract, so parts are dealt with in the future through arms-length interaction rather than within a relationship. There are no examples of this type of known traded bargain within the case studies because these were all design-build projects with the relationship between the parties a principal goal. Therefore, a modified example is utilized to inform our perspective.

The need for a Knightdale Connector arose when the owner realized neither of the two ongoing adjacent projects included the connecting ramp between the projects. The owner added the Knightdale Connector to one of the projects indicating it was easy to do because it was a design-build project. This trade of a benefit for an additional burden would have occurred

differently in the absence of an ongoing relationship. In design-build, the boundary object on the project establishes a connection between parties with permeable boundaries allowing them to negotiate during the performance to deal with encountered problems quickly and seamlessly. This change would have been more complicated if the relationship were stripped away, as if it occurred in a traditional design-bid-build setting where boundaries are impermeable, and the boundary object communicates the full extent of the work. In this case, the contractor has the potential to use his monopolistic delivery status to perform what might be characterized as a "holdup" during negotiations.

Three examples highlight the second type of traded bargain. In the first, the design-build team's low first cost decision creates a maintenance burden for the owner. In the other two examples, the owners incorporate measures to reduce externalities. One project continued the owner's involvement during design with an additional option to purchase an added warranty. The other project used incentives to reduce environmental impacts.

Design flexibility was provided for the I-77 guardrail with a requirement to meet the minimum standards set by codes. The design-builder chose a double-faced guardrail which provided a low-first cost benefit while creating a maintenance burden to the owner due to drainage problems and the requirement to cut grass using weed eaters on the steep, narrow medians. An incomplete contract risks that the owner's expectations will not match the other party's deliverable. Flexible design within an incomplete boundary object allows the design-build team to make individual decisions that benefit them while burdening the owner. This situation constitutes an externality highlighting three things. First, the contractor's short-term perspective naturally focuses on short-term goals that can inadvertently result in long-term burdens being pushed on others. Second, the designer working as a subcontractor lacks the

authority to consider the non-safety needs of all stakeholders. Third, design choice alternatives such as those seen here could be addressed by developing a standard lifecycle code as mentioned in Suggestions for Future Research.

The I-15 Request for Proposal (RFP) required "over-the-shoulder" design reviews in addition to a warranty add-alternate included in the proposal. The "over-the-shoulder" design reviews allowed the owner's team to be present and approve decisions during design. The warranty add-alternate allowed the owner to decide at the end of construction whether to continue the involvement of the design-build team for maintenance. The owner ultimately chose not to purchase the warranty due to the high quality of the observed work. "Over-the-shoulder" design reviews and warranty were means of preventing externalities, with the RFP serving as the boundary object in stipulating both requirements. "Over-the-shoulder" reviews thinned the boundaries during the design allowing communication and stakeholder representation while making design decisions. The warranty provided a final means of owner protection by preventing a short time horizon contractor from pushing burdens over his boundary onto others.

The Knightdale Connector was in an environmentally sensitive area containing wetlands, hazardous materials, and archaeological sites. These concerns led the owner to develop an environmentally focused selection criterion and offer monetary incentives for reducing impacts. Incentives were a means to mitigate externalities by providing a benefit to the design-build team associated with taking on the burdens and preventing spillage of the burden onto the owner or the environment.

Case study examples highlight four types of bargains. A divided bargain has the owner partitioning and assigning certain project parts to particular participants. A shared bargain might have the owner planning some parts of the projects while leaving others to be dealt with in the

future within the relationship. An allocated bargain has the proposing design-build teams offering adjustments to the owner's design solution during the proposal phase. A traded bargain is illustrated using a modified example of an owner's change in one case, a design-build team spilling over certain burdens to the owner in another, and an owner preventing spillovers in two additional cases.

5.5.5.7 Delphi Application

A Delphi panelist suggests you should "transfer risks to the party best able to manage the risks." Four risk categories are associated with construction: known, unknown, contracting, and performance risks. These categories include most encountered risks in construction, although it is not intended to be exhaustive. Known risks are mentioned by a Delphi panelist noting these can be identified before the contract is entered. Unknown risks are unexpected and are made present and known in the future. Contracting risks are associated with the flexible scope and the provided end product. Performance risks are associated with uncoupling benefits and burdens during execution.

The four bargains identified in the conceptual framework can bring a clarifying perspective in understanding the nature of these risks and how these can be managed. Known risks are dealt with in a divided bargain. These risks are identified and assigned in the contract to the party who can handle them most efficiently; this would be the party who has experience in the matter and can deal with it at the lowest cost and most efficiently.

Unknown risks are dealt with in a shared bargain. These risks are unknown until they present during the performance and include such risks as unforeseen site conditions and unusually severe weather. Procedures for dealing with these future situations can be planned into

the contract. Parties also expect they will be able to negotiate an equitable solution within the relationship.

Contracting risks are dealt with in an allocated bargain. These risks are associated with a flexible scope that can be addressed through an extended proposal phase. The parties negotiate and agree to acceptable solutions before entering the contract. This approach may be desirable for owners that are uneasy about providing flexibility and want to approve designs to ensure the end product meets their expectations. It may also be beneficial for a design-build team offering an innovative design that is foundational to their bid and wants the owner's approval before entering an agreement.

Performance risks are dealt with in a traded bargain. These risks are associated with burdens decoupled from their benefit and pushed elsewhere or onto someone else. The solution in dealing with externalities is to address potential concerns in a bilaterally traded bargain with both parties aware and agreeing to what is being traded. Alternatively, in a unilaterally traded bargain, one party is unaware that a burden has been pushed onto them. These risks can often be anticipated based on history and dealt with during planning. For instance, quality or maintenance concerns can be addressed by extending the involvement of the design-build team into the utilization phase or requiring them to provide an extended warranty. The owner might retain the right to be involved during design decision-making. Or they might ensure key stakeholders' voices are heard through directive elements of the selection criteria. Environmental concerns can also be addressed in the selection criteria or by offering incentives in the RFP to minimize the impacts.

The Delphi panelists directly addressed one category of risk, known risks. Three additional risk categories were identified: unknown, contracting, and performance risks.

Bargains allow project participants to deal with these uncertainties and provide the perspective needed to identify other solutions beyond the simple transfer of risk that is possible for known risks. The conceptual framework was used to draw parallels between known risks that can be identified and assigned in a divided bargain and other forms of risk. Unknown risks can be dealt with in the relationship through a shared bargain. Contracting risks can be addressed during the proposal phase in an allocated bargain. And performance risks can be avoided through a bilaterally rather than unilaterally traded bargain.

5.5.5.8 Summary

MacNeil indicates one of the distinguishing characteristics of discrete and relational contracts is how each handles benefits and burdens. Discrete contracts typically divide benefits and burdens, while relational contracts allow the participants to share them. This idea was expanded by focusing on the broader view of the bargain.

Benefits and burdens are part of a bargained exchange that may be divided, shared, allocated, or traded. Divided bargains contain presentiated benefits and burdens which are sharply divided and assigned in the contract. Shared bargains have futurized benefits and burdens which allow flexibility to deal with them in the relationship when they are encountered. Allocated bargains begin as futurized but are negotiated and divided in the agreement during the proposal process. Traded bargains involve the bilateral or unilateral exchange of benefits and burdens that can be known or unknown when they are exchanged.

5.6 Chapter Summary

Professor MacNeil identifies 12 factors, combining two of his original 13, that differentiate discrete and relational contracts. These factors were the starting point to the grounded theory presentation of design-build as a relational contract. After using MacNeil's

work in defining each, these factors were supported by the Delphi panel data. Then, the characteristics were further developed and expanded using literature. Next, they were described within a construction context and then synthesized into a conceptual framework for their application. Next, the factors were used to understand events occurring on case study projects and finally used within a conceptual framework to address concerns mentioned by the Delphi panel.

The 12 factors are grouped into four categories: boundaries, actors, time, and planning. The nature of boundaries, events occurring inside and outside of them, and the interactions across them highlight two factors: the "Overall Relation Type" and the combined factors of "Basic Sources of Socioeconomic Support" and "Sources of Contractual Solidarity." Actors, the attributes they possess, and how and when they participate during the project were used to demonstrate three factors: "Power, Hierarchy, and Command," "Numbers," and "Attitudes." Aspects of time such as participant involvement, entering the contract, and product delivery was discussed in two factors: "Commencement, Duration, and Termination" and "Transferability." Characteristics of planning and the elements of the plan were discussed in five factors: "Planning," "Future Cooperation," "Measurement and Specificity," "Obligations," and "Benefits and Burdens."

"Overall Relation Type" has three distinguishing characteristics: personal involvement, types of communication, and subject matter of satisfaction. It can be described using three boundary-related concepts: boundaries, boundary objects, and boundary spanners. Boundaries separate and define, making it challenging to interact outside of them, but are overcome at boundary interfaces through boundary objects and

boundary spanners. The boundary object's form and the boundary spanner's role are influenced by the nature of the boundaries that are in place.

"Basic Sources of Socioeconomic Support" was identified by MacNeil in his initial work and then removed in a later work when "Sources of Contractual Solidarity" appeared. Both perspectives are relevant and addressed jointly. The initial perspective is external and focused on moral, legal, social, economic, and other sources of support for exchanges offered through societal mechanisms. The latter is internal and focused on contractual solidarity and the relationships with its support provided from within contractual and organizational boundaries. Thus, solidarity for exchanges is described in two ways: external contractual solidarity and internal social solidarity. Contractual solidarity comes primarily from socioeconomic sources of support outside the exchange boundary, while social solidarity comes from relational sources inside the exchange boundary.

"Power, Hierarchy, and Command" each provide the ability to impose one's will on others. Power can be either bilateral or unilateral. Bilateral power is exercised through exchanges involving promissory transactional elements achieved through negotiations and other agreement processes. Unilateral power is exercised through the holder's authority in the forms of hierarchy and command. In a hierarchy, those in positions of authority have unilateral power to direct those below them. Unilateral power can be exercised to direct work, command action, and make choices.

"Numbers" represent the actors involved in an exchange and are described using network concepts of nodes, links, and boundaries to depict the participants, illustrate how they are connected, and show how they are grouped.

"Attitudes" portray participants' perspectives using four characteristics: awareness of conflict of interest, unity, time, and trouble. First, "awareness of conflict of interest" is captured in the dominance of self-interest. Second, "unity" is defined by five fundamental elements: altruism, reciprocity, cooperation, opportunism, and trust. Altruism is an action benefiting another individual carrying no anticipation of reward. Reciprocity is an action followed by the expectation of a favorable reaction. Cooperation is a joint action for a common purpose. Opportunism is action motivated by self-interest, with its absence serving to foster unity. Trust is confidence in another individual. Third, "time" is addressed using five concepts: presentiating and futurizing about moving time; horizontal and vertical time deal with our relationships to time; sequence, synchronization, and rate relate to temporal ordering; private and public time refers to actor accessibility; and conversion and flow relate to production. Fourth and finally, "trouble" reflects a problem requiring an action that can either be pre-planned or determined when trouble presents itself.

"Commencement, Termination, Duration" describes the beginning, ending, and longevity used in referring to such things as the overall transaction, the forming of the agreement, actor participation, and actor interactions. These events can be defined using temporal boundaries, which can be characterized as fuzzy or sharp to capture modes of entry and exit and can also indicate both functional and temporal differentiation and integration.

"Transferability" describes the ease with which a handover can occur to another participant. Three main transfer points are identified in construction: transfer to the

market, transfer for performance, and transfer for use. These points are preceded by a phase that develops the deliverable to what is provided at each transfer.

"Planning" is preparation for action and has two outcomes in the context of exchange: a presentiated contract or a futurized one. Each is distinguished by six planning attributes: substance-process, completeness-specificity, tacit assumptions, participation, post-commencement planning, and bindingness.

"Future Cooperation" represents the need for further interaction for either planning or performance and can be described as cooperation through planned procedures based on a script or working together within a relationship.

"Measurement and Specificity" is the communication of the deliverable in measurement, description, and performance. Both sides of the bargain are measured and specified in a complete boundary object before transferring for delivery. Or enough information is provided to establish both sides of the bargain in an incomplete boundary object.

Three kinds of "Obligations" or promises are associated with construction: performance obligations which are those associated with a contract; role obligations which are those associated with a profession; and constructive obligations, which are those used to fill in the gaps. Obligations are distinctive in how promises load on three mechanisms: sources of content reflecting the origin of the promises; sources of obligation representing support for the promises; and specificity describing the definitiveness of the promises.

"Benefits and Burdens" are advantages and obligations associated with the bargain. Four types of bargains are identified: divided, shared, allocated, and traded. A divided bargain assigns benefits and burdens to individual participants. A shared bargain leaves benefits and burdens to be dealt with in the relationship. An allocated bargain negotiates and subsequently assigns

benefits and burdens in the contract. A traded bargain spills over to the detriment or, in some instances, the benefit of another participant.

The goal of this triangulation process was to make sense of past projects and provide a means to plan for positive outcomes on future projects while avoiding adverse outcomes. This developed conceptual framework can be used as an individual tool or in concert with others.

Chapter 6

Conceptual Model Applications

6.1 Introduction

This chapter demonstrates the developed conceptual model's usefulness in understanding and applying current design-build procedures and practices and in analyzing, evaluating, and modifying them. The model represents a design-build body of knowledge in line with the revised Bloom's Taxonomy (Anderson et al. 2001), which is an updated version of the taxonomy used by ASCE for its Body of Knowledge (ASCE 2019). The revised Bloom's Taxonomy identifies six increasingly complex cognitive process dimensions: remember, understand, apply, analyze, evaluate, and create (Anderson et al. 2001). The conceptual model goes beyond the three basic cognitive dimensions of implementing design-build procedures and practices in the field—remembering, understanding, and applying—to the higher dimensions of analyzing, evaluating, and creating by providing a framework to dissect, explain, attribute, and ultimately problem-solving these practices and procedures.

While the focus here is on the more complex cognitive process dimensions of analyzing, evaluating, and creating, the effort also encompasses the more basic dimensions. The simplest cognitive process in the taxonomy, "remember," is not a stated objective here because it is believed that the practitioners will commit to memory the implemented design-build procedures and practices through repetition over time. And failing memory, published references are readily available for practitioners. To "understand" is a cognitive process facilitated by using the conceptual model to work out practices and procedures as a composite of elemental components rather than a single comprehensive construct. This piece-wise organization of the practices and

procedures using the twelve conceptual elements of the model provides a classification or categorical system to match new knowledge with prior experience.

"Apply" is another cognitive process in the taxonomy divided into carrying out or using procedures on familiar and unfamiliar tasks. If the task and procedure are familiar, then "apply" refers to executing the procedure on the task. With unfamiliar procedures or tasks, the initial steps of the "apply" cognitive process are using shared familiar elements to restructure that which is unfamiliar into a familiar context. The twelve conceptual elements of the model provide a means of abstracting procedures and tasks, both familiar and not, into a familiar context.

The chapter focuses on the taxonomy's three more advanced cognitive process outcomes. "Analyze" is an extension of understanding and a prelude to the "evaluate" and "create" cognitive processes. In analyzing the considered procedures, they are broken into constituent parts reflected by the individual concepts of the model. This involves differentiating and determining the relevant and irrelevant features, which consists in organizing how the primary and secondary/tertiary concepts pertain. This researcher then "evaluates" the procedures by considering the model concept interactions to identify positive and negative influences between the interacting concept and any unintended consequences due to the pairing. The effort will conclude with the "create" cognitive process of the taxonomy by proposing modifications to the existing procedure to achieve better outcomes during implementation.

A state-of-the-practice review of design-build was conducted of state DOT manuals (CDOT 2016, GDOT 2018, MnDOT 2017, WSDOT 2018) and the consensus work done by Prof. Molenaar and others (Molenaar et al. 2020a, 2020b; Gransberg et al. 2014; AASHTO 2008) who consolidated design-build policy into procurement, post-award contract administration and Alternative Technical Concepts (ATCs) guidebooks, summaries of which can

be found in Chapter 2. From these design-build guides, three procedures were selected for application of the model: co-location, ATCs, and over-the-shoulder design review. These three procedures are chosen because they represent typical design-build procedures and address the proposal and delivery phases when the owner and design-build team are jointly involved. Co-location was successfully used on the I-15 project and is recommended in all the DOT design-build manuals reviewed. ATCs is a highly valued procedure to which NCHRP dedicated a guidebook. Over-the-shoulder design review was used on the hugely successful I-15 project, which set the stage for other owners to implement it, including an owner of another case study project. Because numerous procedures are used with design-build, for instance, the NCHRP contract administration guidebook (Molenaar et al. 2020a) identifies 28, it was necessary to limit the number of procedures addressed here to limit the length of the discussion. These three chosen procedures are believed sufficient to demonstrate the model's relevance to current design-build guidance.

6.2 Development Plan

The remaining sections of this chapter describe the conceptual model applied to the three selected procedures. The discussion of each procedure occurs in six parts. First, the procedure is described according to the design-build manuals. Second, additional literature is enfolded to further define the procedure and highlight potential advantages and disadvantages. Third, the principal reasons why the procedure is used are discussed. Fourth, the conceptual model is applied with individual concepts analyzed, then pairs of concepts evaluated. In both instances, the discussion addresses the most impactful concepts and is not intended to be exhaustive. Fifth, there are suggested modifications for future implementation of the procedure. Sixth, there is a summary and conclusions. The chapter concludes with an overall summary.

6.3 Co-location

Co-location is a recommended procedure in all reviewed design-build manuals. Still, the rationale for use is largely lacking except for the NCHRP guidebook (Molenaar et al. 2020a), which describes co-location as bringing project resources together at one location to expedite decisions, communication, design and construction processes, and conflict resolution; and facilitate constructability, innovation, and risk mitigation. However, CDOT (2016) indicates designers are sometimes reluctant to leave their home offices and relocate to a shared project office.

6.3.1 Literature

Co-location is members of different teams temporarily sharing a common workspace to work closely on a specific project (Donnerberg 2019). Six notable advantages of co-location are communication, team cohesion, interaction, collaboration, learning, and problem resolution. Co-location:

(1) allows quicker and richer communication among team members (Leicht et al. 2016),

(2) creates a more cohesive group (Leicht et al. 2016),

(3) facilitates more significant interaction and more personal engagement (Kahn and McDonough 1997),

(4) aids in achieving collective goals, reaching mutual understanding, and the sharing of ideas, information, and resources (Kahn and McDonough 1997),

(5) provides an opportunity for learning and applying knowledge to practice, with designers gaining a deeper understanding of the construction process and contractors gaining a deeper understanding of the driving factors behind design decisions (Powell and Champlin 2009), and

(6) allows participants to become aware of and address problems more efficiently (Thompson and Ozbek 2012).

While disadvantages are not discussed as much, there are four notable disadvantages: speed of work, additional responsibilities, existing organizational structure, and organizational separation. Co-location:

(1) is associated with a fast pace, and being continuously on-demand may be challenging for some designers (Powell and Champlin 2009),

(2) may result in leaders becoming facilitators of discussions in addition to their everyday tasks (Thompson and Ozbek 2012),

(3) may be more difficult if the existing organizational structure and culture do not promote freedom of interaction among participants (Donnerberg 2019), and

(4) can negatively impact a designer's intra-organizational collaboration by separating him from resources and team members with whom he has simultaneous projects (Kim et al. 2020).

6.3.2 Reasons for using Co-Location

Co-location is typically used for three primary reasons; it facilitates collaboration, communication, and team building. First, since parties utilizing design-build do not make decisions independently, co-location facilitates collaboration making it easier to work in unison while also providing the contractor opportunities to contribute construction knowledge. Second, the proximity of the participants to each other shortens the lines of communication, making it easier to share information and have questions answered. Third, interactions occur more often, which can strengthen the team, particularly beneficial when parties have little or no history of working together.

These reasons are reflected in the conceptual model. Collaboration loads principally on four factors: Overall Relation Type, Attitudes, Obligations, and Future Cooperation. Communication loads on three: Overall Relation Type, Numbers, and Attitudes. Team building loads on two: Attitudes and Sources of Contractual Solidarity. There are two additional factors—Power, Hierarchy, and Command and Benefits & Burdens—that these reasons do not directly load on, but this is indicative of the conceptual model's ability to highlight aspects of procedures that may not initially be considered. Each of these factors is addressed next, and many of the discussions allude to these general aspects of use.

6.3.3 Analyzing the Procedure Using the Conceptual Model

This section analyzes co-location using the components of the conceptual model. While the procedure could be described from the perspective of all 12 major model components, the discussion is narrowed to the eight most insightful. The organizing themes used to group the factors in Chapter 5 are carried through into this chapter; three are relevant to co-location: boundaries, actors, and planning. Co-location thins organizational boundaries, restructures actors, and facilitates completion of planning. The influence of co-location on boundaries is addressed with "Overall Relation Type" and "Sources of Contractual Solidarity." The impact of co-location on the actors is discussed with "Numbers," "Power, Hierarchy and Command," and "Attitudes." The facilitation of planning is covered with "Future Cooperation," "Obligations," and "Benefits & Burdens."

6.3.3.1 Overall Relation Type

Co-location thins organizational boundaries, an aspect of the procedure evident from the perspective of the Overall Relation Type, which uses boundaries, boundary spanners, and boundary objects to describe relationships. Thinning of the boundary is the result of the frequent

interactions that co-location facilitates, and opportunities for informal communication and the ease with which it can occur given the proximity of the participants means permeable boundaries typical of a relationship become even more permeable. It is because boundaries for a relationship are also flexible; they can be manipulated to restructure resources to a shared office allowing participants, characterized as "boundary spanners," to traverse their organizational boundaries more easily as they work to complete the incomplete contract that sits at their boundaries as a "boundary object." The I-15 project utilized co-location with great success, with the owner indicating it enhanced communication and facilitated coordination among the parties. Questions were easily addressed, and co-located participants could stay up to date on the latest project information, which proved to be more difficult with their other design consultants located throughout the country.

6.3.3.2 Sources of Contractual Solidarity

Co-location helps strengthen the relationship highlighted by the "Sources of Contractual Solidarity." Collaboration and cooperation that occur with co-location create harmony in the relationship. When the relationship becomes the dominant mode of governance, the desire to seek the assistance of an external party is pushed to the background. The I-15 project used co-location in combination with partnering to resolve issues. Co-located participants could address questions in their daily interactions, and any lingering issues could be addressed in weekly meetings. This was supplemented by partnering, which involved an escalation process for conflict resolution to handle the problems at the lowest possible level.

6.3.3.3 Numbers

Co-location brings a group of actors together in a shared office. This is conceptualized in the context of Numbers as a network defined by nodes, links, and boundaries. When drilling

down and observing the working level, the individual participants are represented by nodes. These actors often engage in frequent, informal communication described in the network by links connecting the nodes, which signify both a relationship and communication that tends to be two-way. These participants sit at the boundaries of their organizations and simultaneously exist within their organizational boundaries and a co-location group boundary. As focus moves up the organizational hierarchy to higher decision-making levels, there tend to be fewer and more formal interactions between participants with authority to make decisions for their organizations. In this instance, the nodes in the network represent groups of participants often represented by surrogates. The links can be two-way for communication and information sharing or one-way for seeking advice or conveying decisions. At the highest organizational level, co-location is represented in its most basic form. Each major organization is defined as a single node with a portion enclosed within the co-location boundary. The I-15 owner indicated co-location expedited communication on the project because the co-located participants were authorized to make many design decisions, thus minimizing time spent traveling to headquarters for approval. Daily interactions among the co-located participants occurred in conjunction with weekly Task Force meetings used to review the design, provide direction to the design teams, and resolve critical issues.

6.3.3.4 Power, Hierarchy, and Command

Co-location places a spotlight on the actors' power during delivery. If co-location is mandated, it is done by the owner during initial planning when he holds unilateral power to make decisions. After the contract is entered, there is a shift in power with the design-build team obtaining unilateral power to make decisions left flexible unless it has been specified otherwise in the contract. This means during co-location, participants hold power and rights inherently

associated with their roles or as defined in the contract. The designer has unilateral power for all design decisions concerning safety, given his fiduciary obligation. The contractor is available to provide construction input, and in instances in which the project is contractor-led, he holds the hierarchical position on the design-build team. The owner is involved for feedback and to ensure contract adherence. Co-location was not used on I-4, but the project is an example to highlight the power dynamic during delivery and co-location. On the I-4 project, the team-leading contractor wanted to reuse the existing guardrail for a new installation. The designer serving as a subcontractor disagreed with its reuse, likely due to safety concerns, thus allowing his exercise of unilateral command based on his professional role obligations for public safety.

6.3.3.5 Attitudes

Co-location synchronizes the involvement of the actors, which highlights their Attitudes. Co-location can reveal differences in Time, foster Unity, reduce Awareness of Conflicts of Interest, and alleviate Trouble. Because the actors share a workspace, the contractor can be more involved and involved earlier than he otherwise may be. The contractor typically has concerns related to short-term elements of the project like costs and schedule and can contribute construction knowledge to address these concerns by improving constructability or the flow of work on the project. The designer simultaneously incorporates his longer-term concerns of viability and safety into the design. The collaboration of the contractor and designer can, in some instances, lead to innovative solutions. Still, their perspective differences can also be more pronounced with co-location since they spend more time together, "public time," meaning they have less time alone, "private time." An example is the I-77 earthen ramp, and while the innovative design did not occur during co-location, it highlights what is possible. An innovative earthen ramp improved construction flow, which could occur during the day by having

construction trucks enter and exit the median from an existing bridge near the site instead of the interstate. The solution was possible because the engineer and contractor worked together with each contributing their unique knowledge, the contractor whose focus is on construction, time, and cost of delivery worked with an engineer with the technical expertise and capability to evaluate and execute the idea. As a team member, the engineer was more aware of construction issues than he might have been if working in isolation.

A shared office creates more opportunities for interaction and cooperation, allowing actors to build trust and creating opportunities for altruism and reciprocity, which fosters unity. The result is a natural reduction in focus on opportunism and diminished awareness of self-interests. The I-15 owner mentioned using co-location to build trust and nurture the relationship to eliminate the "them versus us" mindset.

Co-location provides easy access to others allowing questions to be answered quickly and problems to be resolved early before escalation to conflict or trouble. For instance, the I-15 co-location meant answers to questions were steps away and when necessary weekly Task Force meetings were also used for resolution of conflicts.

6.3.3.6 Future Cooperation

Co-location facilitates the continuation of planning as a procedure for cooperation that allows participants to structure their future interactions. While aspects of the procedure can be planned in advance, much of the cooperation will occur naturally in the relationship. For instance, structural aspects of co-location can be planned if desired, like the location of the office, the participants involved, and the frequency of group meetings, but other aspects occur naturally, i.e., the participants advance plans, deal with problems, and engage in informal interactions. Cooperation during co-location will rely on industry norms, give-and-take, and

good faith. On the I-15 project, cooperation occurred in many ways. The design and construction team and the owner's project team were all located in the same office referred to as "the Hub," where there were daily informal and unplanned interactions among the participants as they advanced the design, coordinated tasks, and addressed questions. There were also scheduled formal Task Force and partnering meetings to review the design, provide direction, and address lingering issues.

6.3.3.7 Obligations

Co-location facilitates the specifying and executing of obligations. As co-located actors collaborate to complete project planning, more obligations will be defined and assigned or assumed, and actors will work to fulfill their project- and role-related obligations. Co-location allows the participants to work collaboratively to complete their performance and project-related obligations, which occurs as they simultaneously fulfill their role obligations. An engineer will have dual obligations when the design-build team is contractor-led, a performance obligation associated with his design contract and a fiduciary role obligation to the public for safety. Co-location also allows collaboration to specify constructive obligations, made specific as the contract is completed. On the I-15 project, the owner provided a complete geotechnical investigation report but did not provide solutions to address the soil conditions leaving this part of the project flexible for the design-build team. The geotechnical work was a project-related obligation that was incomplete. In areas with high settlement potential, the design-build team used multiple innovative solutions to accelerate, reduce, or eliminate settlement. The role-related obligations of the designer included the planning and safety of these solutions, and the contractor's role obligations included the solutions' execution. Co-location of the participants, an

obligation specified in the contract, facilitated the management of this and other such obligations.

6.3.3.8 Benefits & Burdens

Benefits and burdens are part of a bargained exchange that are often shared for a relationship, and co-location allows participants to monitor and manage the bargain more easily. Collaboration and co-located communication enable participants to be involved as decisions are made, have their voices heard, and negotiate when a decision creates consequences for them. The team building that occurs with co-location also makes it less likely that one party will knowingly push burdens outside their boundary to another party and more likely that an inadvertent pushing of burdens will be recognized by those involved. Although the I-77 project did not use co-location, the procedure could have been beneficial for the design of the guardrail. While the provided guardrail met the scope requirements, it was difficult for the owner to maintain, and involvement through co-location may have provided an opportunity to identify this, express concerns, and negotiate an alternative.

6.3.4 Evaluating the Procedure Using the Conceptual Model

This section evaluates the conceptual model by considering pairs of concepts. These interactions provide a better understanding of how the concepts work together and indicate possible positives and negatives of the procedure. The discussion is not exhaustive, but five examples are selected to illustrate the potential of the conceptual model.

6.3.4.1 Attitudes: Time with Benefits & Burdens

Attitudes influence actors' decisions during planning. There are four Attitudes—Time, Trouble, Unity, and Awareness of Conflict of Interest—each associated with benefits and burdens as participants use co-location to help manage the shared bargain.

There are three notable aspects of co-location highlighted by time. First, the increase in group time, "public time," can benefit the contractor because it allows him to be more involved in the design. Still, it can burden the designer by reducing the amount of alone time, "private time," he can dedicate to the design while simultaneously increasing the amount of input he receives and must process during the design. Second, co-location allows the contractor to contribute construction knowledge which can influence the "rate" at which the project is completed. A faster pace of work, which would naturally be a point of focus and a benefit for a contractor concerned about project completion, may be a burden for the designer who is used to working at his own pace. Third, co-location can create opportunities for "conversions," innovative design solutions developed by the designer with input from the contractor and owner, resulting in cost and time savings. While innovation can benefit both the owner and the design-build team, the burden for the design solution falls mainly on the designer. The reconfigured I-85 design did not occur through co-location, but it is an example of "conversion" and the type of solutions that can result from a team effort. The owner's original design was modified to create a safer entry for the traveling public onto the interstate resulting in design changes that lowered first costs, reduced the schedule, and were expected to lower maintenance costs.

Co-location can be beneficial for dealing with Trouble with the main parties' members easily accessible to answer questions, deal with problems as they arise, or take the issue back to the appropriate person in their organization when needed. The I-15 project established an escalation process for conflict that rose to the highest officials in the organizations. Still, their goal was to deal with issues at the lowest possible level beginning with the co-located participants.

Co-location can be a catalyst for Unity. The shared working environment can foster relationships and create opportunities for altruism, reciprocity, cooperation, and trust to be built while also diminishing the likelihood of opportunistic behavior. The I-15 project owner mentioned that co-location was one way they achieved their desire to foster a spirit of unity and build trust.

Co-location allows actors to foster their relationship, particularly when the parties have no previous history. It can help reduce the Awareness of Conflicts of Interests and act as a deterrent for self-dealing. The I-10 Blackwater Bridge project was an emergency project that did not use co-location or incorporate other means of developing unity. When the soil issue on the project was encountered, the parties could not be unified in their response and instead focused on their individual interests.

6.3.4.2 Numbers with Obligations

Incomplete planning requires the mutual participation of the actors, which co-location facilitates uniquely. Still, the co-location network defined in Numbers can positively and potentially negatively impact the specifying and fulfilling of Obligations. There are at least three positive aspects. First, the network of co-located actors can be beneficial for achieving those obligations associated with delivering a completed facility and performance obligations. The links between the participants allow communication and cooperation as they work to fulfill their obligations. Second, the network facilitates collaboration for specifying those initially left unspecified, constructive obligations. As the project progresses, these obligations become knowable and assignable, and co-location can make communication and allocation of these obligations easier. Third, co-location may be helpful for the contractor in achieving his role obligations by allowing him to have construction input early with opportunities to improve

constructability and steer the design towards his strengths. For instance, the St. George Island Bridge contractor used an unusually large diameter pier that he had used previously, which created less disturbance in the bay where oyster beds were a significant concern. While this design solution did not occur during co-location because the project did not utilize the procedure, it is an example of what is possible.

The potentially negative impact of co-location is on the designer, who may find it more difficult to achieve his role obligations. Changes in the way he designs, for instance, no longer designing in isolation and receiving additional input during design that is seen with a shift to design-build, are heightened with co-location. The difference can also impact the owner. At the same time, the designer will ultimately always make decisions that are in the public's best interest; however, he no longer holds the role as an agent to the owner, so owners should be aware that the decisions the designer make influence the end-product the owner receives. These decisions may focus more on first costs. This was perhaps the case with the I-77 guardrail, which the owner was unsatisfied with because of the difficult maintenance, but it likely had a low first cost for the design-build team and was free from the service as the owner's agent; the designer was only bound by his fiduciary obligation for safety.

6.3.4.3 Overall Relation Type with Future Cooperation

Boundaries can facilitate joint planning—as they are thinned and become more permeable, cooperation becomes more accessible and efficient. Defined in part by characteristics of organizational boundaries, the Overall Relation Type directly impacts how future cooperation is carried out. For relationships in which organizations have thin, flexible, permeable boundaries, co-location is a possibility and, when used, allows the actors who operate as "boundary spanners" to more easily span their organizational boundaries as they work to complete the

contract. The frequent engagement of the actors further thins the boundaries. There is a potential downside for the owner, who not only has to be more involved than he may typically be but he may also be asked to provide approvals along the way on partially complete designs. The I-15 project owner had a positive experience with co-location crediting it with contributing to the project's success and linking it to their initial goal of achieving cooperation. The parties could easily communicate tasks and keep the other participants up to date on the design as it progressed.

6.3.4.4 Attitudes: Time with Power, Hierarchy, and Command

The synchronization of the actors can highlight their differences. Specifically, co-location highlights differences in actors' power and perspectives. The contractor often holds a position of power as the team leader, and his increased involvement through co-location and short-term time perspective lead to concerns about his influence on the design. The designer having a long-term view and a fiduciary obligation, makes decisions based on the safety and viability of the facility but is often in a subcontractor position leading to a concern about his design authority during co-location. But at least two conditions will control and should provide some measure of comfort for concerned owners and designers. First, there are standards set by codes that establish minimums that must be followed. Second, the designer will always have authority when decisions concern public safety, as seen when the engineer opposed the reuse of the existing guardrail in the new I-4 project installations, as mentioned previously.

6.3.4.5 Attitudes: Time with Sources of Contractual Solidarity

Boundaries determine how actors interact across them. Co-location allows actors to engage more than they otherwise would, further thinning existing boundaries and creating an opportunity for the actors to strengthen their bonds. The group time, "public time," produced by

co-location can directly impact internal solidarity. The frequent interactions with co-location can foster the relationship and make it more likely that the participants develop solutions to problems within the relationship rather than seek them outside. Internal solidarity is beneficial in many ways, including specifying obligations, allowing participants to determine and assign obligations jointly, and resolving issues with the group's best interests in mind when dealing with conflict. When lacking internal solidarity, parties rely on external support, which can be complicated for an incomplete contract needing an outside party to interpret the contract and its original intent to fill the gaps. The I-10 Blackwater Bridge project did not use co-location or seem to foster the relationship in any other way. When poor soils were encountered, the parties could not resolve the issue within the relationship and had to rely on the outside assistance of a Dispute Review Board for resolution. The relationship devolved, and subsequent problems also required the external aid of the Dispute Review Board, an indication it's difficult for a relationship to recover after seeking external support.

6.3.5 Creating New Aspects of the Procedure

The conceptual model guides suggestions on how the procedure can be modified to accommodate concerns. This demonstrates this capability and is not exhaustive, focusing on one primary concern, the difficulty the procedure can present for a designer due to changes in private design time.

The modifications focus primarily on the actors' structure, with boundaries used to define the actors. The network concept defined in Numbers can be modified to meet specific needs and is the primary concept used here to make accommodations for engineers co-locating. Three suggestions are made: profession-based clusters, a primary connector node, and a tiered decision-making structure.

First, the network concepts of boundaries and clusters can be used to identify and group the professions in the network. Consideration can be given to locating these groups together in the shared space. Hart (1999) suggests a range of possibilities, such as participants in different rooms on the same floor, different floors but the same building, or different buildings but the same site. This would allow those engineers who desire more private time to obtain it more easily.

Second, the network can be structured so designers have a primary contact person. This participant, represented by a node in the network, would have the most links to nodes within his cluster, defined by a professional boundary, and be the primary conduit for communication outside of it. While there could also be actors with other links to other participants, this primary link would allow those participants to carve out more private time while remaining connected to the team and obtain and share valuable information when needed. This idea goes back to an original Delphi panel concern about who subconsultant designers report to. In the context of the conceptual model, this concern is seen as a question about the connections between participants. For co-location, when there is a primary connector, there should be considerable focus on ensuring the right person occupies this position. There are characteristics of boundary spanners identified in the Overall Relation Type. While it is desirable to have all those who are co-located possess as many of them as possible, these characteristics are particularly desirable for the participant acting as the primary contact. For example, this person should be a problem solver, outgoing, and able to work well on a team.

Third and finally, it may be desirable to structure the network so that there is a higher management level where final decisions are made, as done on the I-15 project. This allows for more connections and interactions at the working level but protects the organizations, so even in

instances where participants may feel impacted by changes in private time or the pace of work, ultimately, decisions are made at higher levels with the protection of the organizational boundary in mind.

6.3.6 Summary

Co-location is recommended in the reviewed DOT and NCHRP design-build manuals, but with minimal information provided to justify its use or point to potential downsides. This section used literature to define the procedure and identify its advantages and disadvantages. The conceptual model was then used to analyze and evaluate the procedure providing additional context, confirming advantages and disadvantages noted in the literature while also bringing to light other aspects of the procedure that may not have been considered. The conceptual model was then used to modify the procedure for the future.

In summary, co-location eliminates the physical separation between the project participants, allowing more accessible and effective communication, leading to more efficient design and construction processes, innovative solutions, and problem-solving. Still, it can also create difficulties for the designer who completes the design as a team member—often working as a subcontractor, receiving input from other participants, and reducing "private time." Owners should consider co-location on a project-by-project basis, aware of the associated tradeoffs, and consider structuring the procedure to fit the project best.

6.4 Alternative Technical Concepts (ATCs)

Alternative Technical Concepts (ATCs) is a procedure during procurement that allows design-build teams to propose equal or better alternatives to the RFP's basic configuration or technical criteria (MnDOT 2017, Gransberg et al. 2014). The procedure typically occurs before the submittal of technical and price proposals. It involves at least four steps: preliminary ATC

submittal, confidential one-on-one meetings, formal ATC submittal, and ATC review/approval (Gransberg et al. 2014). Since the process requires considerable resources from the proposing design-build teams, many owners offer a stipend to help offset costs for the unsuccessful teams. Still, by accepting the compensation, the design-build team often gives ownership rights of the concepts to the owner (Gransberg et al., 2014).

6.4.1 Literature

ATC has been used across delivery methods, including with design-bid-build and construction manager at-risk but is most often used with design-build (Tian et al. 2020). It has four main advantages: improved constructability, enhanced innovation, shortened schedules, and lower costs (Actis et al., 2012, Antoine and Molenaar, 2016). ATCs allow:

(1) preferred contractor means and methods to be incorporated into the design,

(2) creative solutions to be devised,

(3) design modifications that reduce delivery time,

(4) changes that can lower initial, operational, and lifecycle costs.

The four main disadvantages of ATCs are the need for: confidentiality, extensive resources, permit and utility adjustments, and incorporation of concepts from unsuccessful proposals. ATCs require:

(1) processes to protect the proprietary designs presented by the design-build teams (Ashuri et al. 2013),

(2) considerable time and money from the designer for development, and time and effort from the owner for execution and contract administration (Ashuri et al. 2013),

(3) additional effort in some instances from the design-build team for permit

modifications and approvals, and from the owner for utility modifications (Ashuri et al. 2013),

(4) the selected design-build team to incorporate the ideas of other teams into their design when the owner requests (Gransberg et al. 2020).

6.4.2 Reasons for using ATCs

There are three primary reasons ATCs are used: they allow design flexibility, provide the owner with multiple design options, and result in design approvals before entering the contract. First, the owner can provide design flexibility, allowing design-build teams to contribute valuable design and construction knowledge, leading to innovative design solutions. Second, the owner can consider multiple designs, some of which he may not have considered. In many instances, he stipulates in the RFP his right to use these ideas on current or future projects even if the proposing design-build team is not awarded the contract. Third, selected ATCs become part of the contract, allowing the owner to control the direction of the design.

Reasons to use ATCs are considered from a conceptual perspective. Design flexibility loads principally on two factors in the conceptual model, Attitudes and Planning, under the organizing categories of Actors and Planning, respectively. Multiple design options load on two factors: Power, Hierarchy, and Command and Benefits & Burdens, also associated with Actors and Planning. Design approval loads on one: Planning falls under the category of the same name, Planning. There is one additional concept, Transferability, in the Time category that is not linked directly to these reasons but again shows the ability of the conceptual model to shed light on areas that may not be initially considered.

6.4.3 Analyzing the Procedure Using the Conceptual Model

This section uses the five factors of the conceptual model to obtain a foundational understanding of the ATC procedure. These factors are Attitudes; Power, Hierarchy, and Command; Planning; Benefits & Burdens; and Transferability grouped under Actors, Planning, and Time categories. Attitudes and Power, Hierarchy, and Command pertain to the Actors and address the opportunities the procedure affords the actors for innovative solutions and design control. Planning and Benefits & Burdens are elements of the category Planning and highlight the owner's involvement in approving the plan and aspects associated with defining parts of the bargain. And Transferability, an aspect of Time, discusses the occurrence of the procedure before the contract is entered. None of the case study projects used ATCs, but elements of the projects are still used in the discussion to illustrate the factors.

6.4.3.1 Attitudes: Time

Actors' Attitudes are primarily based on their roles and the inherent perspectives those roles create. One Attitude, Time, conceptualizes a central aspect of the ATC procedure: the opportunity for alternative solutions. The owner's flexibility allows each actor on the design-build teams to contribute his unique knowledge, leading to innovative solutions. The designer brings his design expertise and experience and long-term focus on time, often leading him to contribute to overall facility improvements; the contractor brings his construction expertise and experience and short-term focus on time, often leading him to offer implementation-based design solutions. Together they can devise innovative solutions that result in production efficiencies and design conversions that may not have been considered otherwise. Although they did not occur in the context of the ATC procedure, two case study examples highlight what is possible with ATCs; the first is a construction-based solution, and the second is design-based. On the St.

George Island Bridge project, located in a bay with extensive oyster beds, the contractor suggested using a huge diameter pile that he had used on a previous project. The result was fewer piles were needed reducing the schedule and the impact on the bay bottom. On the I-85 project, the design-build team reconfigured the preliminary design provided by the owner eliminating a bridge on the interstate and facilitating a left-hand merge of traffic into the slow lane rather than a right-hand into the fast lane. The reconfigured design was safer for the traveling public, reduced the schedule, lowered initial costs, and was expected to lower maintenance costs.

6.4.3.2 Power, Hierarchy, and Command

Different actors throughout a project hold power. The ATC procedure occurs during the proposal phase when the owner has unilateral decision-making power, which gives him authority to select the designs he likes. Still, because the signing of a contract marks the end of the phase, there is an opportunity for bilateral negotiations leading up to the contractual agreement. Among other things, this often includes a decision by the unsuccessful design-build teams about whether to accept a stipend, which sometimes requires them to give up control of their designs. Also, when specified in the contract, the owner may pick and choose ATC designs from multiple proposals and can command the successful design-build team to incorporate the ideas of unsuccessful proposers into their design, or he can choose to use the ideas on future projects. Although this is not believed to have occurred on any of the case study projects, it is conceivable that if presented in an ATC setting, the multiple innovative solutions used by the I-15 design-build team to deal with the poor soils could have been incorporated by the owner with another design-build team. For instance, lime cement columns and wick drains were used to accelerate, reduce and eliminate settlement, allowing the project to be completed years earlier than otherwise.

6.4.3.3 Planning

Planning can span multiple project phases when the parties are entering a relationship, but planning carried out during the proposal phase is often included in the contract. As a result, ATCs chosen by the owner become part of the contract and are binding. For owners who may be uncomfortable giving up control, ATCs allow them to provide design flexibility but ultimately select which designs will be used. Owners can also consider multiple design options, yielding solutions that may not have been considered. This occurred on the I-85 project with the reconfigured design mentioned above. Although it did not happen in the context of an ATC procedure, it is an example of a design-build team collaborating to develop a design that met the owner's needs better than his preliminary design.

6.4.3.4 Benefits & Burdens

"Benefits & Burdens" focuses on the bargain, an aspect of planning. The ATC procedure benefits an owner by allowing him to be directly involved in establishing the bargain by selecting ATCs included in the contract. Because the procedure occurs during the proposal phase, the owner has the benefit of receiving design options during a time when there is competition for the contract. Still, the burden falls on the design-build team, particularly the designer. Considerable time and money are required to develop ATCs without a guarantee of being awarded the contract. Even when a stipend is offered, it typically only covers a portion of the costs often; accepting compensation means giving up rights to the proposed ideas. Again, using the I-85 project mentioned above as an example, the design-build team reconfigured the design eliminating an interstate bridge. If this had occurred during an ATC process where the design-build team had not been selected, the stipend likely would not have covered the cost burden of the group, and the owner could benefit from the idea.

6.4.3.5 Transferability

Transferability is an aspect of the Time category focusing on moments in time when events occur. ATCs occur during the proposal phase, which commences with the transfer to the market and ends with the transfer for performance. Still, the procedure often extends the time between these transfers due to the additional time needed, which requires extra effort from the owner to execute. Since the procedure occurs before the owner transfers the project to the design-build team for delivery, he is actively involved in making the decisions about the project's future. His approved ATCs can be included in the technical proposals of the design-build teams, which he often evaluates using selection criteria that reflect his preferences; for instance, time for completion, cost, and innovation may be considered. The I-77 earthen ramp is an example, although it was not presented as an ATC. The design allowed construction to occur during the day rather than at night as anticipated by the owner due to safety concerns. A member of the I-77 construction team believed this innovative solution won them the job because it lowered the cost below what was estimated and shortened the delivery time, which were both factors in selection. The design-build team received high points for this innovation. Once the team was selected, the proposal became part of the contractual agreement.

6.4.4 Evaluating the Procedure Using the Conceptual Model

This section provides additional insight into the ATC procedure by observing it through the lens of the conceptual model's factor interactions. These interactions consider how the concepts work together, providing a better understanding and revealing potential positives and negatives about the procedure. Three pairs of interactions are discussed below: Planning with Attitudes: Time, highlighting the joint participation in planning and influence of the actors' perspectives of time when developing ATCs; Benefits & Burdens with Planning, underlining

positives and negatives associated with planning ATCs; and Transferability with Power, Hierarchy, and Command, highlighting power during the ATC process based on its occurrence before the project is transferred for delivery.

6.4.4.1 Planning with Attitudes: Time

The ATC procedure allows actors to finalize aspects of the plan early, with any planning occurring during the proposal phase becoming part of the contract. Participants' Attitudes regarding Time directly impact how they approach Planning ATCs. The procedure allows design-build teams to propose changes to existing plans. These changes often center around how the groups believe they can provide value or gain a competitive advantage. Some provide value through creative design solutions, some through optimizing rate, and some through both. Those design-build teams who provide value through creative design solutions are often led by a designer whose long-term perspective of time leads him to focus on the end-product but whose knowledge allows him to make innovative ideas a reality. For instance, the I-85 reconfigured design eliminates an interstate bridge on the project. Teams who provide value by focusing on rate—the pace and flow of activities—are often guided by the contractor whose short-term perspective of time leads him to concentrate on construction means and methods. For instance, the St. George Island Bridge has the large diameter piles mentioned above. There are also those teams who do both, optimizing the contributions of both parties and merging the creative and technical abilities of the designer with the means and methods perspective of the contractor, as seen with the I-77 earthen ramp.

The natural focus of participants on an aspect of time may influence whether a design-build team even pursues ATCs. Evaluation and approval of ATCs are followed by assessment of technical and price proposals and selection of the design-build team, but the selection process

presents a concern. There is a possibility that a group that proposes no ATCs and focuses exclusively on rate could obtain enough of an advantage with a low bid to be awarded the job. The design-build teams who focus on ATC design elements are at a disadvantage because they incur high design costs; the stipend likely covers only a portion of that cost. A concern is that over time it is possible the market could begin to morph, with fewer proposing teams presenting ATCs because of the uncompensated cost burden.

6.4.4.2 Benefits & Burdens with Planning

When used, ATCs are part of the Planning that takes place during the proposal phase to establish the bargain. The procedure is associated with certain Benefits and Burdens for the participants. An owner who desires more control over the design benefits from ATCs because he can approve the plans before entering the contract, but the designer bears the burden. The ATC procedure requires the designer to develop these ideas before the contract is awarded, creating two primary concerns, there is no guarantee the design-build team will obtain the job. Even if awarded the contract, the designer often does not benefit financially as much as if the concept was developed during the performance phase.

Although the ATC procedure requires additional time and effort from the owner to execute, it can benefit an owner because it allows him to review multiple design options before establishing the bargain. When the owner offers a stipend, and it is accepted, as stipulated in the contract, he obtains the right to use the ideas of the unsuccessful proposers. The concern in an extreme scenario might be an owner undertakes the procurement process and, after paying stipends to obtain the rights to the design-build teams' ideas, cancel the procurement, hires a designer to redesign the project incorporating the innovative concepts, and then put the project out to bid a second time. In a more likely scenario, the owner asks the selected design-build team

to incorporate aspects of the unsuccessful proposals into their design. These changes benefit the owner by further reducing the cost. However, they can be a burden for the design-build team, who must now incorporate them into their existing design without a benefit unless the owner chooses to share the savings. Although it did not occur through an ATC process, the difficulty this can create for a design-build team is shown with the sealed plans provided by the owner on the I-15 project. A short delivery time led the owner to provide complete plans for some structures to the selected design-build team allowing work to begin as soon as the project was handed over. Still, the design-build team had difficulty incorporating some designs into their plans and requested changes in some instances.

There are also aspects of the ATC procedure that can benefit the design-build team. For instance, ATCs provide the contractor the benefit of being involved in the design and contributing ideas that may lower the cost or reduce the schedule, providing a competitive advantage for his design-build team. There are also instances in which the ATC process can benefit the design-build team by receiving owner approval of an innovative idea before entering the contract. This is particularly beneficial for a design-build team if the design is the basis of their bid. This was seen on the I-77 earthen ramp mentioned previously. While it did not occur in the context of an ATC process, the innovative solution was the basis of the design-build team's plan and bid. Still, it deviated from the owner's plan to conduct construction only at night when interstate traffic would be lightest and construction trucks entering and exiting the interstate would be safer. This plan received owner approval and was included in the contract.

6.4.4.3 Transferability with Power, Hierarchy, and Command

Power shifts with transfers. Because the procedure occurs before the transfer for performance, the power dynamic varies from what it would be during the delivery phase, even

when all three parties are actively involved. During the proposal phase, when ATCs occur, the owner has unilateral approval power allowing him to provide design flexibility while controlling the results. Requiring the designs to be submitted during the proposal phase means the design is subject to owner approval rather than simply owner review for conformance to the contract requirements, a difference marked by contract award, and a subsequent transition in power from the owner to the design-build team with the transfer for performance. For the design-build team, this impacts a fundamental advantage of the design-build delivery method, flexibility for the design-build team after the contract is awarded, having unilateral decision-making power for those aspects of the design left flexible. Although it did not occur in the context of an ATC process, the I-77 project owner was dissatisfied with the guardrail design due to the difficult maintenance even though it met the scoping requirements. The owner would perhaps have opted for a different design if it had been presented during a time when he had the power to reject the idea and consider other options.

6.4.5 Creating New Aspects of the Procedure

Using the conceptual model to create new aspects of the ATCs procedure leads to suggestions related to the Actors that consider the amount of Planning required and the Time associated with developing the designs and executing the procedure. Given that the conceptual model points to benefits related to the ATCs procedure but also highlights the burden it can present for design-build teams, specifically designers, below are three suggestions for reducing the burden for the proposing teams.

First, an owner may consider greater compensation for the designer to create more balance in the Benefits & Burdens. As the participant tasked with developing innovative solutions, the designer dedicates significant time and incurs high costs during the ATC process, a

point acknowledged by the NCHRP indicating the need for greater compensation for the engineer (Gransberg et al. 2014). Structured like a value engineering process, to help compensate the designer for his efforts, owners may want to consider sharing the savings that result from the ATCs.

Second, for owners to continue to attract design-build teams who will develop innovative solutions, careful consideration should be given to aspects of the selection process leading to the transfer for performance addressed with Transferability. For instance, owners may want to short-list proposers before the ATC procedure, so each team has a greater possibility of receiving the job and also define and weight the selection criteria to provide adequate credit for innovative ideas.

Third, the use of ATCs should be determined on a project-by-project basis. In some instances, owners may want to consider other procedures that may be a better fit, such as add/deduct alternates or "over-the-shoulder" design reviews discussed briefly here. The over-the-shoulder review is discussed in detail as a standalone procedure later in this chapter. Like ATCs, add/deduct alternates are presented during the proposal phase before the owner transfers the project for performance, a facet of Transferability described in the conceptual model. And while both procedures occur during the proposal phase, they occur at different times and impact how the bargain is structured. ATCs are typically presented and evaluated before bidding. Those ATCs selected by the owner are included in the proposing design-build teams' bids. The add/deduct alternates are included in addition to the base bid as a separate line-item choice for the owner. The owner selects to add or deduct alternative proposals increasing or reducing the bid, allowing an owner to better accommodate the needs, desires, and budget for the project. With both procedures, the ideas are advanced and developed by the design-builders as an offer,

while the owner has unilateral power to pick the design he wants before the contract is entered. This differs from the over-the-shoulder reviews in which decisions are still in play after the contract is entered. After the project is transferred for performance, the design-build team typically gains decision-making power for aspects of the design left incomplete, and the owner participates in a more advisory role, often simply reviewing designs for conformance; this power shift is associated with the owner's participation in a procedure like over-the-shoulder design review used during delivery. This contrast in decision-making among the different approaches is highlighted in the "Power, Hierarchy, and Command" factor of the conceptual model.

Aspects of the procedures are also linked to the parties' Benefits & Burdens. For instance, procedures during the proposal phase benefit the owner who wants a more hands-off approach during delivery or is concerned about leaving too much flexibility to the design-build team. The owner also benefits by considering multiple designs when numerous teams compete for the job. However, creating these designs for ATCs can burden the proposing design-build teams, who must dedicate considerable time and money to developing ideas. Even when stipends are offered, they typically only cover a portion of the costs. In some instances, owners stipulate their right to use the proposed ideas, which can create an additional burden for the selected design-build team, particularly when owners request designs that are challenging to incorporate into their plans. This contrasts with add/deduct alternates which are often less of a burden for the owner to review and can even shorten the duration of the proposal phase, an aspect of the concept of Commencement, Duration, and Termination. And it's less of a burden to develop add/deduct alternatives for the proposing design-build teams when the owner requires only a short statement and preliminary design while maintaining the ability to request additional information during the bid review if needed to make an informed decision. This procedure could

have benefited the contractor on the I-4 project, who was interested in reusing existing guardrails in new installations, an idea opposed by the designer. If the I-4 contractor could have presented the idea to the owner as an add/deduct alternate, he could have provided the cost savings for the reused sections and allowed the owner to decide. A potential benefit for the proposing design-build teams with add/deduct alternates and ATCs is that ideas are presented during the bilateral negotiation period, and those selected become part of the contractual agreement. This is particularly helpful when the design-build team's idea is the basis of their bid and is concerned about the owner's approval. For instance, although the innovative earthen ramp used on the I-77 project was part of a typical proposal process and not an add/deduct alternate or ATC procedure, it deviated from the owner's plan. It was the basis of the design-build team's bid. However, they received the owner's approval before being awarded the contract. This is a potential burden associated with over-the-shoulder reviews; the bargain is not set until sometime during the performance, and while the design-build team has the flexibility to complete the design, they may be unsure in some instances about the owner's approval.

These are just a few examples of how the conceptual model can be used to consider nuances between procedures and to determine the best fit or modifications that can be made to accommodate the circumstances better.

6.4.6 Summary

The ATC procedure is often embraced by owners because of its potential to lower costs, reduce the schedule, or improve the end-product while also allowing design control. The conceptual model confirms these as potential advantages and points to potential downsides like the burden designing ATCs can create for proposing design-build teams and the reduced flexibility for the design-build team after entering the contract. These aspects of the procedure

were evident from analyzing and evaluating factors like Power, Hierarchy, and Command and Benefits & Burdens. For instance, Power showed owners who desire more control of the design; the ATC procedure encourages innovative ideas but allows owner approval. And as addressed with Benefits & Burdens, while the cost savings and schedule reduction often associated with ATCs benefit the owner, the burden of developing the design during the proposal phase falls on the designer. Innovative ideas require time and money to create, and the designer has no guarantee his team will receive the job. Stipends typically cover only a portion of design costs and, if accepted, often require giving up rights to the proposed ideas. As a result, owners may want to consider modifications to the procedure to better compensate the design-build teams for their effort and lessen their burden.

6.5 Over-the-Shoulder Design Review

"Over-the-shoulder" design review is a procedure during delivery in which the owner is updated and can provide feedback on the design as it progresses (Molenaar et al. 2020a). These informal reviews, often used with formal reviews, allow the owner to verify that the design meets the contract's requirements and enable the parties to decide how to proceed (Molenaar et al. 2020a, MnDOT 2017, CDOT 2016). The procedure varies in its implementation, in some instances occurring as regularly scheduled meetings or in conjunction with Task Force meetings, while at other times as part of co-location or day-to-day interactions (CDOT 2016, Molenaar et al. 2020a).

6.5.1 Literature

Over-the-shoulder design reviews are associated with three main advantages; they enhance communication, facilitate collaboration, and expedite formal design reviews. Over-the-

shoulder reviews:

(1) create direct and informal lines of communication between the owner and design-builder (Minchin et al. 2014, Gransberg et al. 2008),

(2) facilitate ongoing interaction among participants allowing them to identify possible innovations in design, discuss and address design issues as they arise, and build trust (Minchin et al. 2014, Schettler 2010), and

(3) create owner familiarity with the design, which can reduce the time needed for formal reviews (Schettler 2010).

The main disadvantage of the procedure is potential owner liability for design input. Over-the-shoulder design reviews can potentially expose owners to design risk. Loulakis et al. (2016) tell owners to "take care not to direct, complete, or otherwise actively control the design-builder's engineering and design efforts…to avoid inadvertently shifting design risk back to the DOT and/or resulting in scope changes that increase project costs." Molenaar et al. (1999) suggest owners specify in the procedures that their comments during over-the-shoulder reviews are not considered formal design approval.

6.5.2 Reasons for using Over-the-shoulder design reviews

Three main reasons over-the-shoulder design reviews are used: the contract can be entered earlier, the owner can remain actively involved after the contract award, and making decisions is easier. First, the procedure structures the continuation of design, which means the contract can be entered earlier than it may have been otherwise, reducing the resources design-build teams must dedicate before being awarded the job. Second, the owner continues to participate in the design with the ability to review the design as it progresses, which can appeal to owners who are uncomfortable going to contract early and leaving design decisions

undetermined. Third, the procedure establishes regular communication among the parties and facilitates design updates, expediting decision-making.

These reasons load on more than one factor of the conceptual model reflect the multi-dimensional nature of the factors. 'Going to contract early' loads principally on the following six factors in the conceptual model: Planning; Transferability; Power, Hierarchy, and Command; Commencement, Duration and Termination; Attitudes; and Measurement & Specificity. 'Continued owner involvement' loads on eight: Planning; Numbers; Transferability; Power, Hierarchy and Command; Measurement & Specificity; Commencement, Duration and Termination; Attitudes; and Benefits & Burdens. 'Expedited decision-making' loads on six: Power, Hierarchy, and Command; Sources of Contractual Solidarity; Attitudes; Overall Relation Type; Benefits & Burdens, and Future Cooperation. Reasons for use are addressed conceptually below.

6.5.3 Analyzing the Procedure Using the Conceptual Model

This section analyzes eleven factors from the conceptual model grouped into four categories: Planning, Actors, Time, and Boundaries. Under the category of Planning are the factors of "Planning," "Measurement & Specificity," and "Benefits & Burdens" that address over-the-shoulder design reviews allowing joint participation in the completion of planning and management of the bargain during delivery as the contract becomes more measured and specified. "Numbers; "Power, Hierarchy and Command," and "Attitudes" are factors associated with the Actors category allowing the analysis of those involved, their power, and their attitudes. "Transferability" and "Commencement, Duration, and Termination" are elements of the Time category, highlighting when during the project lifecycle the procedure occurs and the participants involved. "Sources of Contractual Solidarity" and "Overall Relation Type" pertain to the

Boundary category highlighting how the procedure impacts the boundary and, as a result, the relationship.

6.5.3.1 Planning

For planning left incomplete when the contract is entered, over-the-shoulder reviews facilitate the continuation of significant project participants in planning. Plans are shared as decisions are made supplementing or replacing large portions of the design reviews at specified points. This allows owners to be involved and informed as the design progresses, providing comfort for those owners who may be uncomfortable leaving the design flexible. This procedure leads an owner to go to contract earlier than he might otherwise, allowing more design to be completed after the contract is awarded, minimizing the resources Design-Build teams dedicate to the design before being selected. On the I-15 project, the owner completed the planning for parts of the project and left other parts flexible for the design-build team but used over-the-shoulder design reviews to be informed about the design before more formal reviews.

6.5.3.2 Numbers

The actors involved in over-the-shoulder reviews and the organizational structure of the procedure can be described using the concept of Numbers. Typically, the owner, designer, and contractor participate along with other key stakeholders who are integral to the design process. When viewed as a network, members from these organizations are enclosed within an over-the-shoulder review boundary. At the lowest organizational levels, each participant is represented by a node and connected to other nodes by links representing two-way communication that is typically informal and occurs often. At higher organizational levels, the participants are depicted as clusters and often connected to other clusters by links between management officials. These links represent two-way communication that tends to be formal and usually planned. The

connections between management and the members of their organizations can be two-way for information gathering or one-way for design direction. The I-15 project had a tiered system for over-the-shoulder reviews. The participants at the lower working level creating the design were co-located and often communicated daily. In contrast, higher-level participants shared information on a regularly scheduled, often weekly, basis.

Over-the-shoulder reviews were also used on the Knightdale Connector. The owner did not require over-the-shoulder design reviews. Still, because permitting responsibilities were included in a design-build contract for the first time, the design-build team chose to incorporate the procedure, asking the owner to be involved and hiring an environmental consultant for assistance.

6.5.3.3 Transferability

Over-the-shoulder reviews occur after the project is transferred to the design-build team for performance highlighted by Transferability, an element of Time. For an owner, the final transfer for use is a point of focus because he wants to be sure he gets the product he desires even though using an incomplete contract. There are many paths an owner can take to reach the final transfer. One includes over-the-shoulder reviews, which begin with the owner issuing the RFP to transfer to the market and stipulates procedures to be used. The subsequent transfer for performance becomes a continuation of owner involvement rather than simply a handoff to the selected design-build team. Being involved in over-the-shoulder reviews gives the owner greater awareness of and, sometimes, input on the end-result.

For the I-15 owner, the end-product was a primary concern. The UDOT incorporated over-the-shoulder reviews but also specified different ways to ensure the end-product meets expectations. Three specifications were used: performance specifications to provide flexibility

for the design-build team to propose new methods and ideas, prescriptive specifications to achieve specific outcomes, and hybrid specifications to specify parts while leaving others flexible. In addition, UDOT developed approximately 30% of the design and completed some final plans to accelerate the start of construction. For the parts of the project that were well-defined little follow-up was required. Still, for those parts left ill-defined, over-the-shoulder reviews were instrumental to the owner's familiarity with the design and the timely delivery of a satisfactory product. In contrast, the I-77 owner received an end-product that did not meet expectations due to the problematic median maintenance due to double lines of guardrails. Over-the-shoulder reviews were not used for the project, but if they had been, perhaps NCDOT would not have approved the guardrail design.

To place the use of the procedure in the context of other choices, when an owner wants to have complete control of the end-product he can complete the scope himself before the transfer to the market, or he can choose to leave the contract incomplete with the transfer to the market but require it to be essentially complete before the project is transferred for performance. The first instance is often associated with design-bid-build, in which the owner hires a designer to develop a complete plan with the owner's input and approval. This process is expensive and often involves little innovation. In the latter instance, the owner develops a partial scope before the transfer to the market and asks proposing design-build teams to further develop during the proposal phase. The proposing design-build teams are required to complete a large amount of the design in their proposals allowing the owner to approve more of the plan before entering a contract. Still, this process is expensive for the proposing design-build teams who must dedicate resources to design with no guarantee of being awarded the project. Both options involve

minimal owner involvement after the transfer for performance and provide the owner with a more specific idea of the end-result.

6.5.3.4 Power, Hierarchy and Command

The over-the shoulder review procedure shines a light on the actors' power during delivery. When used, an owner's involvement during performance expands, and his power can range from ministerial to discretionary. If ministerial, the owner is limited to checking adherence to established requirements and standards. If discretionary, it becomes more challenging to determine the limits of his authority, opening the door for the owner to have a lot more influence and input in the design process. The latter situation creates the most significant uncertainty for the design-build team and may be factored into their bid. Unless otherwise specified, the design-build team typically has unilateral power during the performance to make the choices left undefined by the owner. The I-77 project is an example of a project in which the owner was not satisfied with the end-product he received due to the difficult maintenance of double lines of guardrails in the median. Over-the-shoulder design reviews were not used, but the project raises questions about the extent of the owner's power if the procedure were used. Given the guardrail met the scope, would the owner have had the authority to reject the design? If it was determined the design was based on cost, could the parties have negotiated a joint solution that improved the design for the owner but also compensated the design-build team for the changes?

6.5.3.5 Sources of Contractual Solidarity

Over-the-shoulder design reviews can strengthen the bonds of the parties within the relationship boundary. When a contract is incomplete, the parties expect to complete it cooperatively within the relationship by filling the gaps with things like industry norms, codes, and standards of practice. Over-the-shoulder design review provides not only an opportunity for

cooperation by facilitating frequent interactions and the exchange of information, which can expedite the "gap-filling" process, but the procedure also provides an opportunity to foster the relationship and the internal support that is necessary to sustain the relationship as decisions are made, and problems are encountered. This precludes the requirement for outside assistance of courts, mediators, or arbitrators—external sources of support—unless as a last resort due to the damage it can cause to the relationship. For example, poor soils were encountered during the I-10 Blackwater Bridge project delivery. Since this was an emergency project and design-build was new for the owner, he adapted their design-bid-build contract for the project. The owner expected cooperation in resolving problems despite the absence of relationship-building measures or procedures like over-the-shoulder reviews. Instead, when the soil issue was encountered, the design-build team referred to the contract for a solution. The parties could not determine jointly how to move forward and requested the assistance of the specified Dispute Review Board. This Board ruled in favor of the design-build team based on the contractual agreement. This issue and the need for outside assistance destroyed the relationship, and the parties were unable to cooperate and had to request Dispute Review Board assistance for additional issues.

6.5.3.6 Measurement & Specificity

Over-the-shoulder design reviews are a procedure associated with the continuation of planning. Because the contract is often not complete when entered, aspects of the project must be specified and measured during the performance. Over-the-shoulder review facilitates information sharing as more of the project is determined. Even though the contract is left intentionally incomplete, it doesn't mean it remains open-ended. The contract communicates intent, and things like codes, industry norms, and best practices, some referenced explicitly in the RFP and others

implicitly applied, guide the completion of the design. For example, in the RFP for the Knightdale Connector, NCDOT stated all work by the design-builder was to be done by the established customs, practices, and procedures of the North Carolina Department of Transportation and in conformity with the standards adopted by the American Association of State Highway Transportation Officials. These and other mechanisms create shared expectations about how the relationship will move forward and how the contract will ultimately be specified.

6.5.3.7 Commencement, Duration, and Termination

The procedure impacts the participants' temporal boundaries, evident when considering Commencement, Duration, and Termination, an element of Time. An owner's temporal boundary is extended when participating in over-the-shoulder reviews. The "sharp out" at the end of the proposal phase, typically marking the end of the owner's active involvement with the design, becomes a "fuzzy out" as he plays an active role during the performance phase. An incomplete design creates a "fuzzy in" for the design-build team at the beginning of the proposal phase as one of many proposers who must advance the design without guaranteeing the project. The I-15 project used over-the-shoulder reviews, which extended the owner's temporal boundary but reduced the number of proposing design-build teams and mitigated the impact of a "fuzzy in" by the owner short-listing the teams.

6.5.3.8 Overall Relation Type

Over-the-shoulder design reviews thin organizational boundaries as evident when viewed from the perspective of the Overall Relation Type, a concept that focuses on boundaries. The procedure facilitates interaction and communication as actors operating as boundary spanners flesh out the design. These actors become deeply engaged in the relationship and possess personal characteristics that allow them to thrive in a group like this—they are outgoing, work

well on a team, and are problem solvers. Using the I-15 project again as an example, the co-located working-level participants involved in the over-the-shoulder review procedure continuously interacted and communicated as the design developed reflected a thin, highly permeable boundary and close personal relationships. There were fewer interactions for the higher management level participants as the slightly thicker boundaries provided more organizational protection. There were scheduled meetings establishing a channel for decision-making and approvals at a level that protected organizational interests.

6.5.3.9 Attitudes

Over-the-shoulder design reviews can foster aspects of actors' attitudes: unity, diminish awareness of conflicts of interest, highlight perspectives of time, and reduce trouble. The opportunity to cooperate as the design is completed can foster a sense of Unity among the actors and provide opportunities for altruism and reciprocity. Trust can also be built and strengthened when opportunism is avoided. For example, the Knightdale Connector project incorporated over-the-shoulder reviews at the request of the design-builder to deal with the permitting process the owner included for the first time in a design-build contract. During delivery, it was determined a ramp connecting this project to another simultaneously built project was omitted from both project scopes. The owner added the work to the Knightdale Connector, indicating the design-build delivery method made that easy to do; it is also conceivable that the cooperative relationship stemming from the over-the-shoulder reviews and the unity created between the parties contributed to the ease of incorporating the additional work into the design.

Over-the-shoulder design reviews can strengthen unity which counters the pursuit of self-interest. Still, there are instances in which the self-interests of the participants are often pushed to the background in relationships as secondary interests begin to seep in. Participants' Awareness

of Conflicts of Interest and the consequences of their actions and the resulting impacts can vary; some are fully aware while others are unaware. Two examples are highlighted from the I-4 Reconstruction project; one addresses the owner's self-interests, and the other addresses the contractor's self-interests. The I-4 owner removed the utility work from the contract because of the uncertainty and concerns of added contingency costs. The owner's decision was based on self-interests stemming from the desire to do what was in the best interests of his constituents. However, the utility work was not completed promptly and ultimately impacted the start of the design-build team's work. Although over-the-shoulder reviews were not used on the project, if the owner had included the utility work in the contract, the procedure could have been a means for the owner to remain involved. In the second example from this project, the team-leading contractor proposed reusing the existing guardrail reflecting his self-interest due to the cost savings, which the team designer rejected. If over-the-shoulder reviews had been used, this is likely a design decision that the owner would have reviewed.

Actors' perspectives of Time vary, influenced by their roles and past experiences. Over-the-shoulder design reviews can highlight these differences. During initial planning, the owner's perspective of time affects the development of the contract. It ultimately impacts whether the procedure is even utilized. It is only necessary when an owner embraces the idea of allowing the contract to be completed in the future. The procedure synchronizes the owner with the contractor and designer, who each bring their unique knowledge to the design. For the contractor who focuses on delivery and the short-term aspects of the project, over-the-shoulder reviews provide an opportunity to have input which often centers around construction and cost efficiencies. The procedure also can speed the design review process because the owner is already familiar with the design, allowing construction to proceed faster. For the designer who focuses on the design

and long-term viability of the facility, over-the-shoulder reviews increase "public time," group time, increases the amount of input and opinions received, and reduce the amount of "private time," alone time, available for design. The procedure can also impact a designer's willingness to pursue innovative solutions. Given the resources required to develop these solutions, designers may be reluctant to pursue them because they might not be approved and instead may resort to standard solutions that are universally accepted. However, when public time creates a strong sense of unity among the team, the designer may see over-the-shoulder reviews as an opportunity to work with the owner to develop innovative design ideas known as "conversions" that may result in cost and time savings. The I-77 earth ramp is an example of an innovative design presented by the design-build team as the basis of their bid during the proposal phase. This design veered from the owner's initial plan. Still, the innovative idea of using an earth ramp allowed construction to occur during the day, drastically reducing costs and schedule. The impetus of this innovative solution resulted from combining the contractor's focus on time and cost efficiency and the designer's knowledge and ability. The owner's approval process likely included consulting with Department specialists to determine the feasibility of the design, the potential impact on existing structures, and the safety of its use during construction. Although over-the-shoulder reviews were not used on this project, this process parallels what may occur during the performance with over-the-shoulder reviews. The owner can review designs and include members of his team as needed to review design elements of concern for them; for instance, the maintenance, geotechnical, bridge, and pavement experts can be involved as necessary.

The procedure allows the parties to review the design as it progresses, which can help deal with Trouble, ideally leading to the identification of any mistakes or errors which can be

handled with less impact on the project schedule and the relationship. The procedure was not used on the I-10 Blackwater Bridge project but could have helped foster the relationship and discover and deal with the encountered problems earlier. Poor soils were encountered during the performance that required a redesign and rework. The parties disagreed on who was responsible. As an emergency project following a hurricane, the owner chose to use design-build because the project could be delivered more quickly. Because the delivery method was new to the owner, the contract was developed from the Department's design-bid-build contract boilerplate. Still, the owner expected a relationship. The assistance of the Dispute Review Board was necessary, and the relationship deteriorated as each party began to look out for their self-interests leading to the need for the Dispute Review Board on subsequent issues. It seems the owner expected unity in the face of trouble, but instead, self-interests were at play, and each party sought to protect its own.

6.5.3.10 Benefits & Burdens

Over-the-shoulder design reviews allow the major project participants to be involved as planning is completed and the bargain is finalized, which is associated with both burdens and benefits for each party. For an owner, there is the burden of a significant time commitment during delivery. Still, as a benefit of being involved, he can voice concerns, particularly regarding the decoupling of benefits and burdens that may allow a present benefit for the design-build team but create a future burden for the owner. Over-the-shoulder reviews would likely have been beneficial for the I-77 project; the owner was dissatisfied with double lines of guardrail due to the difficult maintenance. This design probably had a low first cost for the design-builder but created a long-term burden for the owner. If the procedure had been used, the owner would have had an opportunity to review the design.

For the designer, a significant burden associated with over-the-shoulder reviews is the increased level of input during design, with both the contractor and owner participating. The benefit, however, is the designer can obtain owner buy-in along the way, which can be particularly beneficial for innovative ideas because the designer can present the concept to the owner to determine if it is feasible before there is a significant resource commitment. The I-85 design-build team reconfigured the owner's preliminary design to create a safer facility expected to lower initial and lifecycle costs. Although it did not occur during over-the-shoulder reviews, if it had, before fully developing the design, the I-85 design-build team could perhaps have asked the owner for approval based on a preliminary design.

For the contractor, the procedure creates an additional time commitment. Still, because he naturally focuses on efficiency, the procedure may allow construction to start sooner because the accelerated design review process can potentially reduce overhead costs and time on site. He also has greater insight into and input in the design, allowing him to contribute valuable construction knowledge when it is most beneficial. This was seen on the St. George Island Bridge project, and although it did not occur in the context of the over-the-shoulder review, it highlights the potential. The project was in an environmentally sensitive location, and of serious concern for the owner were construction impacts on the bay and disturbance of the oyster beds. Rather than many small diameter piles, to minimize the effects, the contractor recommended using a smaller number of large diameter piles with which he had previously worked.

6.5.3.11 Future Cooperation

Over-the-shoulder review is a procedure for Future Cooperation during planning. It structures the parties' interactions and ensures continuous cooperation and communication about the design. Some structural aspects of the procedure may be planned, for instance, the parties

involved and when and how reviews will occur, but much of what happens takes place in the future within the relationship. The degree of cooperation among the participants can vary, as illustrated by a spectrum where cooperation exists at one end and competition at the other. Cooperation is often an extension of the relationship which may be preexisting from a past project or be fostered through team-building activities or procedures like over-the-shoulder design reviews. This is seen in two project examples; in the first, there is cooperation, and in the second, there is not. On the I-15 project, over-the-shoulder reviews were required in the contract and incorporated at two levels. At the lower level, participants were co-located and able to share design updates, discuss ideas, and answer questions daily; at the higher organizational level, over-the-shoulder design reviews occurred as regularly scheduled meetings. In addition to procedures like over-the-shoulder reviews, co-location, and partnering, there was also a focused effort to strengthen the relationship among the participants through shared meals and sporting events. On the I-10 Blackwater Bridge project, the opposite occurred. The owner expected a relationship and cooperation despite a largely discrete contract and the absence of over-the-shoulder reviews or seemingly any other relationship-building measures. When poor soils were encountered, the contractor resorted to an exact interpretation of the contract rather than the parties cooperating on a solution. Dispute Review Board assistance was needed for resolution. The relationship then devolved into competition with the owner, subsequently identifying discrepancies between contract requirements and actual implementation, requiring additional Dispute Review Board rulings.

6.5.4 Evaluating the Procedure Using the Conceptual Model

This section evaluates the conceptual model by examining the interactions between pairs of concepts. This not only provides a greater understanding of the complexity of the model but

also provides a more holistic view reflecting how the factors impact each other and allow potential concerns associated with the procedure to become evident.

Six interactions are discussed below: Attitudes with Benefits & Burdens highlights the impact of participants' perspectives as the bargain is finalized with the aid of over-the-shoulder design reviews, Overall Relation Type with Numbers describes the organizational structure and characteristics of the relationship when the procedure is used, and Commencement, Duration, and Termination with Power, Hierarchy and Command highlights participant involvement and the power dynamic associated with the procedure. Planning with Future Cooperation describes over-the-shoulder reviews as a procedure for cooperation when planning is incomplete, Measurement & Specificity with Sources of Contractual Solidarity addresses over-the-shoulder reviews as a source of support used to complete the contract, and Transferability with Planning highlights planning for transfers when the contract is incomplete and over-the-shoulder reviews are used.

6.5.4.1 Attitudes with Benefits & Burdens

The Attitudes of participants can directly impact Benefits & Burdens. Because over-the-shoulder design reviews are used when the contract is incomplete, benefits and burdens are being parsed as the bargain is being set. An owner's attitude regarding time during the initial planning and development of the contract determine how the bargain will be defined; he either wants to complete the contract in the present, or he is willing to leave the contract incomplete and allow it to be completed in the future. When he chooses the latter, parts of the bargain may be negotiated during the proposal process. Still, those parts that remain incomplete when the contract is entered are dealt with during performance, and the owner must choose whether over-the-shoulder design reviews will be used as completed. Choosing to use over-the-shoulder reviews and going to

contract early can be beneficial for both the design-build team who wishes to get under contract as quickly as possible to minimize the resources dedicated to the design before being selected and the owner who negotiates the design with one team rather than multiple design-build teams involved during the proposal phase.

The design-build team's attitude toward time is split into two parts based on the differences between the contractor and designer. For a contractor who naturally focuses on short-term concerns, over-the-shoulder reviews can be beneficial, providing an opportunity to incorporate efficiencies that can speed delivery—he can contribute construction knowledge when it can be most impactful. The review of the design can be expedited. The I-15 project owner indicated the process led to the owner's familiarity with the design, which sped up the design review process. For a designer who focuses on long-term aspects of a project, the additional "public time" and faster pace of work associated with the procedure can be burdens. Still, the designer has the expertise to devise innovative solutions, and over-the-shoulder reviews can be beneficial for obtaining owner buy-in when there is unity. Still, in its absence, the burden of a significant resource commitment with no guarantee of design approval may be a deterrent to pursuing such solutions.

Participants' attitudes associated with unity and conflicts of interest can be revealed when unanticipated events—trouble—occur, and some benefits must be captured or burdens must be absorbed. When there is unity, participants operate in good faith and manage events as a group; when there is self-interest, participants focus only on what is best for them. For instance, in the case of the I-10 Blackwater Bridge project, an unexpected burden of poor soils revealed the opposing attitudes of the participants—the contractor believed the burden was the responsibility of the owner based on the contract and stood firm to protect his interests and the owner believed

unity was inherently part of the design-build delivery method and thought the parties could work together to manage the burden. Unable to cooperate, third-party assistance was required. A ruling in favor of the design-builder led the owner to switch to a self-interested posture for the remainder of the project. Dispute Review Board assistance was necessary for subsequent issues.

6.5.4.2 Numbers with Overall Relation Type

The relational characteristics of the Overall Relation Type facilitate interactions of the Numbers of Participants involved in over-the-shoulder design reviews. Relationships occur between organizations with thin, permeable boundaries that allow the participant interaction and communication necessary to complete an incomplete contract. Participants traverse these organizational boundaries as part of an overall network within which over-the-shoulder reviews occur. At the highest organizational level, the network is defined by a single node, and the boundary representing over-the-shoulder reviews captures a small part of each organization at their boundary. This boundary interface is the "meeting ground" where the over-the-shoulder procedure occurs, where the contract sits as a "boundary object" serving as a communication device but also the focus of the continued planning, and where links between participants from different organizations extend. When zooming in and looking within the boundaries at lower levels of the organizational structure, the individual participants involved in the over-the-shoulder reviews are observed represented by multiple nodes and connected by links representing the flow of communication and information. These participants, also referred to as "boundary spanners," have personality characteristics that make them well-suited for the procedure, such as problem solvers and working well with others. While many of these participants remain consistent throughout the procedure, participants can be added and subtracted when additional expertise or a particular voice is needed. On the I-77 project, the owner's

dissatisfaction with the guardrail could have been remedied with over-the-shoulder reviews and input from an added maintenance team member. On the I-15 project, the owner attributes the project's success in part to over-the-shoulder design reviews, which were implemented at two levels, a lower organizational level with co-located participants who had frequent, informal communication and a higher management level with scheduled meetings and more formal communication. Using the conceptual model, this lower level of the network would be characterized by organizational boundaries that are highly permeable with many nodes with multiple links to other team members. The boundaries are less permeable at the higher level, with fewer nodes and connections.

6.5.4.3 Commencement, Duration, and Termination with Power, Hierarchy, and Command

Commencement, Duration, and Termination highlight Power, Hierarchy, and Command. The temporal boundaries of the significant actors overlap during over-the-shoulder reviews, and each holds distinct power associated with design. Over-the-shoulder reviews allow some participants to be involved earlier and others to be involved longer than they otherwise would be. For instance, the contractor commences his involvement earlier and can contribute to the design's constructability. The owner terminates his active involvement later and can review the design as it progresses during the performance. This continued involvement is a change from the relatively "sharp out" at the end of the proposal phase, where he only monitors for contract adherence and makes progress payments. Under over-the-shoulder review, the owner's opportunities to influence the design expand.

While the owner typically holds a hierarchical position on a project and initially has unilateral power to make choices when the design is left flexible until the performance, the design-build team typically has unilateral power to complete the design during performance.

When the owner remains actively involved, a concern is the extent of the owner's power and ability to direct (command) the contractor. This can be problematic if he makes design requests outside what was expected and budgeted for in the contract.

Over-the-shoulder design reviews mean more people are present when decisions are being made, providing an opportunity to have their voices heard, interests expressed, and knowledge shared, but with it can come a power shift. The expansion in the owner's temporal boundaries was noted with an extended duration of active involvement and later termination. Still, the I-15 project had aspects that seemed to balance the owner's power with that of the design-build team. The I-15 owner required over-the-shoulder reviews but also specified his right in the contract to choose whether to purchase an extended warranty at the end of construction. This option for a warranty would have made it possible for the owner to relinquish more power to the design-build team for design while protecting himself from potentially unfavorable choices. The owner also set up a tiered over-the-shoulder review process establishing a hierarchy for decision-making, with the highest tier having more power to protect organizational interests.

6.5.4.4 Planning with Future Cooperation

Planning an incomplete contract will require additional subsequent planning. Over-the-shoulder review is a procedure for cooperation during continued planning, structuring the parties' interactions, and ensuring each is involved in and aware of the design as it develops. Two concerns arise when viewing over-the-shoulder design reviews through the lens of planning and future cooperation, there is a potential for scope creep to occur and innovation to be impeded. First, while it is natural for an owner to desire more from a project when the design is incomplete and he remains actively involved through over-the-shoulder design reviews, he may

act on these wishes causing the scope to expand beyond what was initially expected. Unless a change is made to the contract, the design-build team suffers the consequences—additional work and often increased costs cutting into their bottom line on a hard bid contract. To account for this uncertainty, some design-build teams may add a contingency to their bids. Second, while a typical advantage of incomplete planning is the opportunity for innovation, over-the-shoulder design reviews sometimes impede innovation because some design-build teams may be unwilling to spend the time and money necessary to develop innovative solutions when they are unsure if the owner will accept them. Instead, they may stick to basic designs they are confident the owner will approve.

6.5.4.5 Measurement & Specificity with Sources of Contractual Solidarity

Over-the-shoulder design reviews are a source of support that aids in Measurement and Specificity during the performance. For a relational contract, the scope is left incomplete and typically not fully specified until the performance, but the cost is set when the contract is entered. The scope is completed using external sources of support like norms, standards of practice, and codes and internal relational sources of support like over-the-shoulder design reviews when chosen. Using over-the-shoulder reviews to complete the scope when one side of the bargain is measured and specified and the other side is not, leads to three major concerns, the potential for scope creep, scope degradation, and design-related cost savings. First, there is the potential for scope creep. The owner's involvement leads to a concern that the scope could balloon out of control. This concern is discussed in greater detail above. Second, there is the potential for the degradation of content. Another concern is that the effort to reduce costs could lead to a degradation of the scope, ultimately impacting the end-product the owner receives. Third, there is uncertainty about how parties will deal with cost savings resulting from a design solution after

the contract is entered. Does the design-build team receive the savings, or is it shared with the owner? On the I-77 project, the design-build team designed an earthen ramp that drastically reduced the cost and schedule for the project. Although it was not developed using the over-the-shoulder review during the performance, how would the cost savings have been managed if it had been?

6.5.4.6 Planning with Transferability

Planning can occur at different times during the project lifecycle when there is a relational contract. Over-the-shoulder reviews are a procedure for planning after the transfer for performance. A project is marked by three main transfer points—transfer to the market, transfer for performance, and transfer for use. When the owner's planning is incomplete once the project is transferred for performance, an over-the-shoulder review can be used to complete the planning within the relationship. When an owner chooses not to complete the planning himself before the transfer to the market, he essentially has two options: require proposing design-build teams to complete it during the proposal phase before the transfer for performance or allow the selected design-build team to complete it during the performance phase. The first instance is often associated with Alternative Technical Concepts (ATCs) and the second with over-the-shoulder reviews, two procedures in which differences can be highlighted by applying the model in this setting. For instance, ATCs occur during the proposal phase and allow owners to review and select desired design options. Over-the-shoulder reviews occur during the performance phase and enable owners to review and approve design choices during the performance. ATCs occur before the contract is entered, and the selected designs are incorporated into the contract. Over-the-shoulder reviews occur after the contract is entered, and yet-to-be-determined parts of the contract are completed during performance yielding the final product delivered at the transfer for

use. ATCs often extend the proposal phase due to the extra time needed for a design. At the same time, over-the-shoulder reviews can shorten it, allowing the transfer for performance to be pushed earlier in the project lifecycle due to the continuation of planning after the transfer. During initial planning before the transfer to the market, the owner develops the scope, often focusing on intent and any elements necessary to ensure the product delivered will be what is desired. Also included are requirements for and parameters regarding the use of over-the-shoulder design reviews and other procedures.

The I-15 project is an example highlighting that not all parts of a project must be dealt with similarly. During initial planning, due to a concern about time, the owner completed some parts of the scope to allow the design-build team to begin construction immediately after the transfer for performance. He left other areas of the scope incomplete. Still, the owner included procedures for over-the-shoulder reviews so that he can remain involved as completed and an option for an extended warranty, further protecting himself from decisions that could impact the end-product. With the decision to purchase the warranty made at the end of the performance phase, the owner could base his decision on a nearly wholly constructed product, providing an ultimate review of the design. This example highlights decisions by an owner that were forward-looking and shows that not all parts of a project will need to be part of the over-the-shoulder review procedure.

Owner involvement may cause some design-builders to be concerned about the amount of freedom they will have during the design, and as a result, they may add a contingency to their bid. Focused on costs, the design-builder will look to reduce costs where possible during performance. One way to do this may be to reduce the resources dedicated to unacceptable ideas by gaining owner buy-in by presenting ideas with few details that, if accepted, will be fully

developed. Or the design-build team may only offer standard designs they believe will be approved. The I-15 project is an example of an owner who used over-the-shoulder reviews to provide the designer with a large degree of design freedom. The option for an extended warranty seems like an added layer of protection that allowed the owner to offer greater design freedom to the design-build team while shielding him from the burden of a low-quality end product.

6.5.5 Creating New Aspects of the Procedure

This section provides modifications to the over-the-shoulder review procedure by addressing some of the concerns illustrated by the conceptual model. Five concerns are addressed: scope creep, design-related cost savings, actors' authority, scope degradation, and participant involvement.

Three of the main concerns associated with the procedure—scope creep, cost savings, and actors' authority—are addressed with one primary suggestion: deal with them in the contract language. Planning a relational contract has been compared to planning a constitution (Goldberg 1976, Palzer 1988, Vanberg 1994). Just as Freeman (1992) references the U.S. Constitution, which defines the roles, power, and procedures of government and the fundamental rights of citizens as mentioned in the conceptual model discussion on Planning, so too can a relational contract specify the roles, power, and rights of those involved in over-the-shoulder reviews and procedures for the future. First, to address the concern of scope creep, an owner can structure the contract to establish procedures that allow for changes while protecting his rights and the rights of the design-build team. Many owners enter a project with one of their primary goals to obtain a desirable result. Suppose, during over-the-shoulder design reviews, it becomes evident that the project will not accomplish this goal or that it can be altered to do so in a better way. In that case, the owner may want the option to adjust the design and should include procedures in the contract

to allow him to do so. It should recognize his right to request changes and the process by which such changes can be made. The owner should also address the right of the design-build to request and receive adequate compensation for any changes requested, including additional design and construction costs and schedule extensions. Second, to address the concern of significant cost savings resulting from a dynamic bargain, the owner can stipulate how the parties deal with a design solution that results in savings in the contract. Some owners may stipulate cost sharing between him and the design-build team, while others may allow the design-build team to receive the full savings. Third, to address the extent of the actors' authority, owners may want to consider addressing things like the roles and specific rights of the participants, how much discretion decision makers will have, and what will guide decisions. Or an owner may choose to set up a hierarchy for design, aspects of the conceptual model discussion on Power, Hierarchy, and Command. By including these or any other procedures in the contract, the contracting parties can agree to the terms before entering the contract.

Fourth, to address the potential for scope degradation, owners should consider selecting the design-build team on a basis other than low first cost or including parameters in the contract that require the design-build team to fill in the gaps left in the design with something different than the minimum standard. It was noted in Measurement & Specificity that the incomplete portions of the scope would be filled in using norms, codes, and standards. Still, a set cost, particularly when it is low first cost, will mean that design-build teams will naturally stick to the minimum requirements, and in rare instances, this may lead to a degradation of the scope. An owner concerned about the latter should include a measure for decision-making other than a low initial cost. As part of this research, one of the suggestions for future research is that a lifecycle code is developed to evaluate decisions based on lifecycle costs. In a similar way that codes

establish a minimum standard allowing parties to meet requirements while achieving a low first cost, a lifecycle code would provide a minimum standard that meets a lifecycle requirement related to cost or durability. If this is developed, owners may want to consider referencing this in the contract as a requirement for design. In the interim, an owner can be more specific in the contract about areas of the design that are of concern, require certain parts of the design to be presented during the proposal phase when he has unilateral power, or establish power to reject designs during over-the-shoulder reviews that do not meet specific expectations.

Fifth and finally, to address the concern that the right people are involved, as mentioned in Numbers, when structuring the procedure, owners should consider including those with decision-making authority and, when necessary, experts. While the participants at the working levels will be engaged in the day-to-day activities, decision-makers are needed at the higher levels to help protect organizational interests and ideally to help ensure incremental approvals that lead to the desired result. Experts with specialized knowledge can be beneficial to make decisions efficiently and can be added as needed to review the applicable design elements. But simply having the right people may not necessarily yield a unified, cooperative team. The relationship will often also need to be fostered, so owners may want to consider joint meetings, team-building activities, and shared meals as part of the procedure.

6.5.6 Summary

To summarize, the over-the-shoulder review is a procedure used during performance to allow the participants to complete the contract jointly. The designer develops the design, the contractor provides construction input, the owner reviews and approves the design, and other stakeholders who contribute to the design or whose voices need to be heard are included as

necessary. These participants are all part of a network and will rely primarily on cooperative relationships, norms, standards, and codes to complete planning.

There are benefits associated with over-the-shoulder design review, but there are also concerns. For instance, the procedure gives the owner the advantage of remaining involved as the contract is completed and allows the design-build team to enter a contract earlier, minimizing the resources dedicated to developing a proposal with no guarantee of receiving the job. However, the owner's involvement leads to concerns about scope creep, authority, and innovation. Scope creep occurs when the owner expands the scope outside the original plan without compensating the design-build team. It may be mitigated in instances where it would otherwise unknowingly occur by the owner's awareness of its potential to occur or through procedures for changes. An owner's authority can range from discretionary to ministerial, but the extent of his authority can be addressed in the parameters established for the procedure. Innovation can be stifled by over-the-shoulder review if the design-build team is concerned about receiving owner approval, but this can be countered if there is unity among the participants and if the design-build team uses over-the-shoulder review as an opportunity to obtain owner buy-in along the way.

6.6 Summary

This chapter applies the conceptual model to three design-build procedures—co-location, ATCs, and over-the-shoulder design reviews—selected as examples to show the value of conceptual knowledge to current design-build practice. Analyzing and evaluating these procedures using the conceptual model provides a better understanding of why things are done, what challenges may be encountered, and how these challenges can potentially be overcome by creating new aspects of the procedures with the aid of the model.

To summarize, co-location is a procedure during the performance phase that brings project resources together at one location to expedite communication, decision making, and conflict resolution. Analyzing concepts such as Numbers, Attitudes, and Planning show that constructability, innovation, and cooperation can be facilitated by co-locating members of the significant project organizations however evaluating the interactions between concepts like Attitudes and Benefits & Burdens revealed that the increase in "public time" and decrease in "private time" may be challenging for some engineers. To help mitigate this concern, creating new aspects of the procedure through the network structure was suggested using the concept of Numbers.

ATCs is a procedure during the proposal phase that allows the owner to consider design options before the contract is entered. Concepts like Planning and Transferability show that not only is the owner able to consider innovative and significant design decisions before the contract is entered, but the procedure also allows a design-build team to obtain owner approval of an innovative design before entering the contract, which is particularly desirable when it is the basis of their bid. One of the concerns highlighted by the interaction of Benefits & Burdens with Planning is that the development of ATCs can be expensive for design-build teams, and there is no guarantee they will be awarded the job. Suggestions were provided to help balance these Benefits & Burdens for the proposing design-build teams.

Over-the-shoulder design review is a procedure during the performance phase that allows the major project participants to be updated and provide feedback on the design as it is completed. Concepts like Planning and Transferability suggest this can be desirable for owners concerned about leaving the contract incomplete. It may allow some to go to the contract earlier than they otherwise would have. Still, the procedure raises concerns about the extent of the

owner's authority, the potential for scope creep, and in some instances, the stifling of innovation as highlighted by the interactions of concepts like Commencement, Duration, and Termination with Power, Hierarchy, and Command and Planning with Future Cooperation. It is suggested, based primarily on the conceptual model concept of Planning, that owners address these concerns in the contract's language through scripted procedures and rights, much like a constitution.

The conceptual model allowed each procedure to be viewed from the perspective of individual concepts and interactions of those concepts and allowed nuances among the procedures to be observed. For instance, it was pointed out in the discussion of over-the-shoulder design reviews that they are like ATCs in that they allow involvement of both the owner and design-build teams in the planning, but different regarding time with ATCs occurring during the proposal phase and over-the-shoulder reviews occurring during the performance phase. ATCs also involve multiple design-build teams, while over-the-shoulder reviews involve the one selected team. ATCs are design decisions that become promises scripted into the contract, and over-the-shoulder reviews are design decisions made after the contract is entered. Like co-location, over-the-shoulder design reviews occur during the performance phase. Both can foster the relationship and facilitate information sharing and answering questions in real-time. While co-location can be used in conjunction with over-the-shoulder reviews, as seen on the I-15 project, participants involved in over-the-shoulder reviews will not necessarily be co-located as seen with the Knightdale Connector.

In conclusion, conceptual knowledge addresses why things are done, and application of the conceptual model to selected procedures indicates its value for better understanding and implementing design-build.

Chapter 7

Summary and Conclusions

7.1 Summary

The re-emergence of Design-Build led many (Metcalf-Kupres 2001, McClain 2007, Solomon 2008, Kubba 2010) to believe it would again be the dominant mode of project delivery, perhaps as early as 2005. However, these early expectations have not materialized. In a recent report commissioned by the Design-Build Institute of America, Duggan and Patel (2015) suggest a more modest growth of Design-Build due to an absence of conceptual knowledge about the method. This absence limits practitioners' ability to implement Design-Build and collectively organize their experiences. Bernstein (2014) found the lack of owners' familiarity with their Design-Build roles and responsibilities and a fundamental misunderstanding of the process itself as significant obstacles. Ling and Poh (2008) suggest this contributes to problems throughout a project.

Others use ill-adapted routines embedded in the knowledge base of different but familiar project delivery methods. Eraut (1985) points out that projects often require decisive and immediate action, where some might misapply the routine principles of design-bid-build without fundamental knowledge about design-build. Reverting to prior knowledge or experience in dealing with new challenges is known as "structural inertia" (Hannan and Freeman 1984) or "historical inertia" (Elvin 2007), which leads to poorly aligned approaches. Mr. Jeffrey Beard, a past president of the Design-Build Institute of America, in Elvin (2007) identifies "historical inertia" as the highest hurdle for design-build.

Numerous professionals express the need to "retool" in deconstructing misaligned routines. Molenaar and Saller (2003) identify additional training in design-build to focus on

procedural skills, such as cost estimating, which are not vastly different than when used in design-bid-build. Notably different is the underlying conceptual knowledge to support these procedural skills that, when applied in practice, enhance one's abilities, as suggested in Bloom's original Taxonomy (Bloom et al. 1986), in which "skills + knowledge = abilities." The skills in properly implementing design-build are immutably linked to conceptual knowledge specific to design-build. The results of this linkage are new routines grounded in this theoretical design-build knowledge. Beard et al. (2001) reflect this construct in their comment that design-build is a concept, not merely a method.

Given the importance of efficiency and immediate action in project delivery, a high level of conceptual knowledge is relevant for two reasons. First, conceptual knowledge provides practitioners with theory and an understanding of why things are done as they are. Second, conceptual knowledge offers practitioners a way of organizing their experiences, allowing them to be generalized, and providing an understanding of why certain decisions are required, allowing practitioners to tailor approaches to project needs.

This research provides foundational knowledge about the design-build process by answering the question: "What are the key characteristics of design-build that when linked form its conceptual knowledge base?" The two principal objectives in developing this core conceptual knowledge are to provide a general perspective on how design-build differs from design-bid-build and to focus on characteristics that allow the design-build process to accommodate specific project needs. Once developed, the conceptual knowledge is applied to design-build procedures with two principal objectives, to confirm its value by showing its applicability to current design-build procedures and demonstrate the framework to understand them fully.

Chapter 2 contains two literature reviews. The first includes two parts, part one offers foundational design-build literature on the process, its history, legal background, and current challenges, and part two provides a state-of-the-practice review. In part one, design-build is described as combining design with construction in an iterative, collaborative process (Elvin 1998). It is historically grounded in the concept of a "master builder" with a complete range of design and construction knowledge and responsibility. This approach was replaced by design-bid-build due to three influences: increases in technological and project complexity which led participants to organize by functional specialization, shifts in the established legal status of design and construction in the 1800s, and an attempt to prevent corruption in public construction during the 1800s and early 1900s. The re-emergence of design-build is driven by owners' dissatisfaction with design-bid-build in meeting demands for higher quality while providing innovative and cost-effective designs with less risk, less litigation, and faster schedules. To achieve these goals, owners desired more participant interaction and a more cooperative environment for better communication and knowledge sharing. In addition to design-build, other options were seen as viable alternative delivery methods such as partnering, construction manager at-risk, design-build-operate-maintain, and the firm. Challenges to using these options include an industry resistant to change and inflexible existing public procurement laws.

In part two, a state-of-the-practice review of design-build is conducted. Included in that review are design-build manuals developed by state DOTs that offer procedural guidance from initial project development through implementation and consensus works of researchers who developed guidebooks for NCHRP that provide procedural guidance for project aspects, such as procurement, ATC, and contract administration.

The second literature review deals with “relational contracts.” This review is presented out-of-chronological research sequence to benefit the reader with the existing literature that is separate from advances made during this research. It provides knowledge concerning relational contract theory as it applies to construction, offers confirmation validating this research, provides connections made by other researchers, and allows the present work to be seen in the context of those earlier works. In this second section, relational contract theory is described as being introduced by Macaulay (1963) in his empirical work on non-contractual business relationships and later labeled and conceptually developed by MacNeil (1974a, 1974b, 1975, 1978, 1980a, 1980b, 1981, 1983, 2001) in his extensive publications on the subject. McInnis (2000) makes the first link between relational contracts and construction, indicating that the legal concept of relational contracting is present in various guises within the construction industry. Other researchers also link construction techniques to relational contracts. This reviewed literature is categorized into four topic areas: boundaries, actors, planning, and time, similar to the research findings.

Chapter 3 lays out the research methodology that employs a process of sequential triangulation combining theory building with theory testing using three coordinated methods: Delphi, Grounded Theory, and Case Study. The Delphi methodology provides an empirical dataset on Design-Build that was inductively coded using Grounded Theory in building the theory. Grounded Theory continued to be used along with the Case Study dataset to refine and validate the developed theory using these triangulated methods. Triangulation was followed by applying the theory to current design-build procedures to confirm its contemporary industrial relevance.

Chapter 4 discusses the Delphi results as the research genesis. The Delphi panel, comprised of leading design-build professionals, collectively proposed 50 critical factors as fundamental design-build principles. Each critical factor was analyzed and placed into seven categories based on similarities: Right Team, Stakeholders, Expectations, Shared Understanding of Scope, Reliance on Something, Reliance on Someone, and Power.

The researcher next conducted a literature review using the Grounded Theory approach, searching for a central theme unifying these seven categories. This literature search began with partnering, a process based on cooperation like design-build. Crowley and Karim (1995) represent partnering organizations using boundaries to characterize the interactions between project participants. Boundaries (Brown 1983) led to the literature on organizational structures and design (Ranson et al. 1980). The literature on inter-organizational structures in business (Gadde et al. 2003) led to the work of Williamson (1975, 1979, and 1985), focusing on two organizing structures: a market of discrete transactions with limited party interaction and a hierarchy of vertical integration within a firm. Williamson also references Macaulay (1963) and MacNeil (1974a, 1978, and 1981) for "relational contracts," which are positioned between the market and hierarchy.

Professor MacNeil (1978) locates contracts on a spectrum from discrete to relational, which extends to the firm at the far relational end, although MacNeil does not push that far. A discrete contract occurs between parties having little or no interaction, merely a transaction, while a relational contract happens between parties having extensive interaction. MacNeil's work on discrete and relational contracts not only parallels design-bid-build and design-build but provides a classifying framework for many of the concerns of the Delphi panel.

Relational contract theory provides the central category able to enfold the seven Delphi categories into MacNeil's (1974a, 1980a) twelve enumerated characteristics of relational contracts that differentiate discrete and relational contracts. These 12 characteristics provide a comprehensive Design-Build theory extending beyond what the Delphi panel expressed in their comments. Moreover, while MacNeil identifies these characteristics and provides basic information about each, additional literature was needed to define and develop each concept fully. This grounding of the theory in literature is presented in Chapter 5 as selective coding continues integrating and validating the data and theory.

Chapter 5 presents the triangulation results, refining and validating the theoretical framework by using MacNeil's twelve factors as the starting point for the grounded theory presentation of Design-Build. After using MacNeil's work in defining each factor, these factors are supported using the Delphi panel data and further developed and expanded using supplemental literature. Next, the factors are described within a construction context and synthesized into a conceptual framework for application. Following this work, the factors are used to provide a sound understanding of events occurring on case study projects and finally used within a conceptual framework to address the Delphi panel's initial concerns. The initial thirteen MacNeil factors are consolidated by combining two factors; the remaining twelve were organized and presented in four categories: boundaries, actors, time, and planning.

7.1.1 Boundaries

MacNeil's contractual spectrum is examined in terms of the boundaries that separate and define participants, noting what occurs inside and outside the boundaries and observing how interaction happens across them. Three MacNeil factors are included in this section: "Overall

Relation Type" and the combined discussion of two factors, "Basic Sources of Socioeconomic Support" and "Sources of Contractual Solidarity."

7.1.1.1 Overall Relation Type

"Overall Relation Type" characterizes the nature of participant relationships defined by MacNeil (1974a) using three parameters: personal involvement, communication types, and satisfaction. A discrete transaction involves a person only to the degree necessary to complete the exchange, communication is limited and formal, and the principal source of satisfaction is economic. Alternatively, a relational contract involves the whole person with participants engaging on a more personal level, communication is extensive and informal, and satisfaction is both social and economic.

Only shadow references exist in the Delphi data, where one might infer from a comment like "pick the right team" a consideration of the individual qualities and synergistic interactions that are significant for design-build success. Also, comments like "it is important to have meetings at the jobsite when the location of the design team is separate from the construction team" suggest the need for deeper participant involvement, enriched in-person communication, and the shared satisfaction associated with jointly building a constructed facility.

"Overall Relation Type" was expanded with literature to describe relationships using three components: boundaries, boundary objects, and boundary spanners. Boundaries separate and divide, making interactions challenging at the boundary interfaces and facilitated by using boundary objects and spanners. Boundary objects and boundary spanner roles are influenced by the nature of boundaries which can be either flexible or rigid regarding the ease of repositioning, as well as permeable or impermeable regarding the flow of communication and resources. Boundary objects take many forms, such as a contract or an industry norm, and can be concrete

and static or dynamic and evolving. These objects are operated by boundary spanners requiring specific skills, abilities, and characteristics.

The conceptual framework is illustrated using case study examples. With completion time a significant concern on one project, an owner developed a boundary object solution—complete plans for long-lead items to reduce idle time—and a boundary-spanning solution—"over-the-shoulder" reviews for efficient design approvals. Both solutions accomplished a similar temporal objective but had different impacts on the overall relationship. In the first instance, little participant involvement and communication were needed, while extensive participation and communication were necessary for the second. On another project, the end product did not meet the owner's desires due to misaligned expectations associated with flexible scope and reliance on design codes as a boundary object complicated by the owner's organizational boundary no longer including the designer as his agent.

The characteristic of Overall Relation Type was validated using two Delphi comments, "provide a detailed scope" and provide "flexibility" in the scope. Although initially seeming contradictory, these comments refer to different boundary object descriptions and, in turn, different overall relations. A detailed scope is associated with contracts close to the discrete end of the spectrum. However, it can also be used for parts of relationships in which minimal involvement and little communication are required. In these cases, boundaries are less permeable and require greater reliance on a complete boundary object. A flexible scope requires more personal involvement and communication. It is seen when organizations have permeable boundaries that rely more on boundary spanning and additional boundary objects like industry norms and codes to supplement the incomplete scope.

7.1.1.2 Sources of Contractual Solidarity

"Basic Sources of Socioeconomic Support" was identified in MacNeil's initial work but later removed when "Sources of Contractual Solidarity" appeared. Each factor addresses the same concept but from slightly different perspectives. The initial perspective focuses more broadly on society's supporting mechanisms for exchange and the latter more specifically on solidarity and contractual support. Contractual solidarity for discrete contracts is a function of the "social matrix," which is society and the other sources outside the transaction providing moral, legal, social, and economic support for exchanges. While in addition to the social matrix and its socioeconomic reinforcement, relational contracts generate contractual solidarity from a complex web of interdependence from social relationships that exerts aspects of exchange governance.

Delphi panelists did not speak directly to "Basic Sources of Socioeconomic Support" or "Sources of Contractual Solidarity," but their comments validate the importance. For instance, "provide a detailed scope" and "language should be specific" are elements of scope definition often associated with legal aspects of external socioeconomic support; "trust between the owner and design-builder" and "pick the right team" reflect internal relational solidarity.

Basic Sources of Socioeconomic Support/Sources of Contractual Solidarity is further defined using literature and then consolidated into a conceptual framework describing solidarity as external contractual and internal social solidarity. Contractual solidarity comes primarily from socioeconomic sources of support outside the exchange boundary, while social solidarity comes from relational sources inside the boundary. The relative prominence of the two varies with location along the contractual spectrum. Support is primarily external in discrete transactions, with a meticulously crafted contract receiving legal support from the courts and economic support from the market, facilitating the exchange of products and services at specified prices.

Support is primarily internal in relational transactions, with the same external support as in discrete transactions moved to the background. Support instead comes primarily from the relationship and is fostered through planned procedures and specified rights and obligations during execution. Building codes, industrial norms, and professional obligations of certain participants are also sources of support for the relationship.

Case studies illustrate these sources in both project successes and failures. One project succeeded after careful planning provided the expected and necessary external support for the specified plans and the internal support for the relationship. Two projects failed due to inadequate support. In one case, an owner expected an internally supportive relationship but failed to plan for it properly. When an unexpected event occurred, external support was necessary from a contractual designated Dispute Review Board. Another owner provided design flexibility but failed to support the maintenance objective, which led to an unsatisfactory result.

Two Delphi concerns were addressed using the framework. One concern was to "provide the design-build team flexibility," and another said in part, "owners should let go of the controls and provide the design-build team flexibility." For owners, the relinquishing of control seems to be an overarching concern. However, owners can provide the desired flexibility while safeguarding project objectives by properly engaging sources of support for both contractual and relational solidarity. External legal support from courts and arbitrators remains available for relational contracts with incomplete scopes. In this case, the outside source must fill the gaps in the incomplete contract using sources such as codes and industrial norms rather than applying the specified requirements of a complete contract as in discrete contracts. Supporting this process of external gap-filling requires stated project objectives and a minimum scope reflecting information that serves as the basis of the bargain, thus allowing the parties to reach a "shared

understanding" of the agreement and the ability for an outside entity to infer one. Internal support can also be fostered, with the parties agreeing to cooperate throughout the effort. If desired, the owner can establish his right to remain involved during delivery through procedures such as "over-the-shoulder" reviews. Also, the design-build teams can foster relationships by providing team-building activities.

7.1.2 Actors

This section focuses on the participants or actors: who they are, how and when they participate, and the attributes they possess. Three MacNeil factors are in this category: "Power, Hierarchy, and Command," "Numbers," and "Attitudes."

7.1.2.1 Power, Hierarchy, and Command

MacNeil (1974a, 1980a, 1980b, 1981) identifies two kinds of power useful in analyzing discrete and relational contracts: unilateral and bilateral power. Unilateral power can be exercised to subject another to a consequence without their consent. In a hierarchy, those in positions of authority have unilateral power to command those below them. Bilateral power arises in an exchange when two parties bargain their respective unilateral powers. In a discrete exchange of an existing item, bilateral power results in a reciprocal rearrangement of unilateral power akin to property rights. For a discrete exchange that occurs in the future by the mutual exercise of bilateral power, each party acquires new unilateral power, the seller to enforce the promise to buy goods, and the buyer to enforce the commitment to sell. In a relational contract, bilateral and unilateral power shift throughout the relationship.

"Power, hierarchy, and command" was not explicitly mentioned but is reflected in the Delphi comments. Most notably are two questions posed by a panelist: "Who typically leads the

scoping process? Owner? A/E? Design-Builder?" and "How critical are contracts being in place to the scoping process?" Both express concerns about power during the critical scoping phase.

"Power, hierarchy, and command" are concepts further developed using literature and consolidated into a conceptual framework focusing on unilateral and bilateral power. Power is control over others expressed either unilaterally or bilaterally. Unilateral power gives its holder authority like that conferred within a hierarchical structure where those in higher positions command those below them. Unilateral power is exercised not only to direct work or command action but also to make choices. Bilateral power is authority conferred through negotiations and agreement on promissory elements of a transaction. Thus, bilateral power is a derivative of those possessing unilateral power consenting to a binding exchange of rights and obligations expressed in a contract. Rights are inextricably linked to obligations in that a right for one individual creates an obligation for another. These rights may be mentioned explicitly in the contract as "specific rights" or implicitly as "residual rights."

This framework is illustrated using five case studies. The first demonstrates an owner's use of unilateral power during planning by making choices and specifying rights about time, cost, and quality. The second case highlights bilateral negotiations during the proposal phase in which the participants agree to an innovative solution for construction. The third case highlights a design-build team's unilateral power in making design choices during the performance. The fourth case illustrates the power structure of a design-build team in which the contractor is the team leader, but the engineer exercises unilateral command over public safety issues. The fifth case shows a dispute resolution hierarchical structure established by a design-build team for handling design and construction conflicts.

A Delphi panelist posed a concern about who should be in charge—owner, architect/engineer, or design-builder—implying unilateral power should be assigned to a single party while asking who might be best qualified. Ultimately, the exercise of power fluctuates between unilateral and bilateral throughout most any project based on the owner's early choices that influence the organizational structure and, as a result, the power dynamic and the parties' rights and obligations. For sequential processes of a discrete project, unilateral power shifts between participants as their phases or tasks are undertaken. For the overlapping phases of a relationship, bilateral power is more pronounced when joint decisions are collaboratively made. However, unilateral power also has its place at certain times during the project.

7.1.2.2 Numbers

The "Numbers" factor suggests that some contracts involve only two parties while others involve many participants, as seen during the bargaining stage. A discrete contract involves a simple two-party transaction defined by an offer and acceptance; a relational contract involves numerous participants whose interests must align in the contract agreement (MacNeil 1974a, 1980a).

The concept of "Numbers" runs throughout the Delphi comments in categories of the Right Team, Stakeholders, Reliance on Someone, and Power. Recognizing the need for a large number of participants, the "right team" implies a collective that consists not only of participants interacting well with others but also Stakeholders whose voices are essential for the project. Interaction of more participants requires "technical competence of the designers and builders" and "trust between the owner and design-builder," which are aspects of Reliance on Someone. The panel expresses concerns about "who should lead the scoping process? Owner? A/E? Design-builder?" and "if there is a sub-consultant designer, the sub-consultant should report only

to the prime design consultant and not the design-build contractor," which seems to reflect the many people involved in relationships.

MacNeil's view of "Numbers" was further informed using "network" literature. Podolny and Page (1998) describe every organizational form as a network varying only by how participants are arranged and connected. A network is a collection of points often referred to as vertices, nodes, or actors connected by edges, links, or ties. These nodes can be viewed at different levels of hierarchical abstraction up to a level where a single cluster may contain all individuals within its boundaries (Everitt 1974).

The conceptual framework uses the network concepts of nodes, links, and boundaries to shed light on how the numbers of participants are identified, linked, and partitioned within different contractual arrangements. Nodes represent individual participants or clustered groups in a zoomed or unzoomed state. Links connect nodes and have a variety of attributes. They can be weak or strong, one-way or two-way, short or long, active or inactive. Furthermore, links reflect different types of connections: such as depicting tasks, communication, and contracted exchanges. Boundaries collect nodes while exhibiting attributes that influence the grouping. Boundaries can be thick or thin, permeable or impermeable, rigid or flexible. In a discrete transaction, participants are represented by nodes with thick, impermeable boundaries connected by a link reflecting either an instantaneous exchange of a good/service or a contract projecting the exchange into the future. In a discrete transaction, these networks are often viewed in an unzoomed state where the many involved participants are abstracted to the two parties directly involved in the exchange. The connection between the parties is a short-lived relationship with bilateral communications that are often specific and formal.

In a relational transaction, actors are represented by nodes within thin, permeable boundaries connected by links representing an enduring relationship and informal communication. They are often viewed in a zoomed state detailing the network groups, subgroups, and individuals interacting within a cooperative, collaborative environment shown by multiple connections between nodes. Some connections at lower levels of the organizations may be project-based, while higher-level connections tend to be long-term.

Three case study projects are used to highlight networks. Two networks are extended in response to unique project situations. In one instance, the network extension was to develop and strengthen relationships within a core constituency, and in another, to include representatives from a critical stakeholder group. A third network withstands the replacement of a participant node during the performance in which there were significant changes at the highest levels of the network while having little impact at the lower working levels.

The conceptual framework of networks provides clarity to a Delphi panelist's suggestion that "a subconsultant designer should report to only the prime designer not to the design-build contractor." In a network, the design-build contractor and prime designer are represented by two nodes grouped within the single boundary of the design-build team and linked by a contract and two-way interaction. Add to this network the node representing the subconsultant designers grouped with the prime designer by introducing a thick, impermeable boundary with linkages to the designer by a contract and two-way communication. There is no link between the subconsultant designer and the design-build contractor. In an alternative option, the design-builder and subconsultant designer are directly connected. The boundaries remain around the design-builder and prime designer, defining them as the main design-build participants, and a permeable boundary around the prime designer and sub-designer, defining them as members of

the design team. There would be a link between the design-builder and sub-designer signifying communication, but not control.

7.1.2.3 Attitudes

"Attitudes" are described by MacNeil (1980a) as one of the most critical behavioral aspects of contracts. Four attitudes are identified as necessary: (1) awareness of conflict of interest, (2) unity, (3) time, and (4) trouble. Awareness of conflicts of interest is high in discrete transactions with complete measurement and planning and a sharp division of benefits and burdens. In contrast, awareness is low in relationships with incomplete obligations and planning and shared benefits and burdens. Discrete transactions have no sense of unity, while parties in relationships agree to cooperate. Participants' approach to time in discrete transactions is to bring the future and everything related to it into the immediate present. In relational contracts, it is to leave the future where it is, dealing with it as it occurs. Theoretically, a discrete contract cannot get into trouble because all conceivable contingencies are planned and considered; however, in relational contracts, "trouble" is expected and will be dealt with collaboratively.

The Delphi panel does not explicitly mention any of the four "Attitudes," but some critical factors reflect shadows of these concerns. For example, the panelist suggesting the importance of the "right team" did not elaborate on its meaning, but these findings shed light on the essential aspects of the right team.

The four "Attitudes" were addressed using supplemental literature. "Awareness of Conflict of Interest" relates to the prevalence of self-interests. Behavior at the discrete end is self-serving, with both parties seeking to maximize their exchange outcomes. At the relational end, participants focus on group interests transforming conflicts of interest through cooperation and unity (Davis 1995; Leblebici 1985; Dwyer et al. 1987).

As the literature suggests, “unity” is the presence of altruism, reciprocity, cooperation, and trust, along with the absence of opportunism. “Altruism” is an action benefiting another individual without anticipation of reward. “Reciprocity” is an action followed by a reaction, for instance, giving and receiving. “Cooperation” is a joint action for a common purpose. “Trust” is confidence in another individual. “Opportunism” is an action motivated by self-interest, the lack of which is essential for unity.

“Time” is the third element of Attitudes and is addressed using five concepts. First, presentiating and futurizing pertain to moving time. “Presentiation” involves bringing the future into the present and planning for it as if it were present, while “futurizing” leaves the future where it is (MacNeil 1974a). Second, horizontal and vertical time deal with our relationships to time (Halinen and Törnroos 1995). “Horizontal time” consists of the past, present, and future, described more specifically as far past, near past, present, near future, and far future (Medlin 2004; Winston 1982). “Vertical time” consists of actors who relate to and perceive time differently based on function, organizational structure, and culture. Third, the time concept of sequence, synchronization, and rate relate to temporal ordering and action (Hassard 1991). “Sequence” requires actions that follow one another in a set order. “Synchronization” allows temporal coordination among parts or activities. “Rate” refers to the pace of activity. Fourth, private and public time pertain to actor accessibility. During “private time,” actors are socially inaccessible to other actors, while during “public time,” actors are accessible (Zerubavel 1979). Fifth, conversion and flow pertain to production (Koskela 1992). “Conversion” focuses on making activities more efficient. “Flow” focuses on reducing or eliminating non-value-added activities that take time, resources, and space.

"Trouble" is the fourth element and is a problem requiring action. The action can be pre-planned, or trouble can be dealt with as it presents itself (MacNeil 1974a, 1980a). Trouble can change into conflict in which a series of conflicts over time can lead to "conflict aftermath" straining the relationship or "conflict escalation" in which a buildup of tension eventually leads to the relationship's demise (Pondy 1967; Anstey 1999).

The conceptual framework addresses the four "Attitudes" individually and collectively by placing them into two categories. One category reflects the opportunities to manifest attitudes, which include "time" and "trouble." The other represents the attitudes captured in the response, which include "self-interest" and "unity." Time and trouble are both time-related elements differing in scale. "Time" is an expansive notion existing in the background of all actions but often goes unnoticed until some event or trouble provides focus on a moment. "Trouble" exists in a narrowly focused segment of time. "Self-interest" and "unity" are two attitudes that can be manifested over time or when trouble occurs. These attitudes differ in motivation and are considered opposites if placed on a continuum.

Case study examples highlight the four attitudes. Participants' perspectives, when synchronized, can result in time-related benefits of conversion and flow, as seen in two projects. Trouble allows participants to exhibit unity as seen on one project or self-interests as seen on another. Synchronization is an aspect of relational contracts reducing the private time of some participants. Two owners created more private time for the designers. One owner completed a large amount of design before making the project public. Another extended the proposal phase with two rounds of reviews.

Everyday actions needed to specify an incomplete contract or deal with unexpected actions to resolve trouble create the need for the "right team," as noted by a Delphi panelist.

Characteristics of the right team are illustrated using the perspective of the conceptual framework developed for Attitudes. First, the "right team" has the "right" actors. These principal project participants act for themselves and other stakeholders while focusing on group interests. Second, the "right team" is composed of actors well-suited for the environment in which they operate, which can involve sequential and synchronized phases and individual and collective actions. There is an expectation that during "private time," when no one else is present for decision-making, the "right" actor considers not only his self-interests but also the interests of the others in the collective and makes the best choice considering immediate and downstream consequences. During "public time" with the whole collective present, the "right" actor can voice his self-interests with the opportunity to negotiate and bargain in reaching an optimal solution based on present and future consequences of the action, which may involve altruism in some cases with the cooperative expectation of reciprocity in others. Third and finally, the "right team" has the "right" attitude that is stabilized through unity between the two ends of the attitudinal spectrum—self-interest and altruism. Opportunities for unity occur when unexpected events arise, and participants are forced to adjust. The "right team" can adapt between the time trouble is realized and its resolution with an attitude of unity.

7.1.3 Time

There are noteworthy points throughout a project concerning time, such as when participants become involved, when contracts are entered, and when products are delivered. These times can vary, with choices impacting when they occur. This section addresses two MacNeil factors: "Commencement, Duration and Termination" and "Transferability."

7.1.3.1 Commencement, Duration and Termination

"Commencement, Duration and Termination" describe discrete transactions as having "sharp in, sharp out" timing; they start sharply, end sharply, and are short-lived (MacNeil 1974a, 1980a, 1981). This sharpness of discrete transactions pertains to both the commencement and termination of an individual's participation in the transaction. Relationships tend to have "fuzzy in, fuzzy out" timing with no sharp beginning or ending and a tendency for long durations. While the current agreement in these relationships may have a distinct beginning, there is often a preexisting relationship between the participants.

The Delphi panel does not speak directly about commencement, duration, or termination, although expressed concerns can be linked to these ideas. For instance, one panelist asks, "how critical are contracts being in place to the scoping process?" Contracts mark the point of consent, and how soon this occurs during scoping impacts the sharpness of the "in." A "detailed scope" suggested by another panelist results in a sharper "in" for the design-build team, while scope "flexibility," which is preferred by another, creates a fuzzier beginning. Another question a panelist poses is, "who should lead the scoping process? Owner? A/E? Design-builder?." This question/concern deals with the temporal boundary placement of the project phases and their involved participants. Another panelist suggests "long-term maintenance, if required, should be well scoped," which impacts project termination and the duration of involvement for the design-build team.

"Commencement, duration and termination" was expanded with supplemental literature and described as moments and segments of time that temporal boundaries can capture. The location and expression of temporal boundaries contribute to our understanding of organizational

life. At the temporal boundary, relationships separate and connect, and the social structures of differentiation and integration emerge (Diamond et al. 2004).

"Commencement, duration and termination" was described in the conceptual framework as temporal elements defining a project or activity's beginning, length, and end. MacNeil (1974a, 1980a) refers to commencement as the "in" and termination as the "out" with modifying descriptors of either "fuzzy" or "sharp." Temporal boundaries indicate functional and temporal differentiation and integration, describing what is occurring during moments that can be defined as fuzzy or sharp.

Three projects were used to illustrate these concepts. Participants' "outs" can impact their perspectives and decision-making, as seen with designers and contractors on two projects. A third project highlights an owner that provides flexibility while protecting himself from potential negative impacts of decisions through an option to extend the temporal boundary of the design-build team into the maintenance period, thereby creating a fuzzier "out."

This conceptual framework addresses a Delphi panelist's concern that there be a "shared understanding of scope," which is often easier to achieve for a discrete contract than a relational one. With a discrete contract, a complete scope is defined by the owner and designer during the design phase creating a "sharp in" for the contractor at commencement. This "shared understanding of scope" is typically more difficult for relational contracts because the scope is incomplete when entering the contract. Two possible approaches to achieving a shared understanding within a relational contract are to focus on the scope or the relationship. Focusing on the scope could have the owner creating a nearly complete scope, much like a discrete contract establishing a "sharp in" for the design-build team. Other owners wanting to provide an opportunity for the design-build team to capture the benefits of temporal integration of the design

may choose to have a large amount of the scope initially submitted in the proposal or to conduct iterative rounds of proposal reviews. As more design is completed before award, a sharper "in" is created for contract commencement.

The second approach to achieving a shared understanding focuses on the relationship. In place of a complete design, clarity in the contract is based on a scope that either specifies an outcome or specifies procedures. The owner focuses on performance specifications to describe the desired product when the outcome is specified. While the delivery phase may be largely undefined, the project termination is marked by a result that meets the specified outcome. When procedures are defined, the owner specifies what must be done to reach a result by focusing on the project function. When followed during delivery, these processes should produce a product acceptable to the owner, creating a "sharper out" for performance.

7.1.3.2 Transferability

Discrete and relational contracts have factors that facilitate and inhibit natural tendencies toward "transferability" (MacNeil 1974a, 1980a). With discrete transactions, nothing inhibits the transfer of either rights or obligations except for the ultimate responsibility for performing. Ease of transfer is facilitated by non-primary relations and careful measurement, along with other characteristics like the completeness and specificity of planning and the absence of sharing of benefits and burdens, which creates little need for future cooperation. Relational contracts have many characteristics which work against simple transferability. Primary whole-person relations depend heavily on the others involved; there is a lack of measurability of content, requiring trust and future cooperation in planning. Furthermore, relationships involve sharing benefits and burdens while existing within a "social matrix" much more complex than discrete contracts.

Transferability was not a topic addressed explicitly by the Delphi panel, but because the research initially focused on scope, all the comments were associated with some aspect of transfer. For instance, Delphi panelists unanimously agree that a "shared understanding of scope" is one of the most critical elements of the project. However, panelists differ in how the scope should be defined. Some panelists desire a "detailed" scope which results in a more discrete exchange which MacNeil notes as easier to transfer. In contrast, others believe that scope should have "flexibility," fostering a relationship that makes transfer inherently more challenging.

Other Delphi comments reflect on the transfer points for a design-build project, such as when an owner solicits project proposals. One panelist suggests proposals should "include soil surveys" while another says it is essential to "provide a clear understanding of what information can be relied on by the design-builder." Another of these transfer points is when the design-build team is selected; they should be the "right team" considering cost along with additional factors such as the "trust between the owner and design-builder," the "technical competence of the designers and builders," and having "evaluators [who] are competent, unbiased and knowledgeable of the project's needs."

Supplemental literature and the conceptual framework organize using three major transfer points important to construction: transfer to the market, transfer for performance, and transfer for use. In "transfer to the market," the owner defines the scope similarly to either property or contract law. Property contracts are to be well-defined, like discrete contracts that are precisely planned. Contract law allows parties to design their agreement as they desire, like relational contracts that vary in form, often leaving aspects initially undefined. The defined selection criteria to be used can either be a single criterion, such as low price, or multiple criteria reflecting the value systems of the owner and stakeholders.

"Transfer for performance" occurs at contract award, with the selected party acquiring the specified rights while beginning the delivery process. The builder either determines the means and methods for performing the work defined in the complete scope, or if performance was made flexible through an incomplete scope, the parties work together to complete the design and construct the facility.

"Transfer for use" returns the project to the owner with full rights and responsibilities in the completed facility. Although in some instances, the delivery team continues their involvement in operation and maintenance due to an owner's choice or perhaps because of an owner's fear of spillover costs resulting from short-sighted decisions made during performance.

Several case study projects were used to illustrate transferability. One project highlighted deliberate owner choices before the transfer to the market to ensure the end product would meet the department's needs. During planning for "transfer to the market," the owner chose to complete some parts of the scope while leaving others flexible while reserving the right for multiple rounds of proposal reviews, retaining certain rights during the performance, and protecting himself from externalities by the option of purchasing an extended warranty. Other projects highlight difficulties associated with particular transfers. In two instances, owner-supplied data in transferring to the market proved insufficient during the performance. In one of these instances, there was a simple, amicable resolution; in the other, the resolution was difficult and damaged the relationship. In the final case study, the owner inadequately described the desired product during "transfer to the market" for it to be achieved in the "transfer for use."

The conceptual framework was used in addressing the concerns about "shared understanding of scope" during the multiple transfers of a project. Some Delphi panelists suggest providing a "detailed scope," which allows a shared understanding to be easily achieved using a

single criterion, low cost, as the mechanism for selection when transferring to the market. The low-price contractor is deemed the "right" contractor and produces the described product during the performance, transferring it to the owner for use. As more "flexibility" is provided during transfer to the market, the owner must consider two subsequent transfers during the pre-proposal phase. The owner may choose to describe the desired outcome using performance specifications or by specifying procedures with prescriptive specifications serving as the basis for shared promises, reflecting the shared understanding of what is to be achieved. The owner may also choose a remedy or warranty as part of the scoping agreement.

7.1.4 Planning

Planning prepares for action and can vary based on the amount and type of planning. This section places five MacNeil factors into two categories; one provides characteristics of the plan: "Planning," "Future Cooperation," and "Measurement and Specificity;" and the other provides elements of the plan: "Obligations" and "Benefits and Burdens."

7.1.4.1 Planning

"Planning" for discrete and relational contracts is described using six factors: substance-process, completeness-specificity, tacit assumptions, participation, post-commencement planning, and bindingness (MacNeil 1974a, 1980a, 1981). The focus in planning for discrete contracts is on the substance of the exchange, while the focus for relational contracts is on the processes of relationships. Discrete contracts are complete and specific, while relational contracts are intentionally incomplete and non-specific. Planning for discrete contracts leaves no room for tacit assumptions, while assumptions are relied on as an element of planning for relational contracts. Discrete contract planning is unilateral, requiring no post-commencement planning, while relational contracts require joint effort and mutual participation. Finally, discrete

contracts are intended to be completely binding, while relational contracts are non-binding, with parts tentatively planned and subject to change throughout the relationship.

The Delphi panelists unanimously agreed on the importance of "Shared Understanding of Scope" but differed on how to achieve it. Some say, "cover all desired work requirements," while others suggest "the owner should let go of the controls and allow the design-build team the flexibility to provide their best and most innovative product." Delphi's concerns seem focused on whether planning will result in a detailed or flexible scope. These concerns are directly linked to the completeness and specificity of planning. The five other attributes identified by MacNeil were not directly addressed but inferred in the comments. "Meetings at the jobsite when the location of the design team is separate from the construction team" are procedures for post-commencement planning. "Long-term maintenance, if required, should be well-scoped," thus eliminating the need for tacit assumptions about maintenance. "Specify expectations for the level of design drawings for the tender offer" reflect mutual participation in pre-commencement planning. Moreover, the question "who typically leads the scoping process? Owner? A/E? Design-Builder?" addresses the organizational structure during pre- and post-commencement planning. Another Delphi comment, "the design-build firm should have the flexibility to modify the preliminary design…" indicates the scope should not be binding.

"Planning" was expanded with supplemental literature in two areas: presentiating and futurizing. The goal of parties planning a discrete contract is to "presentiate" by bringing all the future into the present, where it is arranged to provide 100 percent complete and binding planning (MacNeil 1974a, 1974b, 1980a). Presentiation yields a "four-corners" agreement (Wessel 2004) in which the object of the exchange and all rights and obligations are completely specified in the contract, with planning for all foreseeable circumstances and specified

procedures prepared for any potentially unforeseen events. Alternatively, planning a relational contract that is "futurized" (MacNeil 1974a, 1980a) can best be described as planning a constitution (Goldberg 1976; Hadfield 1990; Gifford 1991; and Vanberg 1994). Rights and procedures are established to guide the future while waiting for it to occur.

Planning is described in the conceptual framework as leading to either a "presentiated" or "futurized" contract or some combination of the two defined by the abovementioned factors. A "presentiated" contract contains a complete scope detailing the object to be exchanged and any conceivable aspects of the interaction between the parties. In these contracts, rights and obligations are clearly defined, and solutions are scripted for any anticipated trouble. There are no expectations beyond what is specified, so tacit assumptions play no part in the transaction. The completeness of the pre-commencement planning makes post-commencement planning unnecessary. Once agreed on, the terms of the contract are binding for both parties, which serve to guide their actions in the future.

A "futurized" contract contains an incomplete scope which will be jointly completed in post-commencement planning. The contract can vary in specificity, often resembling a constitution by specifying rights and procedures for how the relationship will be conducted. The incompleteness creates reliance on tacit assumptions resulting in conditions being subject to change with circumstances, thus limiting bindingness other than the ultimate commitment to the relationship.

Several case study projects illustrate this conceptual framework. For example, during initial planning on one project, the owner differentiated between presentiating some parts and futurizing others. The presentiated portions exhibited attributes associated with discrete planning, with the owner developing complete plans through unilateral planning, focusing on the exchange

object. For futurized portions of the project, the owner specified the rights and processes for the relationship reflecting a "relational constitution" structuring and facilitating mutual participation in post-commencement planning. On another project, the owner transferred responsibility for permit modification and compliance to the design-build team but specified procedures highlighting the processes aspect of the "substance-process." Another project had a high level of the design completed by the owner reflecting "completeness-specificity," which is commonly associated with presentiated contracts. Portions of another project were futurized by relying on "tacit assumptions" and "post-commencement planning," however the owner's expectations ultimately did not align with the design-build team. Another project highlighted the mutual "participation" and "post-commencement planning" required for futurized contracts, along with difficulties experienced due to organizational structure. The reconfigured design of the design-build team highlighted the flexibility in the "bindingness" of preliminary designs.

A Delphi panelist suggests using performance specifications for design-build, which answers a broader relational question: "How might an owner plan a project to receive the desired product?" Using performance specifications is one option; however, other options exist besides a futurized contract. These include presentiating parts initially, requiring parts presentiated before commencing the contract, and futurizing parts. The owner can specify parts he wants to be completed in a certain way. Other parts can remain flexible for design, although the owner wishing to retain approval authority can make it part of the proposal submission and review process before contract formation. Parts the owner is willing to leave flexible after the contract commences can be planned by the design-build team following procedures specified by the owner.

The owner makes these choices before issuing the RFP, resulting in planning occurring in different ways and by different participants. Before the RFP, the owner is the sole participant determining how to plan the project, with some parts complete and specific, others requiring mutual participation during the proposal phase, and others requiring post-commencement planning. The time immediately after the RFP is a time of mutual participation through negotiations culminating in a binding agreement for those parts that are complete and specific and for processes for those that are not. After the contract is awarded, some parts will be completed as already planned, while others will require post-commencement planning that depends on processes previously established by the owner.

7.1.4.2 Future Cooperation

"Future cooperation" is required in discrete contracts during the performance and in relational contracts for both post-commencement planning and performance (MacNeil 1974a, 1980a, 1981). A discrete exchange is a highly structured transaction in which every aspect of the future exchange is presentiated in the contract. Cooperation is required only to adjust the original plan if needed. A relational exchange that uses an incomplete contract depends on trust, established norms of practice, and compromise during the performance requiring additional post-commencement planning. Cooperation varies from implementing structured procedures specified in the contract to unstructured negotiations within the relationship.

"Future Cooperation" is reflected in many Delphi comments. A panelist suggests providing a "detailed scope" that requires less cooperation in future planning than would a scope where the "owner let[s] go of the controls," as also suggested. One panelist recommends, without elaboration, "pick the right team," which one might assume would mean having the skills and abilities to collaborate and cooperate.

The topic of "future cooperation" is supplemented using literature that addresses differences in the nature and extent of cooperation needed for pre- and post-commencement planning in an exchange environment using a theoretical model. The "Prisoner's Dilemma" (e.g., Axelrod 1984; Rappaport and Chammah 1965) and "Iterative Prisoner's Dilemma" (Wessel 2004) model cooperation and its potential outcomes in a competitive exchange environment where players choose to either compete or cooperate using various strategies. Additionally, unbalanced power and unresolved problems may lead to conflict that can quickly shift cooperation into a competition that must be managed within the relationship or resolved with procedures planned into contracts (Tjosvold and Johnson 1983).

The conceptual framework describes cooperation as achieved through planned procedures or within relationships. Planned procedures foster cooperation in which parties execute the stipulated procedures when unplanned events occur. Relationships encourage cooperation through trust, industry norms, give-and-take, and good faith.

Two case study projects highlight the need for "future cooperation" in relationships. In the first example, the owner successfully facilitated cooperation by thoroughly planning certain portions of the project, limiting the need for future cooperation. Dividing risks where some require cooperation and others do not. And, planning procedures for cooperation during post-commencement planning. The design-builder encouraged cooperation by co-locating parties in a hub office and providing team-building activities.

The second project illustrates intended cooperation that dissolved into a competition over handling an unforeseen event. The owner believed these events would be handled through negotiations and cooperation within the relationship. However, the design-build team viewed the contract as including the Dispute Review Board procedure for such occurrences. The parties

could not restore cooperation after this initial conflict, and the self-interest element of competition emerged.

This framework offers a perspective on how one might address whether a party will beneficially cooperate in completing an incomplete contract and the expectations associated with this cooperation. The Delphi panel's comment that "parties understand what is expected of them" reflects this concern. In line with the framework for a discrete contract, the defined procedures for cooperation are detailed in the contract, including procedures covering unforeseeable elements. For a relational contract, cooperation can occur in either pre- or post-commencement planning within the relationship. Pre-commencement cooperation occurs during the proposal phase with clear expectations established in the RFP that specify "expectations for the level of design drawings for [the] tender offer," as indicated by a Delphi panelist. Cooperative expectations may include procedures for how the submittal/review process will occur and providing "knowledgeable" evaluators as suggested by the Delphi panel. Flexibility during delivery requires post-commencement planning and cooperation, which presents the most significant concern for owners; however, relationships do not have to be completely unstructured. Specified procedures can plan cooperation through "job-site meetings" as recommended by a Delphi panelist or "over-the-shoulder" design reviews, as seen in a case study. Cooperation can also be left to occur organically in relationships that align with industry norms and good faith.

7.1.4.3 Measurement and Specificity

"Measurement and Specificity" (MacNeil 1980a, 1981) takes up how "exchange components" are stipulated relative to planning, measurement, and specificity. The measurement and specificity of a discrete contract are achieved with money on one side and something easily

monetized on the other in planning for a contract agreement. Much remains immeasurable and nonspecific during the initial planning of a relational contract, leaving amounts and relative values vague and obligations diffuse and unmeasured. Specificity is achieved during the actual performance, which increases the importance of relational norms like trust and reliance.

The Delphi panel addresses measurement and specificity in seemingly contradictory recommendations. On the one hand, the panel advises "provide a detailed scope" and "cover all desired work requirements," and on the other hand, suggests using "performance specifications" and warns against being "…overly prescriptive." These contradictory remarks express different planning approaches to measurement and specificity. Providing a detailed scope aligns with a discrete contract in which the deliverable and monetized value are detailed in the original agreement. Using performance specifications pertains to the relational end of the spectrum by stipulating the intended outcomes while providing flexibility in the approach.

Supplemental literature was used to expand the "measurement and specificity" concept with "boundary objects" developed during planning or performance. If fully developed during planning, a presentiated contract serves as the boundary object in which all details are made present and fixed with clear performance expectations established within the contract's "four corners" (MacNeil 1974b; Poppo and Zenger 2002). If not fully developed until the performance, the contract is futurized, leaving "…the future where it is; waiting to happen" (MacNeil 1980a), which requires the parties to rely on other implicit and explicit boundary-related objects. A futurized contract is a fluid option functioning under conditions of uncertainty by replacing the precise definition of a discrete contract with an agreement open to adaptation and change as the exchange evolves and the relationship unfolds (Salbu and Brahm 1994).

The conceptual framework reflects “measurement and specificity” as being communicated by measure, description, and performance through a boundary object expressed in either a presentiated or futurized contract. For a discrete contract, measurement and specificity occur in the boundary object developed during planning and expressed in a presentiated contract defining both sides of the bargain, the deliverable and related obligations clearly and completely defined, and the measured cost. For a relational contract, the boundary object is likely incomplete at the time of the agreement but adequate to establish both sides of the bargain. The deliverable is described in terms of performance and a monetized value or a means to arrive at it. Measurement and specificity continue during the performance and, in some instances, are not complete until the end of the process.

The conceptual framework for “Measurement and Specificity” is illustrated using five case studies. The first case study highlights the measurement and specificity occurring at different times during the project lifecycle through the utilization of various scoping methods that different participants implement. The second shows undesirable measurement and specificity results that rely on a State DOT standard without addressing supplemental expectations of the owner. The third illustrates better-than-expected results from the design-build team using a proposed reconfigured layout to meet project objectives. And, the fourth and fifth case studies highlight the difficulty during planning associated with the measurement and specificity of a boundary object when it is used to separate highly uncertain work from the overall deliverable.

The measurement and specificity reflected in the conceptual framework can bring a clarifying perspective when applied to the expressed concerns of the Delphi panel. A Delphi panelist mentions the need for a “shared understanding of scope” in the contract. This shared

understanding can be reached in different ways based primarily on how and when measurement and specificity occur, even within the same project. For a discrete contract, the shared understanding is easy; the owner defines the scope, and the contractor determines the price. For a relational contract, rather than having a shared understanding based on clearly defined tasks, the measurement and specificity occur at different times throughout the project, a mutual understanding occurring contemporaneously as issues arise, requiring trust and cooperation between the parties. For some relationships, the measurement and specificity occur during the proposal phase; for others, a futurized boundary object leaves the scope flexible with the measurement and specificity occurring during the performance period by building on contractual promises that form specified "oughts," stipulated procedures, or expressed outcomes supplemented by other implicit industrial norms while relying on a collaborative relationship.

7.1.4.4 Obligations

Obligations are legal duties requiring the action or inaction of a person in a particular situation. MacNeil (1980a) characterizes the differences in obligations along a three-pole contractual spectrum anchored by a single discrete contract pole at one end and two dissimilar relational poles at opposite ends, one a primitive contractual relationship and the other a modern relationship. MacNeil suggests that the three parameters that distinguish these obligations are sources of content, sources of obligation, and specificity. With a discrete contract, the sources of content are the parties' expressed promises, the sources of obligation are from the promise-enforcing social matrix, and the separation between the sources of content and obligation leads to its high specificity. In a primitive relationship, both the sources of content and obligation come through slowly evolving relational patterns of custom and law with only modest input from individual promises. A modern contractual relationship combines sources of content by using

both parties' promises as in discrete transactions and those that arise from the relationship as in primitive relationships; sources of obligation arise from both the relationship and the social matrix, which provides the relational structure by enforcing obligations that tend to be both specific and general.

Delphi panelists do not specifically mention obligations, but many comments reflect the obligational parameters addressed by MacNeil. Comments like "identify special project requirements" and "identify responsibility for unforeseen conditions…" refer to obligational sources of content contained in expressed promises. Other comments like "…the sub-consultant should report only to the prime design consultant…" and the question of "who typically leads the scoping process…" are sources of obligations, aspects of the relationship, and references to the social matrix that can both create and enforce obligations. The specificity of obligations tends to reflect the planning, which means comments like "provide a detailed scope" and the "scope should not be overly prescriptive" reflects how the obligations are expressed in the contract, where some panelists prefer specificity while others prefer flexibility.

Three kinds of obligations identified in the literature that are important to construction are performance, role, and constructive obligations. Each of these obligations can be better understood using MacNeil's attributes of how obligations differ in the source of content, source of obligation, and specificity. Performance obligations are duties necessary for achieving a result. The sources of content may be the contract or the relationship. The sources of obligation may be courts enforcing contractual promises or playing a surrogate role within a relationship, although relationships often serve as their own source of obligation. Specificity for performance obligations varies from specific to non-specific.

Role obligations are duties related to the functions of participants arising from expressed promises or implied norms. The source of content may be the agreement or professional standards. The source of obligation is either the contract or the social matrix from which norms and professional requirements originate. These obligations may be initially specific or become specific during the relationship.

Constructive obligations are duties filling gaps fashioned from intent and norms. The source of content may be the contract that establishes intent and expectations or the relationship through which obligations are made specific. The source of obligation is the social matrix in which certain norms and expectations become standard. Specificity occurs as these obligations are determined.

These obligations were demonstrated using case study projects. Two examples were given of performance obligations, one dealing with the timing of specificity and one with unspecified performance obligations not completed as expected. Three examples of role obligations conflicting with performance obligations, where role obligations control in one, performance obligations rule in another, and the two obligations are balanced in the third. Constructive obligations examples were specified using intent and expectations, industry standards, or third-party intervention.

The conceptual framework of the three obligations and their defining attributes brings clarifying perspective when applied to the Delphi panelist's expressed concerns, suggesting there should be a "clear allocation of responsibilities" reflecting concern about differences in the specificity in transitioning from design-bid-build to design-build. Three examples were provided. One has the owner allocating all responsibilities in a discrete contract. The source of content is the contract in which performance and role obligations are specified and easily enforced by the

courts as an external source of obligations. Second, the more relational option has the owner providing an incomplete contract relying on the role and constructive obligations to establish a baseline for performance and a means to fill the gaps. Parties assume obligations as the project progresses, with negotiations occurring within the relationship when necessary. Third, an intermediate option involves creating more fixed boundaries around participants and their activities, with the owner specifying obligations for certain project parts. The contract is a source of content for these obligations and the created relationship. In this resulting mixture of external and internal sources of obligations, specificity would vary for different parts of the same project.

7.1.4.5 Sharing and Dividing Benefits and Burdens

"Sharing and Dividing Benefits and Burdens" suggests some relations share undivided benefits and burdens while others divide them sharply, as characterized by MacNeil (1980) with "…each party has his benefits, all his, and his burdens, also all his" which parallel the use and non-use of measurement and specificity in contractual relations. In well-measured and specified discrete transactions, the contract functions to assign particular benefits and burdens to one party or the other with no sharing. In less measured and non-specified relational transactions, it is common to have shared benefits and burdens. However, it is possible to have some of the effort measured, specified, and divided between the parties (MacNeil 1974a, 1980).

Delphi panelists address sharing and dividing of burdens but use different terminology while ignoring the benefits side of the exchange. Comments such as "transfer risks to the party best able to manage the risks" and "identify potential unforeseen conditions" are examples of the recognized need to identify and allocate burdens in the effort.

The concept of "Benefits and Burdens" was expanded using supplemental literature in four topic areas: bargains, boundaries, risks, and externalities. Benefits and burdens are an aspect

of a bargain that is either solidified through the present promises of a contract or dealt with in the future of a relationship. Boundaries depict how benefits and burdens will be handled using boundary objects to communicate the assignment of benefits and burdens across these boundaries. Risks are a specific type of burden concerning the uncertainty of a future outcome. Externalities occur when benefits and the corresponding burdens are uncoupled with one component pushed or pulled over a boundary.

The developed conceptual framework casts benefits and burdens as a part of a bargained exchange that may be divided, shared, allocated, and traded, with each bargain distinguished using boundaries, boundary objects, risks, and externalities. A "divided bargain" assigns benefits, burdens, and risks to participants within well-defined boundaries using a complete boundary object that attempts to prevent externalities. A "shared bargain" deals with benefits, burdens, and risks in a relationship through negotiations among participants having permeable boundaries. Externalities may occur in a shared bargain if one participant decides on an issue without the other's involvement. An "allocated bargain" ultimately assigns benefits, burdens, and risks in the boundary object. The participants have permeable boundaries allowing them to negotiate the assignment during the proposal phase, which ideally will prevent externalities. A "traded bargain" pushes benefits, burdens, or encountered risks over a participant's boundary, compensated or not, to another participant or the environment. There are two types of traded bargains. The first occurs bilaterally and is known to the parties, with appropriate adjustments being made to the original bargain. The second occurs unilaterally in which the re-bargaining is not known by all parties as the benefits and burdens are traded uncoupled, directly impacting the end-product, other participants, or the environment.

Case study examples were used to highlight the four types of bargains. A "divided bargain" has the owner partitioning and assigning certain parts of the project to particular participants. A "shared bargain" might have the owner planning some parts of the projects while leaving others to be dealt with in the relationship. An "allocated bargain" has the proposing design-build teams offer adjustments to the owner's design solution during the proposal phase. A "traded bargain" is illustrated using a modified example of an owner's change which in one case has the design-build team spilling burdens over to the owner and, in two other cases, the owner preventing the spillovers.

The four bargains identified in the conceptual framework can bring a clarifying perspective in understanding the nature of the four risk categories associated with construction—known, unknown, contracting, and performance risks—and how these can be managed. Known risks are dealt with in a divided bargain. These risks are identified and assigned in the contract to the party who can manage them most efficiently; as a Delphi panelist suggests, "transfer risks to the party best able to manage the risks."

Unknown risks are dealt with in a shared bargain. These risks are unknown until they present during the performance and include unforeseen site conditions and unusually severe weather. Procedures for dealing with these future situations can be planned into the contract with the expectation of parties negotiating an equitable solution.

Contracting risks are associated with the flexible scope. They can be addressed in an allocated bargain by extending the proposal phase with the parties negotiating and agreeing to an acceptable solution before entering the contract. This approach may be desirable for owners who want to approve designs to ensure the end-product will ultimately meet their expectations and for

design-build teams wanting the owner's approval of an innovative design that is foundational to the bid before entering a binding agreement.

Performance risks are associated with burdens decoupled from the associated benefit and pushed elsewhere, reflective of an externality. The solution is to address potential concerns in a bilaterally traded bargain with both parties aware and agreeing to what is being traded. Alternatively, in a unilaterally traded bargain, one party is unaware that a burden has been pushed onto them. These unilaterally traded risks can often be anticipated based on history and dealt with during planning.

7.1.2 Conceptual Model Applications

Chapter 6 demonstrates the usefulness of the developed conceptual model, which represents a design-build body of knowledge in line with the revised Bloom's Taxonomy (Anderson et al. 2001), an updated version of the taxonomy used by ASCE in its Body of Knowledge (ASCE 2019). This demonstration validates what is presumed in Chapter 1, that conceptual knowledge that defines underlying principles and "why things are done" is beneficial in supplementing existing procedural knowledge and organizing past experiences.

Five significant steps are included in this effort. First, a state-of-the-practice review of design-build was conducted on state DOT manuals and consolidated guidebooks. Second, three procedures, co-location, ATCs, and "over-the-shoulder" design reviews, were selected to demonstrate the conceptual model. These procedures were chosen for four reasons: they represent typical design-build procedures, address phases where the owner and design-build teams are jointly involved, are successful in use, and are collectively recommended in the reviewed design-build guidebooks. Third, relevant conceptual model factors are identified, and each procedure is analyzed through the lens of these factors. Fourth, factor interactions were

identified, evaluated, and discussed. Some interactions tend to support implementation, and others hinder it. Select interactions are included in the discussion highlighting a benefit or potential concern associated with the procedure. Fifth, procedure modifications are suggested to achieve better results.

The outcome of these steps for each procedure is summarized below.

7.1.2.1 Co-location

Co-location brings project resources together at one location, consequently thinning organizational boundaries, restructuring actors, and facilitating the completion of planning. Eight conceptual factors of the model provide these insights: Overall Relation Type; Sources of Contractual Solidarity; Numbers; Power, Hierarchy, and Command; Attitudes; Future Cooperation; Obligations; and Benefits & Burdens.

Five interactions of factors were evaluated in applying the model: Attitudes with Benefits & Burdens, Numbers with Obligations, Overall Relation Type with Attitudes; Attitudes with Power, Hierarchy, and Command; and Attitudes with Sources of Contractual Solidarity.

Modifications suggested for co-location all focused on one primary concern: the difficulty the procedure can present for a designer due to changes in private design time. The network concept defined in Numbers is used to make three suggestions for accommodating designers' co-locating: profession-based clusters, a primary connector node, and a tiered decision-making structure. First, it is suggested that the network concepts of boundaries and clusters be used to identify and group the professions in the network and in the shared space allowing those who desire more private time to create it more easily. Second, it is suggested that the network be structured so that designers have a primary contact person. This participant, represented by a node in the network, would have the most links to nodes within his cluster,

defined by a professional boundary, and be the primary conduit for communication outside of it, allowing the designer to carve out more private time while remaining connected to the team and able to obtain and share valuable information when needed. Third and finally, it is suggested that the network be structured so that there is a higher management level where final decisions are made. This allows for more connections and interactions at the working level but protects the organizations, so even in instances where participants may feel impacted by changes in private time or the pace of work, ultimately, decisions are made at higher levels with the protection of the organizational boundary in mind.

7.1.2.2 ATCs

ATCs is a procurement procedure allowing design-build teams to propose equal or better alternatives to the RFP's basic configuration or technical criteria. It affords design-build team actors an opportunity for design control, innovative solutions, and planning aspects to be finalized before the contract is entered. Five factors were analyzed from the conceptual model to provide insight concerning this procedure: Attitude; Power, Hierarchy and Command; Planning; Benefits & Burdens; and Transferability.

Three interactions were evaluated and discussed: Planning with Attitudes; Benefits & Burdens with Planning; and Transferability with Power, Hierarchy, and Command.

There are suggestions for modifications to the procedure. While the conceptual model points to benefits related to the ATCs procedure, it also highlights the burden it can present for design-build teams, specifically designers. This leads to three recommendations for reducing the burden for the proposing teams. First, an owner may consider greater compensation for the designer to create more balance in the Benefits & Burdens, for instance, sharing the savings. Second, for owners to continue to attract design-build teams who will develop innovative

solutions, careful consideration should be given to aspects of the selection process leading to the transfer for performance addressed with Transferability. For instance, owners may want to short-list proposers before the ATC procedure, so each team has a greater possibility of receiving the job and define and weight the selection criteria to provide adequate credit for innovative ideas. Third, the use of ATCs should be determined on a project-by-project basis. In some instances, owners may want to consider alternative procedures like bid add alternates allowing the owner to receive design options but taking less time to execute, requiring less Planning, and being less of a burden for the designer.

7.1.2.3 "Over-the-shoulder" design review

"Over-the-shoulder" design review is a procedure during delivery in which the owner is updated and can provide feedback on the design as it progresses. From a conceptual perspective, it thins organizational boundaries, creates a network of actors for design review, facilitates joint participation in the completion of planning, and occurs during delivery—the segment of time after the transfer for performance. Eleven components of the model were analyzed and discussed for their insights: Planning; Numbers; Transferability; Power, Hierarchy and Command; Sources of Contractual Solidarity; Measurement & Specificity; Commencement, Duration, and Termination; Overall Relation Type; Attitudes; Benefits & Burdens; and Future Cooperation.

Six interactions were evaluated and discussed: Attitudes with Benefits & Burdens; Numbers with Overall Relation Type; Commencement, Duration, and Termination with Power, Hierarchy, and Command; Planning with Future Cooperation; Measurement & Specificity with Sources of Contractual Solidarity; and Planning with Transferability.

Five suggestions for modification are made for future implementation to address the concerns about scope creep, design-related cost savings, actors' authority, scope degradation,

and participant involvement. Three of the main concerns associated with the procedure—scope creep, cost savings, and actors' authority—are addressed with one primary suggestion: deal with them in the contract language. Because planning a relational contract was compared to planning a constitution in the conceptual model, to address the concern of scope creep, an owner can structure the contract to establish procedures that allow for changes while protecting his rights and the rights of the design-build team. Second, to address the concern of significant cost savings resulting from a dynamic bargain, the owner can stipulate how the parties deal with a design solution that results in contract savings. Some owners may stipulate cost sharing between them and the design-build team, while others may allow the design-build team to receive the full savings. Third, to address the extent of the actors' authority, owners may want to consider addressing things like the roles and specific rights of the participants, how much discretion decision-makers will have, and what will guide decisions. Or an owner may choose to set up a hierarchy for design, aspects of the conceptual model discussion on Power, Hierarchy, and Command. Fourth, to address the potential for scope degradation, owners should consider selecting the design-build team on a basis other than low first cost or including parameters in the contract that require the design-build team to fill in the gaps left in the design with something different than the minimum standard. Fifth and finally, to address the concern that the right people are involved, as mentioned in Numbers, when structuring the procedure, owners should consider including those with decision-making authority and, when necessary, experts.

The application of the conceptual model included analyzing individual impacts of factors, evaluating cross impacts of factors, and creating modifications for future use of the procedures. This process provides insight that led to a greater understanding of the procedures, including

why they are used, what potential concerns may be associated with them, and how they can be modified to address them in the future.

7.2 Conclusions

This research provides a perspective of design-build separate and apart from design-bid-build. Although this research initially sought to guide the design-build scoping process, it instead gave guidance for the overall design-build process by defining design-build as different from design-bid-build. This new paradigm was created by providing knowledge at two levels of detail. The higher level offers a holistic perspective of design-build as a relational contract in which the "presentiated" contract seen with design-bid-build is replaced with both a "futurized" contract and a relationship while using design-build.

The lower detail level focuses on 12 characteristics of the process that not only allows design-build to be viewed as distinctly different from design-bid-build but also allows design-build to be viewed at an operational level. This knowledge equips participants with the skills to tailor design-build to meet the needs of a particular project and for owners to make better decisions during planning. Design-build is unique, having its own identity separate from design-bid-build, and requires the knowledge and skills necessary to tailor the process to the project's particular needs.

This research applies the knowledge to existing design-build procedures to show how it can begin to be utilized. Analyzing individual concepts provided a focused perspective, and evaluating their interactions provided a holistic view of the procedures giving participants a better understanding of what they are doing and why they are doing it while also revealing potential strengths and weaknesses, which the knowledge was also used to suggest possible modifications for the future. Incorporating case study projects as illustrations allows practitioners

to connect the developed knowledge to their experiences, help organize past experiences and guide future actions.

7.3 Suggestions for Future Research

There are three areas of relevant future research: two stems from the contents of the theory, and one from the application of the theory. The first two areas of relevant future research are the "futurized" contract and the "activated network." There are five areas of futurized contract research noted here. First, research is needed on developing a futurized contract to include what is necessary to establish and enforce intent and expectations. Second, research is needed on the "gap-filling" of an incomplete contract to include how project participants might fill gaps and, failing this, how sought-out third parties might fill these gaps using such things as norms. While courts may be reluctant to involve themselves in futurized contracts that are intentionally incomplete, other means of resolving conflicts, such as mediation and arbitration, might be researched as a means for these decisions and their archival. Third, research is needed on decisions in which a lifecycle code can provide a minimum standard for decision-making, allowing judgments based on the first cost to be weighed against lifecycle costs so the best overall decision could be made. Fourth, research is needed on the selection process to identify project stakeholders and involve them in the project for futurized contracts. And research focusing on developing the selection criteria, how the criterion is weighted, and how they map back to specific stakeholders is needed. Fifth and finally, research is needed on the impact certain design-build organizational structures have on participants, particularly the impact that contractor-led design-build has on the engineer. A significant concern is the dual obligations this structure creates for an engineer; he has a fiduciary obligation to the public and a contractual obligation to a contractor who naturally has a different perspective.

Research is also needed for the "activated network," an organization assembled for a particular project. A coordinating "hub firm" activates the network resources based on a project's individual needs. Four areas for future research are described. First, research is needed to determine how the activated network is operationalized. For instance, which party, the designer or the contractor, is best suited to be the hub firm, and how does the hub firm determine which participants to activate. Second, research is needed on what the contractual agreement would look like between the owner and the hub firm and between the hub firm and the activated participants. Third, research is needed on how the participants are coordinated and how they communicate in determining which participants should be linked and how they should be linked. A tool like Building Information Modeling (BIM) could be studied to determine its usefulness for communication and coordination to determine how the work among a large number of participants is coordinated to ensure proper sequencing of the participants and how the hub firm can ensure the individual design elements completed by each participant create a unified design.

Fourth and finally, additional research regarding the activated network should be done to compare it to other organizational structures. For instance, the firm is a static organization with established resources potentially underutilized. The dynamic quality of the activated network assembled on a project-by-project basis could be compared to the firm. Also, the activated network could be compared to other relational arrangements, such as alliances and integrated project delivery, to determine similarities and differences.

The final area suggested for future research stems from applying the conceptual model to current design-build procedures. There are three suggestions. First, additional research is needed to analyze and evaluate other procedures. Expanding the application of the conceptual model beyond the three procedures used as examples in this research will provide a better

understanding of current design-build practices and build the conceptual knowledge base for design-build. Second, case studies of other design-build projects could be conducted. Analysis using the conceptual model can provide a new perspective and, in some instances, a better understanding of what occurred on projects. Third and finally, at a more advanced research level, create new procedures from the theoretical construct. Characteristics from the conceptual model could be incorporated into a set of procedures that are developed theoretically rather than experientially.

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Appendix A

The Delphi Method

Delphi Process Overview

The Delphi method uses iterative rounds of questionnaires to obtain a consensus opinion from an expert panel. The purpose of the Delphi method for this research was twofold: to yield a list of potential case study projects, both successes and failures, and to create a list of critical success factors for scoping. The process involved two major steps: (1) assemble the expert panel and (2) conduct iterative rounds of questionnaires. This research assembled the panel of experts using a nomination round and then conducted four rounds of questionnaires.

Step 1: Assemble the expert panel

The expert panel was assembled using a Nomination Round in which individuals who had published literature on design-build or participated in the design-build portion of the Transportation Research Board Conference were asked to nominate themselves or others who they considered experts on design-build.

The Nomination Round yielded a list of 34 design-build experts from which a panel of ten experts was created. There are two reasons why a panel of ten was used. First, based on the literature reviewed, a group of ten is adequate to provide sufficient information for the study while producing a manageable amount of data. Second, it is well documented that the Delphi process produces better results and a higher response rate when the panel members are interested in and committed to the process. There were nine members of the nomination committee who nominated themselves and two nominees who received two nominations each. Based on this, initially a panel of 11 composed of those mentioned was formed. The two nominees who received multiple nominations were sent letters inviting them to participate in the research

project. One reply was received which led to an expert panel of ten members. The panel contained two Architects, an Architectural Engineer, a Construction Attorney, and six Engineers with experience in the public and private sectors.

Step 2: Conduct iterative rounds of questionnaires

Ultimately, four rounds of questionnaires were conducted. Each round involved two main steps, develop the questionnaire and analyze the responses.

The first round posed a general question about "successful" and "failed" design-build projects and asked the panelists to respond based on their experiences. The responses were organized and compiled for the second round into a list of design-build projects and a preliminary list of critical success factors gleaned from the panelists' comments about their project experiences.

The second round of the Delphi process asked the panelists to rank the importance of the responses from the previous round on a Likert scale of 1 (lowest) to 5 (highest). The responses were analyzed and used to develop the third round questionnaire. Data analysis consisted of calculating the mean, median and standard deviation for each project and factor. The third round questionnaires were developed by presenting each panelist with his initial ratings and the group's mean ratings. The panelists were also given the opportunity to provide additional comments if they felt there were other important critical factors.

The third round asked the panelists to re-rate each item with the additional knowledge of the group data. The data was then analyzed and given the small variation in the group values from the second to the third round it was determined that a consensus opinion was reached on the preliminary data, but the critical factors added by panelists during the second round needed to be presented for final ratings.

The fourth round consisted of providing the panel with results from the third round and asking them for their final ratings for the additional comments provided in the second round.

The Delphi process concluded with the researcher organizing the critical factors into groups and selecting the projects for case study analysis with the help of the Graduate Advisory Committee.

Case Study Project Selection

Given the large number of projects identified by the Delphi panelists it was necessary to reduce the number to a size manageable for case study analysis. A meeting with the Graduate Advisory Committee was held in which the results of the Delphi process were presented. Because four of the six projects identified as failures were transportation projects, a collective decision was made to focus the case studies, and as a result, the research and the validation of the critical factors in the transportation sector. A total of eight projects were selected for case study analysis—four represented the successes of the delivery method and four represent "failures" from a flawed scope.

In determining the successful projects for case study analysis, the committee chose four projects that were selected either because they had a high Delphi rating or because they were a successful project completed by the same owner of one of the failures—the committee felt it was important if a failure by an owner was evaluated, that a success by the same owner also be highlighted.

The eight design-build transportation projects picked for case study analysis were as follows:

<u>Flawed Scoping</u>

- Interstate 4 Improvement (Polk County, FL)

- Interstate 10 Blackwater River Bridge Replacement (Santa Rosa County, FL)
- Interstate 77 (Mecklenburg County, NC)
- Interstate 85 Mecklenburg County (Mecklenburg County, NC)

Successful Scoping

- Interstate 15 Reconstruction (Salt Lake County, UT)
- Knightdale Connector (Wake County, NC)
- Metro Gold Line Eastside Extension Light Rail (Los Angeles County, CA)
- St. George Island Bridge Replacement (Franklin County, FL)

The researcher contacted a member of the owner's team for each of the projects. A member of the Metro Gold Line Eastside Extension Light Rail indicated they would be unable to participate in the research which resulted in seven projects being studied, four failures and three successes.

Delphi Panel
Below are biographical summaries for the ten expert panelists.

Panelist A (Engineer): State Roadway Design Engineer at a state Department of Transportation (DOT) with 22 years of design experience in the public sector and 16 years of design-build experience.

Panelist B (Engineer): Innovative Contracting Engineer at the Federal Highway Administration (FHWA).

Panelist C (Engineer): Director of Construction at a state DOT with 20 years of design experience in the public sector and 6 years of design-build experience.

Panelist D (Architectural Engineer): Project Director and Design-Build Manager at a construction company with 8 years of experience in the private sector and 8 years of design-build experience. Also, a research scholar with published literature on the design-build delivery method.

Panelist E (Engineer): Senior Project Manager at a state DOT with 7.5 years of design experience in the public sector, 2 years of design experience in the private sector, and 3 years of design-build experience.

Panelist F (Attorney): Construction Lawyer at construction law firm with 26 years of experience in the private sector and 15 years of design-build experience. Also, has published literature on design-build.

Panelist G (Engineer): Vice-President and Deputy Director of Surface Transportation at the second largest transportation firm and largest bridge design firm in the U.S. with 28 years of design experience in the private sector and 12 years of design-build experience.

Panelist H (Architect & Attorney): Principal, Architect, and In-House Legal Counsel at an architecture, planning and interior design firm with 27 years of experience in the private sector and 16 years of design-build experience. Also served as American Institute of Architects (AIA) Design-Build Task Group Chair.

Panelist I (Engineer): President at a consulting firm with 22 years of design experience in the public sector, 3 years of design experience in the private sector, and 13 years of design-build experience. Previously served as Executive Director for a state DOT.

Panelist J (Architect): Principal at a Design-Build consulting firm with 2 years of experience in the public sector, 44 years of experience in the private sector, and 25 years of design-build experience.

Delphi Data Summary: Case Study Projects

Design-build projects instrumental in the success of the project delivery method

Project
Applied Process Engineering Laboratory (Richland, WA)
Everett Special Events Center (Everett, WA)
Federal Courts Facility at Union Station (Tacoma, WA)
Harold Washington Library (Chicago, IL)
Hawaii Convention Center (Honolulu, HI)
I-15 Reconstruction Project (Salt Lake City, UT)
I-77 Mecklenburg County (Mecklenburg County, NC)
I-85 Mecklenburg County (Mecklenburg County, NC)
I-85 at Ruin Creek Road (Vance County, NC)
Kap Shui Mun Bridge and Ma Wan Viaducts (Hong Kong, China)
Knightdale Bypass (Knightdale, NC)
Knightdale Connector (Knightdale, NC)
Legacy Parkway (Salt Lake City, UT)
Metro Gold Line Eastside Extension Light Rail Project (Los Angeles, CA)
Pentagon Memorial (Arlington, VA)
The Portland Building (Portland, OR)
Seattle Central Community College Parking Garage (Seattle, WA)
SR68 (Kingman, AZ)
The Tacoma Dome (Tacoma, WA)
Thomas B Manual Bridge (St. Lucie Canal, FL)
United States Postal Service Parking Facility (Portland, OR)
University of California-Berkeley University Village at Albany Restoration (Albany, CA)
University of New Mexico Student Residence Center (Albuquerque, NM)
University of Washington, Research and Technology Building (Seattle, WA)
Washington State Department of Ecology Headquarters Building (Lacey, WA)
Whittier Tunnel (Whittier, AK)

Design-build projects on which scoping was critical

Applied Process Engineering Laboratory (Richland, WA)
Everett Special Events Center (Everett, WA)
Federal Courts Facility at Union Station (Tacoma, WA)
Harold Washington Library (Chicago, IL)
Hawaii Convention Center (Honolulu, HI)
I-4 (Polk County, FL)
Kap Shui Mun Bridge and Ma Wan Viaducts (Hong Kong, China)
Metro Gold Line Eastside Extension Light Rail Project (Los Angeles, CA)
Pentagon Memorial (Arlington, VA)
The Portland Building (Portland, OR)
Seattle Central Community College Parking Garage (Seattle, WA)
St. George Island Bridge (Franklin County, FL)
SR68 (Kingman, AZ)
The Tacoma Dome (Tacoma, WA)
Thomas B Manual Bridge (St. Lucie Canal, FL)
United States Postal Service Parking Facility (Portland, OR)
University of California-Berkeley University Village at Albany Restoration (Albany, CA)
University of New Mexico Student Residence Center (Albuquerque, NM)
University of Washington, Research and Technology Building (Seattle, WA)
Washington State Department of Ecology Headquarters Building (Lacey, WA)

Design-build projects that best demonstrate successful scoping

Hawaii Convention Center (Honolulu, HI)
I-15 Reconstruction Project (Salt Lake City, UT)
Kap Shui Mun Bridge and Ma Wan Viaducts (Hong Kong, China)
Knightdale Bypass (Knightdale, NC)
Knightdale Connector (Knightdale, NC)
Pentagon Memorial (Arlington, VA)
St. George Island Bridge Project (Franklin County, FL)
University of Washington, Research and Technology Building (Seattle, WA)
Whittier Tunnel (Whittier, AK)

Design-build projects that best demonstrate flawed scoping

Everett Special Events Center (Everett, WA)
I- 4 (Polk County, FL)
I-10 Blackwater River Bridges (East of Pensacola, FL)
I-77 (Mecklenburg County, NC)
I-85 Mecklenburg County (Mecklenburg County, NC)
University of New Mexico Student Residence Center (Albuquerque, NM)

Delphi Data Summary: Design-Build Critical Factors

Rank	Critical Factor
T-1	Parties share an understanding of the scope
T-1	Parties understand what is expected of them
T-1	Pick the right team
T-1	Technical competence of the designers and builders
T-1	There should be clear understanding of what information can be relied on by the design-builder (for example, survey and soil boring data)
6	Identify special project requirements
7	Clear owner objectives/expectations
8	Outline the performance expectations for the design-builder
9	Owner leads the scoping process
T-10	Scope matches available budget
T-10	Users should review and have a full understanding of the project based on the initial program requirements
T-10	Identify who is responsible for unforeseen soil conditions outside of the areas where borings were provided
T-10	Transfer risks to party best able to manage the risks
T-10	Long-term maintenance, if required, should be well-scoped
T-10	Define expectations of the project
T-10	Clear allocation of responsibilities
17	Be clear about what the project is to accomplish
T-18	Trust between the Owner's team and Design-build team
T-18	Specify expectations for the level of design drawings for tender offer
20	Allow design innovation
T-21	Provide written program requirements
T-21	Collaboration between offices during scope development
T-21	Language should be specific
T-24	Obtain customer input
T-24	In a competitive public selection process, evaluators should be competent, unbiased and knowledgeable of the project's needs
T-24	Program and performance specifications should be reasonable for the building type and the current state of the art in the specific discipline
27	Cover all desired work requirements
T-28	Use performance specifications
T-28	Program and performance requirements should be objective
T-28	Provide a detailed scope
31	Scope should encompass all disciplines and activities
32	Avoid gaps and overlaps
33	The owner should let go of the controls and allow the design-build team the flexibility to provide their best and most innovative product

"T" indicates a tie

Rank	Critical Factor
T-34	Provide conceptual design
T-34	Identify potential unforeseen conditions
T-34	The design-build firm should have the flexibility to modify the preliminary design and still meet the scope and requirements of the RFP without sacrificing safety and life cost of the final product
T-37	Include soil surveys
T-37	It is important to have meetings at the jobsite when the location of the design team is separate from the construction team
T-39	Contractor's input before the proposals are submitted is important to finding holes in the scope
T-39	In a competitive public process, if the scope and budget are not matched, it is important that there is a process to allow the design-builder to exceed the budget with unsolicited alternates to the program and/or performance specifications that allow the project to meet its budget limitations while achieving basic program requirements
T-39	Include expectations for project specific insurance
T-42	If there is an oversight agency, the agency should be involved throughout the scoping process
T-42	Scope should not be overly prescriptive
44	If the location of the design team is separate from construction, it is important to specify who must attend the jobsite meetings
45	If there is a sub-consultant designer, the sub-consultant should report only to the prime design consultant and not the design-build contractor
46	Peer reviews can be used to ensure the scope is not excessive
47	Contract should be in place during scoping
48	Use relationship diagrams
49	Design-builder leads the scoping process
50	Architect-engineer leads the scoping process

"T" indicates a tie

Delphi Critical Factors Grouped into Seven Categories

1. The Right Team

T-1 Pick the right team

2. Shared Understanding of Scope

T-1 Parties share an understanding of the scope

- Work requirements
  - 6 Identify special project requirements
  - T-10 Long-term maintenance, if required, should be well-scoped
  - T-34 Identify potential unforeseen conditions
  - T-39 Include expectations for project specific insurance
- Collaboration
  - T-21 Collaboration between offices during scope development
  - T-37 It is important to have meetings at the jobsite when the location of the design team is separate from the construction team
  - 44 If the location of the design team is separate from construction, it is important to specify who must attend the jobsite meetings
- Roles and responsibilities
  - T-1 Parties understand what is expected of them
  - T-10 Transfer risks to party best able to manage the risks
  - T-10 Clear allocation of responsibilities
- Scope definition
  - Description
    - -Detailed
      - 27 Cover all desired work requirements
      - T-28 Provide a detailed scope
      - 31 Scope should encompass all disciplines and activities
    - -Flexible
      - T-28 Use performance specifications
      - 20 Allow design innovation
      - T-24 Program and performance specifications should be reasonable for the building type and the current state of the art in the specific discipline
      - 33 The owner should let go of the controls and allow the design-build team the flexibility to provide their best and most innovative product
      - T-34 The design-build firm should have the flexibility to modify the preliminary design and still meet the scope and requirements of the RFP without sacrificing safety and life cost of the final product
      - T-39 In a competitive public process, if the scope and budget are not matched, it is important that there is a process to allow the design-builder to exceed the budget with unsolicited alternates to the program and/or performance specifications that allow the project to meet its budget limitations while achieving basic program requirements
      - T-42 Scope should not be overly prescriptive

2. Shared Understanding of Scope (continued)

Format

T-10 Scope matches available budget
T-18 Specify expectations for the level of design drawings for tender offer
T-21 Language should be specific
T-28 Program and performance requirements should be objective
32 Avoid gaps and overlaps
T-21 Provide written program requirements
T-34 Provide conceptual design
48 Use relationship diagrams

3. Reliance on Someone

T-1 Technical competence of the designers and builders
T-18 Trust between the Owner's team and Design-build team

4. Reliance on Something

T-1 There should be clear understanding of what information can be relied on by the design-builder (for example, survey and soil boring data)
T-10 Identify who is responsible for unforeseen soil conditions outside of the areas where borings were provided
T-37 Include soil surveys

5. Expectations

T-1 Parties understand what is expected of them
7 Clear owner objectives/expectations
T-10 Define expectations of the project
17 Be clear about what the project is to accomplish

6. Power

Who's in charge?

9 Owner leads the scoping process
49 Design-builder leads the scoping process
50 Architect-engineer leads the scoping process
45 If there is a sub-consultant designer, the sub-consultant should report only to the prime design consultant and not the design-build contractor

When is the contract in place?

47 Contract should be in place during scoping

7. Stakeholders

Constituents

T-10 Users should review and have a full understanding of the project based on the initial program requirements
T-24 Obtain customer input

7. Stakeholders (continued)

Owner's team

T-24 In a competitive public selection process, evaluators should be competent, unbiased and knowledgeable of the project's needs

T-42 If there is an oversight agency, the agency should be involved throughout the scoping process

46 Peer reviews can be used to ensure the scope is not excessive

Design-build team

T-39 Contractor's input before the proposals are submitted is important to finding holes in the scope

*The Delphi factors are placed by the researcher in the categories deemed to be the best fit. Some factors appear in more than one category to show that many factors have multiple homes.

Delphi Critical Factors Categorized under MacNeil's Characteristic Factors of Contracts

Overall Relation Type
T-1 Pick the right team
T-37 It is important to have meetings at the jobsite when the location of the design team is separate from the construction team

Measurement and Specificity
20 Allow design innovation
T-21 Language should be specific
27 Cover all desired work requirements
T-28 Use performance-style specifications
T-28 Program and performance requirements should be objective
T-28 Provide detailed scope
T-34 Provide conceptual design
T-42 Scope should not be overly prescriptive

Basic Sources of Socioeconomic Support/Sources of Contractual Solidarity
T-1 Pick the right team
T-18 Trust between the owner and design-builder

Duration, Commencement and Termination
47 When during scoping should contracts be in place?

Planning
T-1 Shared understanding of the scope
6 Identify special project requirements
8 Outline performance expectations for the design-builder
T-10 Scope matches available budget
T-10 Long-term maintenance, if required, should be well-scoped
17 Be clear about what the project is to accomplish
20 Allow design innovation
T-21 Provide written program requirements
T-21Collaboration between offices during scope development
T-25 Program and performance specifications should be reasonable for the building type and the current state of the art in the specific discipline
T-28 Use performance-style specifications
31 Encompass all disciplines and activities
32 Avoid gaps and overlaps
33 The owner should let go of the controls and allow the design-build team the flexibility to provide their best and most innovative product
T-34 Identify potential unforeseen conditions
T-34 The design-build firm should have the flexibility to modify the preliminary design and still meet the scope and requirements of the RFP without sacrificing safety and life cost of the final product
T-37 Include soil surveys

Planning (continued)
T-39 In a competitive public process, if the scope and budget are not matched, it is important that there is a process to allow the design-builder to exceed the budget with unsolicited alternates to the program and/or performance specifications that allow the project to meet its budget limitations while achieving basic program requirements
46 Peer reviews can be used to ensure the scope is not excessive
48 Use relationship diagrams

Future Cooperation
T-37 It is important to have meetings at the jobsite when the location of the design team is separate from the construction team
44 If the location of the design team is separate from construction, it is important to specify who must attend the jobsite meetings

Sharing and Dividing Benefits and Burdens
T-10 Transfer risks to party best able to manage the risks
T-10 Identify who is responsible for unforeseen soil conditions outside of the areas where borings were provided

Obligations
T-1 Parties understand what is expected of them
T-1 Reliability of owner supplied information
7 Clear owner objectives/expectations
T-10 Identify who is responsible for unforeseen soil conditions outside of the areas where borings were provided
T-10 Long-term maintenance, if required, should be well-scoped
T-10 Define expectations
T-10 Clear allocation of responsibilities
T-18 Specify expectations for the level of design drawings for tender offer
T-39 Include expectations for project specific insurance

Transferability
T-1 Shared understanding of the scope
T-1 Reliability of owner supplied information
T-18 Specify expectations for the level of design drawings for tender offer
T-37 Include soil surveys
47 When during scoping should contracts be in place?

Numbers
T-1 Pick the right team
T-1 Technical competence of the designers and builders
T-10 Users should review and have a full understanding of the project based on the initial program requirements
T-21 Obtain customer input
T-25 Evaluators should be competent, unbiased and knowledgeable of the project's needs

Numbers (continued)
T-39 Contractor's input before the proposals are submitted is important to finding holes in the scope
T-42 If there is an oversight agency, the agency should be involved throughout the scope process

Attitudes
T-1 Pick the right team
T-18 Trust between the owner and design-builder

Power, Hierarchy, and Command
9 Who's in charge? Owner
33 The owner should let go of the controls and allow the design-build team the flexibility to provide their best and most innovative product
45 If there is a sub-consultant designer, the sub-consultant should report only to the prime design consultant and not the design-build contractor
47 When during scoping should contracts be in place?
49 Who's in charge? Design-builder
50 Who's in charge? Architect-engineer

*The Delphi factors are placed by the researcher in the categories deemed to be the best fit. Some factors appear in more than one category to show that many factors have multiple homes. These groupings are not intended to be exhaustive.

Appendix B

Case Studies

Seven projects identified during the Delphi process were studied using the Case study method, three had successful scoping—Interstate 15 Corridor Reconstruction, Knightdale Connector, and St. George Island Bridge Replacement—and four had flawed scoping—Interstate 4 Improvement, Interstate 10 Blackwater River Bridge Replacement, Interstate 77 Reconstruction, and Interstate 85 Reconstruction. The researcher interviewed representatives from the owner's, contractor's and designer's teams and reviewed project websites, documents, reports, and published literature. Each project is summarized with focus on aspects of the projects important to this research.

INTERSTATE 15 CORRIDOR RECONSTRUCTION

Location: Salt Lake County, Utah
Owner: Utah Department of Transportation (UDOT)
Contractor: Wasatch Constructors, a joint venture of Kiewit Pacific, Granite Construction, Washington Construction
Designer: Sverdrup/DeLeuw, a joint venture of Sverdrup Civil, Inc. and DeLeuw, Cather and Company
Initial Cost Estimate: $1.5 billion (with all add alternates)
Contract Amount: $1.325 billion
Final Cost: $1.297 billion
Timeframe: October 1996 to May 2001
Brief Project Description: Reconstruction of 17 miles of Interstate mainline from 10800 South to 600 North.

Need

The original Interstate 15 Corridor (I-15) was built through Salt Lake County during the 1960s to serve travel needs projected through the 1980s. Over the years, the surrounding area changed from suburban and rural to urban. With I-15 as the main North-South (N-S) transportation route through Salt Lake County and the State of Utah and no major parallel or substitute routes for N-S traffic for most of the length of the corridor, time, traffic, and the elements took their toll on the roadway and structures causing operational and performance problems (Drennon 2002, Nelson 2005).

By the 1980s, there was an immediate need to reconstruct the corridor to correct the operational and performance problems associated with capacity, structural, and criteria deficiencies (Carter and Burgess 1999, Postma 2004, Drennon 2002, Nelson 2005, Drennon and Higgins 1997). The problems were attributed to two main issues: increased traffic demands and deteriorating structures. First, the traffic demands began to far exceed capacity. Substantial growth in surrounding communities over the years meant the capacity of I-15 was no longer adequate for the traffic volumes. Second, the roadway and structures were in a deteriorated state mainly because of two issues: weather and increased use. The use of deicing salts during cold

weather had caused severe deterioration in most of the bridges and elevated structures and years of increased loads had taken a toll on the corridor. Additionally, the design and safety criteria were out-of-date—none of the existing structures had been designed to meet the current seismic design standards.

To meet increasing traffic demands, during the mid- to late 1980s the Wasatch Front Regional Council, the Metropolitan Planning Organization, and Utah Transit Authority concurrently considered options to expand highway and transit service within the Salt Lake Valley and the decision was made to prepare a joint highway and transit needs and environmental study of the corridor. At the conclusion of the study in the early 1990s, it was determined I-15 needed to be reconstructed and additional capacity added (Postma 2004, Nelson 2005, Drennon and Higgins 1997).

Design-Build Project Delivery Decision

Although UDOT began developing plans to expand and upgrade the highway in 1983, it was not until the 1990s that the project began to take shape (Postma 2004, Drennon and Higgins 1997). Consulting firm Parsons, Brinkerhoff, Quade and Douglas was hired and began the development and planning of a traditional design-bid-build project. Initially, availability of funding necessitated dividing the project into approximately 20 segments to be constructed in phases over an eight to ten-year period, but in early 1996 the Executive Director of UDOT decided the reconstruction needed to be completed in a timelier manner and made the decision to use design-build. This decision was motivated by two factors: (1) strong public desire to have the project completed as soon as possible to minimize the period of severe traffic congestion associated with the diversion of more than half of the traffic off I-15 during the construction

period, and (2) the desire to have the construction finished prior to the 2002 Winter Olympics hosted by Salt Lake City.

The decision to use design-build was made after an investigation of possible alternatives to expedite the construction of the project indicated design-build was the best option (Drennon and Higgins 1997). Design-build cut the original construction schedule by nearly 50 percent and relieved UDOT of the problems associated with the coordination of design and construction of dozens of individual projects.

State procurement laws had to be modified to authorize the use of design-build and to permit the award of the contract to the team who provided the "best value" proposal (Drennon and Higgins 1997). During the 1996 legislative session and concurrent with the decision to use design-build for the reconstruction of I-15, legislation was introduced and passed permitting the use of the delivery method on a limited basis for state projects. In the 1997 legislative session, the 1996 legislation for highways was amended to allow a two-phase selection process in which award could be made to the proposer whose proposal was considered most advantageous to the state after considering price and other identified factors. Also, in 1997 the Utah state legislature established the Centennial Highway Fund to address the unfunded transportation needs across the state. The I-15 project was a centerpiece of the plan.

In April 1996, UDOT requested approval from the Federal Highway Administration (FHWA) to use design-build for the I-15 project. Because design-build was not at the time considered a standard delivery method, FHWA granted approval under the provisions of FHWA Special Experimental Project (SEP-14) (Drennon and Higgins 1997).

Procurement Process

The Department began by advertising the project internationally asking those interested in proposing to submit a Letter of Interest (LOI) (Postma et al. 1998, Drennon and Higgins 1997, Postma et al. 2002). Request for Qualifications (RFQ) were then sent to all teams who responded with a LOI. It was decided a maximum of five proposers would be short-listed and eligible to receive a Request for Proposals (RFP). Three teams submitted the Statement of Qualifications (SOQ) in response to the RFQ, and all three were prequalified to respond to the RFP. The short-listed teams were then provided the RFP which was a two-step process that required separate technical and fixed price proposals.

The Department used a "best value" selection process with a review team of over 60 individuals with separate technical and price proposal reviewers (Baxter and Daves 2005, Baxter 2005, Drennon and Higgins 1997, Postma et al. 2002). The Technical Evaluation Board was responsible for the technical review and supervised the detailed review of the proposal by the technical evaluation groups who each evaluated specific technical areas of the proposals. The four primary technical areas, listed in order of importance, were:

(1) Technical Solutions

(2) Work Plan/Schedule

(3) Management

(4) Organizational Qualifications

Simultaneously, prices were evaluated by the Price Evaluation Team using predetermined criteria which separated costs into specific areas for evaluation.

After a review of the price and technical factors, the Department had the option to award the contract based on the information received or to proceed to a Best and Final Offer (BAFO)

process. The Department chose to invoke the BAFO and used a review process similar to the initial process. Although the owner reserved the right to continue to repeat this process, the owner indicated in the RFP that the process would be limited to one round barring extreme circumstances. The contract was awarded after one BAFO round.

Work Required

The I-15 Corridor Reconstruction involved the reconstruction of approximately 17 miles of urban interstate highway from 10800 South to 600 North and included the replacement or construction of approximately 140 structures, eight interchanges, and three major freeway-to-freeway junctions (Drennon and Higgins 1997, Postma et al. 2002). The corridor was widened to five lanes in each direction with the addition of a high-occupancy vehicle (HOV) lane and a general purpose lane. Modifications were made to portions of I-215, I-80, and State Route 201 (Kieways 2000).

The project included replacement or construction of all pavements and all structures along the corridor including the reconstruction of all the interchanges, railroad grade separation structures, and viaducts leading in and out of the Salt Lake City central business district. Numerous frontage roads and local streets were modified, relocated and/or reconstructed along the corridor. Reconstruction also included clearing, removal of existing highway structures and appurtenances, removal of buildings, excavation and embankment, and regrading; construction of noise walls and retaining walls; construction of the drainage system including modifications and additions to the existing system and new outfalls from the highway to the Jordan River. Also included was the introduction of landscaping and aesthetic treatments; placement of signing and pavement marking for all new pavements, including that required to tie to existing facilities; construction of new traffic signals and modifications to existing traffic signals; placement of

traffic control and safety devices, including barriers, delineators, reflectors, attenuations, among others. Advance Traffic Management System (ATMS) components were also required along the corridor, as well as on surface streets and other regional freeways impacted by traffic diverted during construction.

Project Details

Specifications

The Department used a combination of three types of specifications: UDOT standard prescriptive specifications, performance specifications, and a hybrid of performance and prescriptive specifications created for the project (Postma 2004, Postma et al. 2002). Prescriptive specifications were used when the owner wanted specific methods or products to be used. For example, the owner used this specification for the Pavement Design requiring Portland Cement Concrete Pavement. Performance specifications contained minimum requirements and restrictions and were used to provide flexibility for certain areas of the project. For example, performance specifications were used for Maintenance of Traffic with the design-build team required to follow the *Manual of Uniform Traffic Control Devices* and conform to the *UDOT Standard Traffic Control Plans*. Hybrid specifications had a mixture of prescriptive and performance provisions and were specific in areas UDOT wanted completed a certain way, but flexible in other areas. For example, hybrid specifications were used for the Structures and were prescriptive regarding such things as materials, concrete cover and reinforcing steel, but provided flexibility regarding the bridge type.

Owner Supplied Information: Preliminary alignment

UDOT provided the design-build teams with approximately 30% complete plans which included alignment of the project and extensive geotechnical investigations conducted in the

corridor (Postma et al. 2002, Postma 2004). UDOT awarded more than ten contracts to consulting engineering firms to prepare the preliminary design which included an emphasis on the development of the functional geometrics for the highway and typical bridge sheets for each structure. This level of design was necessary to identify conflicts with utilities and railroads and the additional right-of-way needed so the Department could fulfill its commitment to obtain all rights-of-way, permits, and utility agreements for the project as part of its risk sharing on the project.

The ten contracts with design firms were many more than necessary, a Department member indicated, but were done to garner the support of the design community for design-build.

Owner Supplied Information: Complete plans

For portions of the work, UDOT completed final plans signed and sealed by consultants. Included were plans for eight structures, the 600 North interchange structure being one example (Drennon and Higgins 1997, Postma et al. 2002). The Department believed it was important to include these completed plans to accelerate the start of construction. While the plans were successful in providing an early start for construction, it was difficult for the design-build team to modify the design elements to suit the contractor's methods and equipment planned for the rest of the project which led the contractor to request some changes to the plans.

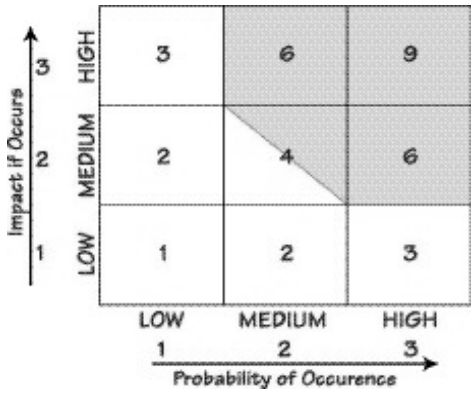
Owner Supplied Information: Complete subsurface investigation

The RFP contained the results of a comprehensive geotechnical subsurface investigation (Drennon 2002, Drennon and Higgins 1997, Postma et al. 2002). The investigation was conducted at every bridge and pier location, embankment areas and other structures to document foundation information. Exploration work, soil log information, drilling logs, and materials

testing and lab reports were included in the data. The information was stamped and sealed by a professional engineer and the Department stood behind it, but the interpretation of the information was left to the design team.

Risk Allocation

UDOT focused on risk management and risk sharing and assigned risks to the party best able to deal with them (Drennon 2002, Drennon and Higgins 1997, Postma et al. 2002). The Department identified, evaluated, and allocated 52 areas of potential risk. A risk matrix, as shown below, was used to assess the significance of each risk. Risks were scored by multiplying the probability they would occur by the value of their impacts and those that scored in the shaded area of the matrix required specific mitigation measures. For example, for utility relocations the probability of occurrence was medium (2) and the impact if it occurred medium (2) for an overall score of 4, so measures were taken to eliminate or lessen the probability of occurrence (Drennon 2002). There were approximately 1,500 utility crossings with 500 to 600 conflicts identified for relocation. Prior to the Notice to Proceed, UDOT negotiated agreements with most of the owners. The design-builder was responsible for design and construction and the Department paid for the relocations. This put the design-build team in control of the utility relocation schedule and eliminated the potential of delays by third parties. Other examples of the risk sharing include the Department assuming responsibility for the right-of-way acquisitions, environmental permits, and the geotechnical investigation, among other things while the design-builder was responsible for railroad permitting activities, construction QC/QA, among others.



UDOT I-15 Risk Assessment Matrix (Drennon 2002)

Outreach for RFP development

A member of UDOT said important to the success of the project was their outreach effort during the development of the RFP. They solicited feedback from the consulting and contracting communities at two levels, one was a technical level with the project team, the other was more policy oriented with the senior members of the contracting companies who were interested in things such as high-level management issues, risk allocation and management, revenue, and the selection process. Prior to issuing the final RFP the Department produced a draft RFP and incorporated the feedback they received into the final document.

Warranty

UDOT believed requiring the design-build team to potentially be responsible for the performance and maintenance of their design and construction could encourage them to produce a quality product (Drennon and Higgins 1997, Postma et al. 2002). As one of ten add alternates to the contract, the design-build teams were required to provide the owner with a maintenance option—a ten-year warranty divided into an initial five-year period with the option for five subsequent one-year periods. The Department was to make the decision near the end of the construction phase of whether to enact the warranty. UDOT elected not to enact the option with a member of the Department saying after evaluating the work they determined the quality was

such that the cost of the warranty would likely have exceeded the cost of any maintenance that would be required.

"Over-the-shoulder" design reviews

"Over-the-shoulder" design reviews were a contract requirement (Postma et al. 2002, Postma 2004). The procedure involved ongoing reviews by UDOT as the project was designed. The purpose was to obtain consensus and buy-off on the design as it was being developed, but the designer was responsible for the correctness of the plans. This process was intended to take the place of more formal reviews that were typical for DOT projects.

Co-location

To coordinate and control the work, Wasatch chose to establish a project office and locate all design and construction staff in the same building (Postma et al. 2002, Postma 2004). UDOT also chose to relocate their project team to the same office building. The consolidated office became known as the "Hub." To facilitate the exchange of information the design-build team and UDOT shared a phone system and common computer network system with separate secure locations for each party (Postma et al. 2002). In addition, because all parties were located at the "Hub," there were regular opportunities for informal discussions.

Partnering

A partnering process was established with the goal of resolving disputes and building a high level of trust between the participants (Postma 2004, Drennon and Higgins 1997, Postma et al. 2002). Partnering occurred at multiple levels in the organizations from the executive level where meetings were scheduled down to the field level where day-to-day, informal interactions occurred.

A primary focus for the teams was the nurturing of the relationships, elimination of the "them versus us" and the building of trust (Postma et al. 2002). This nurturing took many forms, such as sharing lunches and dinners, celebrating project milestones, sharing in holiday festivities and activities, and participating in sports or sports activities together and other social events that built an atmosphere of camaraderie and trust. When trouble arose, the managers would get the team together for a social activity.

Changes to the contract

The partnering process implemented on the project led to a memorandum of understanding which provided more flexibility in considering design and construction changes (Postma 2004, Postma et al. 1999, Postma et al. 2002). The memorandum of understanding allowed Wasatch to make changes to their proposal, the performance specifications or the standard specifications if the quality of the changes was equal to or better than the original contract requirement. Changes were accepted using a Technical Agreement process with no changes to contract price or time.

Innovative Construction Methods

There were soft soils underlying most of the highway, conditions particularly challenging given the time constraint for the project which required innovative solutions (Postma et al. 2002, Postma et al. 2002). When the original features of I-15 were constructed in the 1950s and 1960s, most foundations were surcharged for several years prior to constructing the final pavement and structures to allow the foundations to consolidate adequately. With a 4-1/2-year time limit for reconstruction of I-15 there was not enough time to construct the features in the manner normally used and the requirement to use Portland Cement Concrete Pavement as the final roadway surface made excessive settlements unacceptable after fills were placed. In addition, all bridge

abutments were required to be placed on pile foundations, a typical Salt Lake Valley area requirement.

There were several construction processes and methods used on this project which had been used in highway construction elsewhere in the U.S. but had not been previously considered by UDOT for Utah. Lime cement columns, stone columns, wick drains, mechanically stabilized earth (MSE) walls, and geofoam and lightweight fill were used to accelerate, reduce or eliminate settlement (Postma 2004, Postma et al. 2002). In addition to the settlement innovations, there were structural innovations including the use of pre-cast pre-stressed concrete girders spliced together, transversely post-tensioned concrete decks, stay-in-place pre-stressed concrete deck panels, jumbo slabs, and moment slabs. Also unique to the project were the seismic design criteria. The Salt Lake Valley lies within a seismically active zone which made the design parameters for the seismic design of structures and walls important. Wasatch used a combination of seismic criteria based on AASHTO criteria and the California methods developed after the Loma Prieta earthquake.

Quality hooks

The decision to place significant responsibility and control in the hands of the design-builder created a concern about the quality of the project. To ensure a quality product would be provided, UDOT built quality measures into the contract referring to them as the project's "quality hooks" (Drennon and Higgins 1997). For example, best value selection allowed the owner to select based on price and technical factors. In addition, it was believed the reimbursement of a portion of the proposal costs would encourage more effort and quality in the proposals so there was a $950,000 stipend offered to the unsuccessful proposers. There was also a long-term maintenance option, it was believed requiring the design-builder to potentially be

responsible for the performance and maintenance of what was designed and constructed would lead to higher quality.

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KNIGHTDALE CONNECTOR
"East Wake Expressway"

Location: Wake County, North Carolina
Owner: North Carolina Department of Transportation (NCDOT)
Contractor: Barnhill Contracting Company
Designer: HDR Engineering, Inc.
Initial Cost Estimate: $57 million
Contract Amount: $45.7 million
Final Cost: $46.2 million
Timeframe: July 2003 to September 2006
Brief Project Description: Construction of an approximately 1.47-mile connector between U.S. 64 and the U.S. 64 Bypass

Need

The Wake County transportation planning group rated U.S. 64 the worst traffic bottleneck in the Triangle—Raleigh, Durham, Cary (AASHTO 2005). Nearly 60,000 motorists traveled on U.S. 64 between Raleigh and Knightdale each day which was approximately one-third more vehicles than the road was designed to accommodate. The increase was in part due to an increase in commercial development within the corridor which exacerbated the traffic congestion already caused by commuters living in eastern Wake County and beyond. One of the Department's solutions to relieve the congestion was a bypass road south and parallel to U.S. 64. Commuter complaints led the legislature to approve a connector road to link U.S. 64 to the U.S. 64 Bypass.

Design-Build Project Delivery Decision

NCDOT was authorized through state legislation to use design-build to complete a maximum of 25 projects per year between 2003 and 2009 (AASHTO 2005). NCDOT decided to use design-build for the Knightdale Connector to meet the public demand to be provided the road in a timely manner.

Work Required

The Knightdale Connector, also known as the Eastern Wake Expressway, is approximately 1.47 miles of six-lane, variable median highway on new right-of-way, with one interchange and six bridges (AASHTO 2007). The Connector begins at the south end of U.S. 64 Bypass just east of the Hodge Road interchange and extends northward to the proposed interchange at existing U.S. 64 between Hodge Road and Lynnwood Road.

The final Environmental Impact Statement (EIS) covered both this project and the Knightdale Bypass which was being constructed at the same time but began prior to the Knightdale Connector (AASHTO 2005). The permit modifications for this project were the responsibility of the design-build team, a first for NCDOT.

Procurement Process

Forty-three design-build teams responded to the Request for Qualifications. The Department asked seven teams to submit Statements of Qualifications. The Department short-listed five teams and provided them the Request for Proposals (RFP). The RFP phase involved a two-step procedure which separated the technical proposals from the fixed price proposals.

Technical proposals were evaluated by the Technical Review Committee on how well they addressed the following specified evaluation criteria (NCDOT 2003):

- Responsiveness to RFP (57 pts.)
- Schedule and Milestones (20 pts.)
- Innovation (10 pts.)
- Maintenance of Traffic and Safety Plan (5 pts.)
- Oral Interview (8 pts.)

Based on the technical score, a quality credit percentage was assigned to each proposal (NCDOT 2003). The maximum quality credit percentage for this project was 25%, so a technical score of 100 received 25.00%, a technical score of 99 received 24.17%, a technical score of 98 received 23.33%, and so on. Each team's price proposal was multiplied by the quality credit percentage earned by the team's technical proposal. This resulted in a Quality Value of the team's technical proposal that was then subtracted from each team's price proposal to obtain an Adjusted Price. The team with the lowest Adjusted Price was awarded the contract. The calculation for the quality adjusted price is shown in the formula below.

$$\text{Quality Adjusted Price} = \text{Price Proposal} - \underbrace{(\text{Price Proposal} * \text{Quality Credit})}_{\text{“Quality Value”}}$$

Project Details

Environmental Permits

In conjunction with the Knightdale Bypass, which was being constructed at the same time, NCDOT acquired most of the permits for the Connector prior to issuing the RFP but transferred permit modification responsibility to the design-build team (AASHTO 2005, AASHTO 2007). Typically, NCDOT retained responsibility/ownership of all permits necessary for its projects, marking this project as a significant departure (AASHTO 2005). The RFP stipulated the design-build team was responsible for compliance with all permitting agencies and all approvals were binding on the design-build team. Ownership of the permits remained in NCDOT's name, but the risk in terms of responsibility for the necessary modifications was transferred to the design-build team. The contract also indicated mitigation measures initially presented as part of the final Environmental Impact Statement were also project commitments. Any modification to a permit required the Department and the relevant agency's approval prior

to the commencement of construction activities, and all permits and permit modification requests had to be routed through NCDOT. The permitting agencies did not allow the design-build team to submit multiple applications for developing a "staged permitting" process for phased construction activities.

"Over-the-shoulder" design reviews

NCDOT worked closely with the design-build team to develop the design in an "over-the-shoulder" design review process (AASHTO 2005). In addition, and although not listed as an RFP requirement, an on-site Natural Resource Specialist was voluntarily provided by the design-builder to ensure regulatory compliance of the plans. The specialist also served a design oversight function to ensure any necessary environmental requirements were met during design minimizing the number of environmental related comments from the permitting agencies after the design was submitted for review.

Incentives for minimization of environmental impacts

Extensive impact minimization efforts were incorporated by the Department as part of the procurement of the environmental permits (NCDOT 2003, AASHTO 2005). NCDOT included incentives encouraging further reduction of impacts to the environmentally sensitive areas within the project boundaries. Incentive payments were offered for reductions in impacts to wetlands, steams, and riparian buffer areas.

The contractor was encouraged to continually apply further minimization efforts during the final design. Development of acceptable mitigation which resulted in the restoration of jurisdictional resources was considered eligible for incentive payments and in addition, the development of any innovative approach implemented to minimize impacts to environmentally sensitive areas for this project would receive an additional one-time monetary bonus if they

could be implemented on future NCDOT projects. Barnhill (2003) proposed the following innovations:

- Designing median areas and ditches to conform to North Carolina Department of Environment and Natural Resources' grass swale Best Management Practices requirements,
- Using retaining walls to reduce impacts to environmentally sensitive areas,
- Using Type VI AASHTO girders in lieu of Type IV girders on the Mango Creek bridges to reduce wetland impacts from piers,
- Reducing Mango Creek bridge bents to three columns per bent from four columns per bent to reduce wetland impacts from piers,
- Adjusting Mango Creek bridges span arrangements to keep piers out of Mango Creek's braided channels,
- Providing deck drains on the Old Faison Road bridge at the future curb line to account for future stormwater spread,
- Using composite design elements and up to 45m girders to reduce the Old Faison Road bridge to three spans to provide improved aesthetics and better value, and
- Building the Old Faison Road bridge just above existing ground and excavating underneath after traffic is shifted onto the new bridge to simplify traffic control and eliminate the need for temporary shoring.

Connecting Ramp

The concurrent construction of the Knightdale Bypass and the Knightdale Connector, the environmental permit that covered both projects, and issues with the scope left the responsibility for the interchange connecting the two projects in question. The Department added it to the

Knightdale Connector and compensated the design-build team for the work, an issue that a member of the Department indicated was easily handled.

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ST. GEORGE ISLAND BRIDGE REPLACEMENT
"Bryant Patton Bridge"

Location: Franklin County, Florida
Owner: Florida Department of Transportation (FDOT)
Contractor: Boh Bros. Construction
Designer: Jacobs/Sverdrup Civil Engineering
Initial Cost Estimate: $82 million
Contract Amount: $71.675 million
Final Cost: $73.4 million
Timeframe: November 1998 to July 2004
Brief Project Description: Replacement of the SR 300 St. George Island Bridge ("Bryant Patton Bridge") with an approximately 4.1-mile new structure in the Apalachicola Bay/St. George Sound connecting East Point to St. George Island

Need

The original bridge and causeway were built in 1965 tying the town of Eastpoint and State Routes 98 and 319 to St. George Island and replacing ferry service to the island (Toussant 2003, Ensley 2002, Zendegui et al. 2005, Silver 2004). The original structure contained two bridges separated by a causeway, had a total length of about 20,000 feet, and contained two 11-foot lanes and no shoulders. The two bridges with connecting causeway contained a low level of simply supported concrete, a high level of steel girder with concrete decking, and vertical clearance over the navigational channel of 50 feet. The north bridge was approximately 7120 feet and the South bridge 6000 feet. The south bridge spanned a heavily traveled stretch of the Gulf Intracoastal Waterway and analysis showed the substructure was not adequate to withstand the projected loads from ship impacts. In addition, the corrosive salt water and the heavy wave action of the bay had damaged the substructure. Most of the piling had been retrofitted with cathodic protection jackets to stop corrosion. Also, the lack of a shoulder and substandard rail caused safety concerns. Despite the repairs in 1985 after hurricanes Kate and Elena and a rehabilitation in 1994, the functional obsolescence and projected high maintenance costs led to the need to replace.

There were three important considerations for the replacement of the bridge (Silver 2004). First, the bridge provided the only vehicular connection between East Point and St. George Island and was a hurricane evacuation route. The existing structure lacked safety shoulders, had inadequate lane widths, and had substandard barrier rails. Second, the constant wave action of the aggressive marine environment resulted in erosion near the existing seawalls of the causeway. Third, maintenance activities carried out from the bridge deck caused traffic delays.

In addition, the traffic volumes had been steadily growing as the area developed. It was expected as the area continued to grow, there was also going to be a steady increase in traffic volumes.

Design-Build Project Delivery Decision

Local opposition and environmental concerns led to the cancellation of another project and FDOT was in danger of losing the federal funding committed to that project (Toussant 2003). By choosing design-build for the St. George Island Bridge, the Department was able to include the project in its work plan in time to take advantage of the available funds.

In addition to the funding, there were four other main reasons why the project was a good candidate for design-build (Toussant 2003). First, there was no right-of-way required. Second, the nature of the site and the environmental concerns lent themselves to the flexibility and the opportunity for innovation design-build allowed the contractor. Third and fourth, design-build would reduce the overall project delivery time and administrative costs.

At the time, this was the largest design-build project for the Department (Ensley 2002).

Work Required

The St. George Island Bridge project involved the replacement of a 4.1-mile bridge over Apalachicola Bay in some of the most environmentally sensitive waters in North America (FHWA 2005, Toussant 2003). The Apalachicola Bay accounted for 90 percent of the oyster harvest in Florida, so the bridge had to be built with minimum impact on the 10,600 acres of oyster beds. The Bay was also home to several endangered species, including the Gulf Sturgeon and West Indian Manatee and the causeway was the home of four kinds of nesting migratory birds—least terns, royal terns, sandwich terns, and laughing gulls.

The state division of Aqua-Culture lobbied the DOT to build the new bridge several miles east of the old bridge where it would not cross oyster beds (Ensley 2002, FDOT 2005). The idea was rejected by the DOT because it would have required the purchase of new right-of-way on the mainland and island and the relocation would have also taken the bridge away from the commercial area of the island.

The new bridge, constructed just west of the old bridge and causeway, was a 4.1-mile continuous span pre-stressed concrete bridge containing two 12-foot lanes with two 10-foot emergency lanes (Wood 2003). At the time of construction, it was the third longest bridge with the longest post-tensioned, spliced girder span in Florida. The five-span unit was nearly 1,200 feet long.

The new bridge was comprised of two parts: (1) the low portion causeway three miles long, mostly on the North or mainland side, with approximately a 14-foot clearance above the water, and (2) the channel or high part with a 65-foot vertical clearance from the water (Toussant 2003, Silver 2004). The low-level superstructure consisted of bridge deck spans supported by pile bents. The bents were pre-cast caps typically supported by three 54-inch post tensioned

cylinder piles. The girders for the low-level section were 125 feet long, 78-inch-deep Florida Bulb T concrete girders with four girder lines used. The high-level superstructure consisted of 30 waterline footing piers of cast-in-place caps and columns supported by four to fifteen piles each. The high-level typically consisted of simple span 78-inch-deep Florida Bulb T concrete girders, with spans of 140 feet, with five girder lines used. The main channel unit was a continuous five-span spliced I-girder design with five girder lines and maximum spans of about 260 feet. The five-span unit traversed the most critical reach of the ship impact zone, and the longer span reduced the number of and the size requirements of the substructure elements. There was a total of 650 piles, mostly three per bent, ranging in length from 70 to 96 feet (Silver 2004).

There were several key improvements featured in the new bridge (Ensley 2002, Zendegui et al. 2005). First, as mandated by the modern federal standards, the hump over the Intracoastal Waterway through the bay was 65 feet above the water, 15 feet higher than the old bridge. Second, the new bridge had two 12-foot traffic lanes along with two 10-foot auxiliary lanes the old bridge did not contain. Third, the deck of the replacement bridge was 15½ feet above the water, 2½ feet higher than the old bridge, a height increase that was intended to reduce the flooding the old bridge and causeway suffered in storms. Fourth, the new bridge had guardrails which meet federal safety standards.

Procurement Process

The Department began by advertising the project then short-listed three of the teams who responded to the RFQ and provided them with the RFP. The RFP phase involved a two-step procedure which separated the technical proposals from the fixed price proposals (FDOT 1998).

The RFP outlined the following as the weighted criteria to be used in scoring the technical proposals (FDOT 1998):

- Innovation and Aesthetics (5 pts.)
- Environmental Protection (20 pts.)
- Maintainability and Warranty (15 pts.)
- Construction Methods (15 pts.)
- Schedule (5 pts.)
- Design and Geotechnical Services/Investigations (15 pts.)
- Design-Build Experience (5 pts.)
- Coordination (10 pts.)
- Quality Control Plan (10 pts.)

The Selection Committee publicly opened the sealed bid proposals and awarded the contract to the firm with the lowest adjusted score calculated using the following formula (FDOT 1998):

$$\text{Adjusted Score} = \frac{\text{Lump Sum Price Proposal}}{\text{Technical Score}}$$

Project Details

Environmental conditions

This project was in an environmentally sensitive area and the following were included as environmental criteria (Toussant 2003): (1) oyster reef protection; (2) preservation of nesting habitats; (3) protection of Gulf Sturgeon and West Indian Manatee; (4) water quality; (5) emergency response plan; (6) work in water less than seven feet deep to be approved by permit; (7) schedule to include 150 days for permit processing; (8) no steel girders, piles or stay-in place metal forms; (9) no dredging.

The Boh Bros./Sverdrup team took the following steps to manage and mitigate environmental effects on Apalachicola Bay (Toussant 2003):

- Performed adequate up-front site investigation during the proposal stage to reduce problems with unexpected site conditions,
- Determined the project's potential short- and long-term environmental ramifications,
- Met with all permitting agencies prior to submitting the proposal,
- Located existing oyster resources in Apalachicola Bay along the proposed alignment through a combined bathymetric and oyster survey to pinpoint the at-risk oyster resources and design a construction methodology to minimize effects on them,
- Addressed and formulated solutions to major permitting issues which included determining appropriate offsite locations for compensatory stormwater treatment,
- Developed plans to use portions of the existing bridge to create artificial offshore reefs and shoreline protection for the causeway island,
- Devised a construction schedule to minimize effects on migrating sturgeon populations and nesting birds,
- Assisted with and sponsored the relaying of nearly 40,000 bushels of at-risk oysters,
- Improved drainage and constructed more than 100 stormwater retention areas off-site to offset the 23 acres of direct runoff into the bay from the new bridge.

Design-build was advantageous for two reasons: (1) it allowed the Department to encourage innovative construction techniques to minimize disturbance to the bay bottom, and (2) it allowed the engineer to design to the strength of the contractor. The contractor suggested the use of an unusually sized 54-inch diameter pile (Silver 2004). The piles, which the contractor had used before, were fabricated in 16-foot-long sections, had a 38-inch diameter hollow core

and 8-inch-thick wall with holes for prestressed and grouted steel tendons. The innovative pile system offered advantages over the conventional piles. Precast cylinder piles could carry a greater load than alternative pile designs, which allowed the bridge to be constructed on longer spans founded on fewer piles. This made pile driving less time consuming, reduced the construction schedule and minimized the effect on the sensitive bay bottom. In the low-level portion of the bridge, which was more than three miles, only three piles were needed at each pier, compared to the six or more piles normally required for smaller conventional piles. If a standard 30-inch pile had been used, approximately 42 would have been needed in the main channel instead of 15 of the larger piles.

Use was also made of construction techniques specially designed for shallow water. Shallow-draft barges with deck engines were employed, and the stockpiling of equipment and materials was kept to a minimum.

Risk Management: Oysters

The Department removed the oyster mitigation from the design-build contract and handled this portion of the work themselves (FHWA 2005, FDOT 2005). The Department hired a design-build consultant to work with the permitting agencies and to assist them in replanting oysters to account for those destroyed. Removing this portion of the project not only removed this as an area of risk for the design-build team, but also allowed the owner to control a portion of the project important to its constituents. In the effort to reduce the impact to the oyster crop, oyster relays were coordinated and carried out by oystermen.

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INTERSTATE 4 IMPROVEMENT PROJECT

Location: Polk County, Florida
Owner: Florida Department of Transportation (FDOT)

Contract 1
Contractor: Jones Brothers Construction, Inc.
Designer: CH2M Hill
Initial Cost Estimate: $71.2 million
Contract Amount: $59.6 million
Final Cost: $65.7 million
Timeframe: January 2002 to August 2005
Brief Project Description: Reconstruction of approximately 3.8 miles of Interstate 4 from West of Memorial Boulevard to West of the I-4/U.S. 98 interchange

Contract 2
Contractor: Martin K. Eby (bought by Lane Construction)
Designer: HDR Engineering, Inc.
Initial Cost Estimate: $49.0 million
Contract Amount: $72.8 million
Final Cost: $73.5 million
Timeframe: January 2002 to July 2005
Brief Project Description: Reconstruction of approximately 16.2 miles of Interstate 4 from East of the I-4/U.S. 98 interchange to East of County Road 557

Contract 3
Contractor: Hubbard Construction Company
Designer: Jacobs Civil Engineering, Inc.
Initial Cost Estimate: $71.5 million
Contract Amount: $62.2 million
Final Cost: $65.7 million
Timeframe: January 2002 to August 2005
Brief Project Description: Reconstruction of approximately 8.9 miles of Interstate 4 from East of County Road 557 to the Osceola County line

Need

Interstate 4 (I-4) is the major East-West thoroughfare across Central Florida (FDOT 2005). Known as "Central Florida's Crossroad," I-4 connects the Tampa Bay area on the Gulf Coast with Orlando and Daytona Beach on the Atlantic Ocean. At the time, I-4 in Polk County was functioning above capacity from Memorial Boulevard to U.S. 27 and at an inefficient level from U.S. 27 to the Osceola County line.

As a catalyst for economic development and tourism, the widening of I-4 was a top priority for FDOT and the Polk County Transportation Planning Organization (FDOT 2005). Widening the interstate by one lane in each direction would further the Department's mission to provide a safe transportation system, enhance economic prosperity and preserve the quality of Polk County's environment and quality of life. In addition, the project improved I-4 as a hurricane/emergency evacuation route.

This project was to lay the groundwork for the ultimate build-out of the interstate (FDOT 2005). Knowing the roadway was already operating above capacity and these traffic levels were expected to increase greatly with time, FDOT created a master plan to ultimately transform the Polk County section of I-4 from its current four lanes into a 10-lane highway. Additionally, the plan included the construction of a high-speed rail system in the median.

Design-Build Project Delivery Decision

Due to the overwhelming logistics of the entire project, including the requirement to rebuild five interchanges and replace three bridges, and the fact it all needed to be completed in a short time frame, FDOT broke the job into four contracts, each to be handled by separate companies (Engineer D).

The Department originally planned to deliver the project using design-bid-build and developed the plans to approximately 60% complete but was waiting for funding to proceed (Engineer D). When September 11 occurred, the Department received an influx of money including the Governor's Economic Stimulus package, and the district decided to put approximately $200 million into the I-4 corridor. This resulted in three of the four contracts being design-build while one remained design-bid-build.

Work Required

The Interstate 4 Improvement Project involved the rehabilitation or reconstruction and widening of approximately 32.4 miles of I-4 from west of Memorial Boulevard in Lakeland to the Polk/Osceola County line (FDOT 2005). In addition, the project involved the addition of a 10-foot shoulder in most areas, reconstruction of five interchanges, widening of three bridges on I-4, and replacement of nine bridges crossing over I-4.

The project was composed of eight legs grouped into four contracts, three were design-build contracts and one design-bid-build. The four contracts were as follows:

- Contract 1: Memorial Boulevard to West of the I-4/U.S. 98 interchange (Design-build)
- Contract 2: East of the I-4/U.S. 98 interchange to East of County Road 557 (Design-build)
- Contract 3: East of County Road 557 to the Osceola County line (Design-build)
- Contract 4: I-4/U.S. 98 interchange (Design-bid-build)

The three design-build segments are described in more detail below. Because of the nature of this research the design-bid-build project was not evaluated and, therefore, is not discussed.

Contract 1: **Memorial Boulevard to West of the I-4/U.S. 98 interchange** (FDOT 2005)

Description

This segment included the expansion of I-4 from a total of four lanes to six lanes from west of Memorial Boulevard to west of U.S. 98, the complete reconstruction of the I-4/Memorial Boulevard and the I-4/Kathleen Road interchanges, the replacement of three crossover bridges, and major improvements to two bridges one of which served CSX.

Length: 6.3 miles

Interchanges

The I-4/Memorial Boulevard and the I-4/Kathleen Road interchanges were reconstructed. At the time, the I-4/Memorial Boulevard Interchange only provided access to Memorial Boulevard from I-4 eastbound and access to I-4 westbound from Memorial Boulevard. The new I-4/Memorial Boulevard Interchange was designed to be a full directional interchange with east and westbound on and off ramps. The I-4/Kathleen Road Interchange improvements included dual turn lanes to the I-4 ramps and two additional lanes on Kathleen Road.

Bridges

The bridges crossing over I-4 at Bella Vista Street, Swindell Road, 10th Street and Griffin Road were replaced with higher and longer bridges which allowed for the ultimate 10-lane configuration of I-4. In addition, the CSX Railroad Bridge crossing over I-4 in West Lakeland was modified.

Contract 2: East of the I-4/U.S. 98 interchange to east of County Road 557 (FDOT 2005)

Description

This segment included I-4 from east of U.S. 98 to east of County Road 557 and involved the expansion of I-4 from four to six lanes, the replacement of four crossover bridges and the widening of three bridges. The two existing lanes in both directions were milled and resurfaced with 2 inches of asphalt. On the new sections, 6.5 inches of asphalt were placed on top of a 12-inch limerock base.

Length: 16.3 miles

Bridges

The Carpenters Way, Old Combee Road, Mt. Olive Road, and CR557A bridges crossing over I-4 were replaced. The I-4 bridges crossing over Socrum Loop Road, Berkley Road and

SR33 were widened. The ramps at the SR559, CR557 and the Polk Parkway bridges crossing over I-4 were lengthened.

Contract 3: East of County Road 557 to the Polk/Osceola County Line (FDOT 2005)

Description

This portion of the project involved expansion of I-4 from four to six lanes from east of County Road 557 to the Polk/Osceola County Line, the complete reconstruction of the I-4/U.S. 27 Interchange, and the replacement of the County Road 54/Ronald Reagan Parkway bridge. Also, improvements were made to U.S. 27, south of I-4 to Sand Spur Circle and north of I-4 to south of Waverly Bar/Dunson roads.

Length: 9.8 miles on I-4, 2 miles on U.S. 27

Interchanges

The I-4/U.S. 27 Interchange was reconstructed. A pair of two-lane bridges crossing over I-4 at U.S. 27 were replaced by a new bridge with six traffic lanes and a sidewalk on both sides. All I-4 on and off ramps were replaced with longer, wider ramps.

Bridges

The bridges over I-4 at U.S. 27 and County Road 54/Ronald Reagan Parkway were replaced.

Procurement Process

The Department began by advertising the project. Interested teams submitted Statements of Qualifications in response to the RFQ. FDOT short-listed three teams and provided them with the RFP. The RFP phase involved a two-step procedure which separated the technical proposals from the fixed price proposals.

The Technical Proposals were evaluated and a technical score for each firm was based on the following criteria indicated in the RFP:

- Environmental Protection/Commitments (10 pts.)
- Maintainability (5 pts.)
- Warranty (15 pts.)
- Schedule (10 pts.)
- Coordination (5 pts.)
- Quality Control Plan (10 pts.)
- Maintenance of Traffic (15 pts.)
- Roadway and Structures Design (15 pts.)
- Geotechnical Services (10 pts.)
- Wildlife Crossings (5 pts.)
- Construction Engineering Inspection (CEI) (10 pts.)
- Economic Stimulus Initiative (5 pts.)

The Selection Committee publicly opened the sealed bid proposals and awarded the contract to the firm with the lowest adjusted score calculated using the following formula (FDOT 2002):

$$\text{Adjusted Score} = \frac{\text{BPP} + (\text{PCT} * \text{UDC})}{\text{TS}}$$

where BPP=Bid Price Proposal
PCT=Proposed Contract Time
UDC=User Daily Costs ($10,000.00 per day)
TS=Technical Score

Project Details

Innovative design

Increasing the vertical clearance under the CSX Railroad bridge without demolishing and replacing it with a higher bridge was one of the key design challenges on Contract 1 (FDOT 2004a). FDOT specified a minimum vertical clearance of 18 feet for all I-4 bridges to accommodate the possible future use of the I-4 median as a high-speed rail corridor. The existing CSX bridge had a clearance of 16.4 feet above I-4, and it could not be elevated. To solve the problem, the designer drafted plans to lower the travel lanes and median under the CSX Railroad bridge and the nearby Bella Vista Street and Kathleen Road bridges by an average of 1.5 to 2 feet. This solution provided the required clearance under all three bridges and saved money by allowing the new Bella Vista Street and Kathleen Road bridges to be built at the existing elevation eliminating the extra costs which would have been incurred with raising the level of the streets they connected.

Utilities

The project had extensive utility conflicts, so the Department made the decision to remove this portion of the work from the design-build contract. A member of the Department said including this reimbursable work in the contract would have inflated the bids by 200 to 300% (Engineer D). He indicated including the work in the design-build contract would have prevented some time delays, but it would have come at a high cost to the Department. In addition, this member of the Department was able to negotiate with the utility company to get them to accept a replacement easement within the interstate right-of-way. If this had not occurred, they would have had to replace the easement outside the right-of-way which would

have involved acquiring a condominium for between $12 to $20 million with a one to two-year court process creating additional delay costs.

Organizational structure

The owner entered a contract with the contractor who was responsible for providing construction, design and inspection services. The contractor had subcontract agreements with a designer and inspector who were both from the same organization. A member of the construction team said the following about the organizational structure and the relationship dynamics (Engineer E):

> "The FDOT was not very participative during the project, and communication between the engineering and the construction team was difficult at times. Also, the inspection staff was torn between working for the contractor and the FDOT. This made the decision-making process challenging for them.
>
> The arrangement was the D-B firm was made up of engineering, construction, and construction inspection. The difficult thing was the inspection team was operated by HDR which was the same as the engineering firm. In the beginning this seemed like a good idea, but it proved to be difficult for the inspection team because the construction company was the leader of the team and also had two different contracts with the engineer and one with the inspection side. The inspection side felt as if they worked for the FDOT since they were responsible for making sure the construction activities were performed with the FDOT specifications and they also had ties to the engineering side and did not agree with some of the ways they designed certain things.
>
> This was the first time Eby had worked with the design engineer HDR. HDR as a corporation had experience with design-build projects but the team assigned to this project did not have any experience. This made it challenging to work together to resolve field problems because the engineers did not like the contractor questioning their design or taking direction from a contractor."

The team dynamic is exhibited in a decision about the guardrail. An FDOT engineer said the contractor wanted to reuse existing guardrail in new installations citing efficiency and time, but the engineer disagreed with this decision.

Resources

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INTERSTATE 10 BLACKWATER BAY BRIDGE REPLACEMENT

Location: Santa Rosa County, Florida
Owner: Florida Department of Transportation (FDOT)
Contractor: Traylor Bros.
Designer: Finley-McNary Engineers, Inc.
Contract Amount: $30.4 million
Final Cost: $33.0 million
Timeframe: October 1995 to January 1998
Brief Project Description: Emergency replacement of twin bridges on Interstate 10 spanning across Blackwater Bay

Need

The Department was concerned about the structural integrity of the existing bridges due to excessive settlement and vibrations (Woods and Crapps 2008). The problem was accelerated by hurricanes Erin and Opal which passed through Pensacola, FL in the summer of 1995 and severely damaged the bridges. Since the bridges were along the main traffic corridor for the Florida Panhandle, FDOT requested an emergency design-build contract for quick replacement of the structures.

Design-Build Project Delivery Decision

The safety concerns along with the location of this project created the need for a fast-track process (Woods and Crapps 2008). Design-build was the delivery method which provided that, so the Department requested and was granted emergency funds from the Federal Highway Administration (FHWA) to replace the bridge. This project was FDOT's first major bridge design-build contract.

Work Required

This project involved the replacement of existing twin bridges with new structural steel bridges approximately 3,000 feet long (FDOT 1995). In addition, the project included one mile

of approach roadway and the associated civil work, as well as the demolition of the two existing bridges.

The Department asked the proposing design-builders to develop designs that would allow for future widening of the superstructure (FDOT 1995). The substructure for each bridge was to be designed and constructed to accommodate an ultimate cross section consisting of three 12-foot lanes and two 10-foot shoulders with barrier railing. The superstructure was to be developed to the degree necessary to determine the requirements for the substructure for the ultimate cross section but designed and detailed for a cross section to be built that contained as a minimum two 12-foot lanes, a 10-foot right shoulder, and a 6-foot left shoulder with barrier rails.

The original bridge was completed in 1968, was 2931 feet long and consisted of 40 spans (Woods and Crapps 2008). The pile bent supported spans were typically 55 feet and the pier supported spans were typically 92 feet. The channel crossing was a three-span continuous unit consisting of 120-foot span, 170 feet across the channel followed by a second 120-foot span. Prestressed concrete piles provided foundation support.

Influencing the new bridge design were the existing bridge conditions, maintenance of evacuation routes, limits of the right-of-way, scour due to the tide and current, and sensitivity of the river environment. Also important to the design team was a long-life, cost-effective bridge designed within the FDOT and American Association of State Highway and Transportation Officials (AASHTO) criteria.

The new twin 2,928-foot dual lane bridges were designed using 24-inch prestressed concrete piles varying in length from 90 to 120 feet (Traylor 1996). A total of 456 piles were used. Each bridge contained 15 river piers between end bents. The typical footings were 28 feet by 26 feet by 5 feet and supported by 15 piles with the navigation channel footings slightly larger

at 34 feet by 16 feet by 6 feet with 18 piles in each. As required by the FDOT in an extremely aggressive saltwater environment, all footings were partially submerged. Typical 16 foot by 4 ¼ foot rectangular columns which reached a maximum height of 34 feet were atop the footings. The pier construction was completed with hammer-head type caps.

The superstructure included 224 steel plate girders which spanned the 184-foot pier spacing and supported a 48-foot-wide cast-in-place deck (Traylor 1996). The channel girders spanned 220 feet between piers. To speed production of the deck, Traylor Bros. elected to use approximately 175,000 square feet of stay-in-place metal decking between girders. At the bridge ends, 18,000 square feet of Tensar mechanically stabilized earth (M.S.E.) wall and 14,000 square feet of precast slab-and-pile seawall were used for the embankment structures.

Traylor first constructed the new westbound bridge just north of the existing structure and then rerouted traffic to the new bridge. The old bridges were then demolished, and the new eastbound bridge constructed over the same alignment as the old eastbound structure. After completion of both bridges traffic was shifted to the final configuration which was the utilization of both new bridges.

Procurement Process

The Department began by advertising the project. Four teams were pre-qualified by FDOT and the FHWA to submit proposals. Due to the fast-track nature of the project, the design-build teams had only weeks to complete proposals with 30% plans. The Department used a two-step selection process to award the contract (FDOT 1995).

The technical proposal score was determined by a selection committee who scored each proposal based on its responsiveness to the evaluation criteria specified in the RFP:

Technical Criteria—

- Innovativeness (6 pts.)
- Maintenance of Traffic (10 pts.)
- Environmental Impact (10 pts.)
- Aesthetics (6 pts.)
- Maintainability (6 pts.)
- Ability of Future Widening (6 pts.)
- Redundancy (6 pts.)
- Understanding of Scope of Work and Services (12 pts.)
- Geotechnical Services and Investigation (12 pts.)
- Familiarity of the Design to the Department (6 pts.)

Management Criteria—

- Contractor experience with type of bridge proposed (4 pts.)
- Contractor's quality control plan (4 pts.)
- Previous joint consultant-contractor experience & design-build experience (4 pts.)
- Experience and availability of staff (4 pts.)
- Experience of geotechnical staff (4 pts.)

Price proposals were opened separately. The contract was awarded based on an adjusted score method in which a formula was used to adjust the price for the number of days

required to complete the project (FDOT 1995). The formula was

$$\text{Adjusted Score} = \frac{A + B}{TS}$$

where A = Bid Price
B = (PCT * TVC)
PCT = Proposed Contract Time
TVC = Time Value Costs ($30,000 per day)
TS = Technical Proposal Score

The contract was awarded to the team with the lowest adjusted score.

Project Details

Electronic Communication

One aspect of the project indicated as a time-saver for the design-build team was the electronic transfer of data (ENR 1998). Instead of waiting for the completion of design drawings to prepare the shop drawings, the transfer of information electronically allowed for the simultaneous preparation of both sets of drawings. Finley-McNary was able to concentrate its efforts solely on the design calculations which were then sent electronically to Tensor Engineering, the detailer, who used the coordinates and basic design information to calculate the structure's geometry and develop detailed plans. The integrated design/detail drawings were then sent electronically to the designer for a final check and review. Tensor was able to prepare the bills of material directly from the detail drawing files and then sent the bills electronically to PDM Bridge for fabrication expediting the material ordering process and the delivery of raw materials from the mill.

Owner supplied information: Geotechnical data

The Department provided its available geotechnical information. Included in this information were soil borings which were mostly in the location of the bridge and essentially none were on the roadway approaches. The contractor was responsible for additional site

investigation including borings, scour analysis, settlement monitoring of the existing bridge during pile driving, and determination of the cause of the settlement of the existing bridge (FDOT 1995).

In November 1996, a clay layer unknown at the time of bidding caused the failure of the approach to the Westbound Bridge (Dispute Review Board 1997a). The mechanically stabilized earth (MSE) walls which had been installed settled 24 inches. As a result, the walls had to be removed and the bridge approach extended 180 feet.

The unforeseen conditions on the west abutment, a muck pocket, led to a claim which resulted in a Dispute Review Board ruling against FDOT (Dispute Review Board 1997a). The Dispute Review Board ruled the emergency situation caused by hurricane Opal and the resulting short timeframe for preparation of proposals did not allow the design-build firms enough time to absorb all the information given to them. This and the other claims on the project are summarized below.

Dispute Review Board Rulings

There were four issues on this project which required the mediation of a Dispute Review Board (DRB). The issues were as follows:

Issue 1—West Embankment Global Stability Issue

Issue 2—Pile Lengths

Issue 3—Preformed Pile Holes

Issue 4—Bridge Jacking

Issue 1: West Embankment Global Stability Issue (Dispute Review Board 1997a)

At the request of Traylor Bros., Inc and FDOT, on January 23, 1997, the Dispute Review Board held a hearing to consider the dispute over the entitlement of additional compensation—

time and money—for extra work because of unforeseen geotechnical conditions at the west embankment of the new westbound bridge. Traylor argued given the short bidding period of less than 26 days, they were forced to assume the accuracy of the data provided to them by the Department which did not contain boring information at the northern limit of the right-of-way where the bridge was to be constructed to indicate the magnitude, extent, or location of the underlying, highly compressible varying clay layer. The Department argued the contractual language for this design-build project placed total responsibility for design and construction on the contractor and indicated additional soil information would be needed for the design. They stated all information provided by them relative to the soil conditions was correct and therefore differing site conditions had not occurred. In addition, the contract did not allow for additional compensation for differing site conditions or for unforeseen conditions.

On February 20, 1997, the DRB found Traylor Bros./Finley-McNary was entitled to additional compensation for extra work due to uncontemplated and unforeseen site conditions. However, the DRB found there were limits to the scope of the entitlement and believed an attempt should be made by the Department and contractor to negotiate those boundaries. The DRB advised the parties should such negotiations prove unfruitful they would rule as to the limits of justified entitlement. The attempts at negotiating a resolution failed and the parties requested the DRB quantify the justified entitlement.

On September 30, 1997 and October 1, 1997 the DRB held a hearing to evaluate the value of the claim presented. The analyses performed by the contractor and the Department both considered the added value to the contract, but their approaches to the calculation of the entitlement were completely different. The contractor evaluated the actual cost of the work completed, with the exception of an estimated allowance for the original contract items which

were not incorporated in the work, this differed from the Department who determined the value added to be the difference between an estimate of the original plan and an estimate of the as-built project. The contractor also requested a time extension, associated extended overhead for the period of extension, and an impact cost for labor and equipment, the Department considered no time extension, extended overhead, or any impact costs. After review of the material presented and an evaluation of the separate analyses of the claim, the DRB found Traylor Bros./Finley McNary entitled to the following as equitable compensation for extra work due to the uncontemplated and unforeseen site conditions:

1) A time extension to the original contract of 60 calendar days.
2) Additional compensation in the amount of $2,601,526.44.

The compensation for costs included all actual costs for the value-added extra work, extended overhead, impact and/or acceleration costs, and a credit for reduction of items contained in the original proposal.

At the request of Traylor Bros, Inc. and the FDOT, the DRB held a hearing on September 30, 1997 and October 1, 1997 to consider the dispute over altered quantities of the items in Issues 2-4.

Issue 2: Pile Lengths (Dispute Review Board 1997b)

The contractor did not agree with the Department's method for determining the pay quantities for furnished pile lengths utilizing the reference line method. Traylor requested payment for the furnished pile lengths be per the authorized length as recommended by the Geotechnical Engineer.

The Department believed the calculations for piling was fair based on the contract. FDOT included the compensation adjustment for altered quantities for piling in the contract to reduce

risk for all bidders. The contract clearly directed amounts to be included in the lump sum bids and clearly defined the compensation adjustments due for altered quantities and the baseline for additions and deductions in compensation.

The DRB ruled in favor of the Department on this issue.

Issue 3: Preformed Pile Holes (Dispute Review Board 1997b)

The contractor did not agree with the Department that a deduction of $61,000 should be made to the contract for not performing the anticipated number of preformed pile holes. The Department indicated the compensation adjustment for altered quantities for preformed pile holes was included in the contract to reduce risk for all bidders. The contract directed amounts to be included in the lump sum bids and defined the compensation adjustments due for altered quantities. There were no preformed pile holes performed, and the contract defined the baseline for additions and deductions in compensation.

The DRB found the contract did define the baseline for additions and deductions in compensation. The baseline was established at the contract quantity of 122.5 holes, therefore, the contractor's decrease in payment was limited to 25% of 122.5 holes at $500 each (30.625 holes at $500 = $15,312.50). The remaining deduction for 91.875 holes was subject to fair and equitable adjustment.

Issue 4: Bridge Jacking (Dispute Review Board 1997b)

The contractor did not agree with the Department that a deduction of $328,000 should be made to the contract based on ambiguity of the contract language and the fact the Department did not recognize the expense Traylor incurred in utilizing methods to install the new bridge piling without damage to the existing bridges. The Department indicated the compensation adjustment for altered quantities for bridge jacking was included in the contract to reduce risk for all bidders.

The contract directed amounts to be included in the lump sum bids and defined the compensation adjustments due for altered quantities. There was no bridge jacking performed, and the contract defined the baseline for additions and deductions in compensation.

The DRB found the contract did define the baseline for additions and deductions in compensation. The baseline was established at contract quantity of 164 pier/bent jackings. Based on the Department's indication that it was understood by all parties that bridge jacking was considered a major item of work, the baseline was subject to the provisions of Article 4-3.2.1 of the contract entitled Significant Changes in the Character of Work. Therefore, the contractor's increase or decrease in payment was limited to +/-25% of 164 piers/bents at $2,000 each (41 jackings at $2000 = $82,000). The remaining addition/deduction was subject to fair and equitable adjustment.

Resources

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INTERSTATE 77 RECONSTRUCTION

Location: Mecklenburg County, North Carolina
Owner: North Carolina Department of Transportation (NCDOT)
Contractor: Rea Construction Co.
Designer: HDR Engineering, Inc.
Initial Cost Estimate: $65.0 million
Contract Amount: $70.9 million
Final Cost: $85.6 million
Timeframe: September 2001 to July 2005
Brief Project Description: Widening and rehabilitation of approximately 8.1 miles of Interstate 77 from the I-85 and I-77 interchange North to North of the interchange with I-485 (S.R. 2117 Hambright Rd.)

Need

Interstate 77 (I-77) was one of the most heavily traveled corridors in the state, and I-77 through Charlotte had experienced major traffic problems for years (Volker 2002). This project was undertaken to help improve the severe congestion.

Design-Build Project Delivery Decision

In 1998, the General Assembly authorized NCDOT to construct three projects per year under the design-build delivery method (NCDOT 2005). The I-77 project in 2001 was NCDOT's first design-build roadway project (Judy 2003).

Work Required

The project involved I-77 from just south of the I-85 interchange, north roughly 8.1 miles to just south of Gilead Road (Edelen 2002, Volker 2002). The work originally consisted of widening I-77 from two lanes to four lanes in each direction, reconstructing part of the I-85/I-77 interchange, installing Intelligent Transportation Systems components, constructing one new bridge, widening five bridges, placing guardrail in the median, and installing extensive noise walls. The interchange design at I-85 was later revised to accommodate three basic thru lanes and one high occupancy vehicle (HOV) lane in each direction. This resulted in the actual

construction of four new bridges and the widening of three. Widening occurred in the median. Also involved were a culvert extension, grading, paving, drainage, median barrier, guardrail, and signing.

The project also included rehabilitation of the existing pavement. The existing road had originally been built as concrete and was later overlaid with asphalt (Judy 2003). Under Rea's design, the new lanes were to be built with asphalt and the existing mainline milled and replaced with approximately 6-inches of new asphalt.

Procurement Process

The Department began by advertising the project. Twenty-seven design-build teams responded to the RFQ and NCDOT selected the three most qualified teams to submit proposals. These short-listed teams were then provided the RFP which was a two-step procedure with separate technical and fixed price proposals.

The technical proposals were evaluated by the Technical Review Committee using these selection criteria indicated in the RFP:

- Responsiveness to the RFP (48 pts.)
- Innovation (23 pts.)
- Construction (24 pts.)
- Oral Interview (5 pts.)

Based on the technical score, a quality credit was assigned (NCDOT 2001). The maximum quality credit percentage for this project was 15%, so a technical score of 100 would receive 15.00%, a technical score of 99 would receive 14.50%, a technical score of 98 would receive 14.00%, and so on. The contract was awarded to the team with the lowest quality adjusted price. The quality adjusted price was calculated as shown below.

$$\text{Quality Adjusted Price} = \text{Price Proposal} - \underbrace{(\text{Price Proposal} * \text{Quality Credit})}_{\text{“Quality Value”}}$$

Project Details

Earth ramp

Due to the high volume of traffic on I-77, access to the median for construction was a challenge (Judy 2003). Rea devised an innovative solution to construct a 28-foot earthen ramp in the median up to the existing W.T. Harris Boulevard Bridge over I-77. Tying the ramp to the existing bridge meant construction trucks could exit the median without entering interstate traffic. The contractor repainted the bridge lanes to make them narrower for a construction truck lane.

The earthen ramp allowed work to be performed during the day without putting construction trucks on the interstate, helped to accelerate the project, and was cited by the highway patrol for contributing to the low number of accidents on the interstate within the project limits (Judy 2003). The project required asphalt trucks to make an estimated 250 trips per day from the nearby asphalt plant to the jobsite. Before the approval for this idea, NCDOT was going to restrict truck hauling to the night only. Rea’s solution to the median-access problem won it two Work Zone Safety Awards, one from American Road and Transportation Builders Association and the other from the National Asphalt Pavement Association (Judy 2003).

The ramp presented unique design and construction challenges (Judy 2003). The shoring had to support the ramp and protect the proposed Harris Boulevard bridge footings to be constructed at the base of the sheet piling. This meant the sidewall height of the ramp was over 20 feet. Since the front wall of the ramp was to be directly against the existing bridge, deflection

of the sheeting could not exceed 0.5 inch, with only 1-inch of clearance between the ramp and the existing bridge (Judy 2003).

GPS technology

The design-build team implemented what was at the time new technology and innovative construction techniques such as GPS and robotic survey systems installed on dozers, motorgraders, and milling machines (Volker 2002). One system provided automatic control of the blade elevation in three dimensions. The system allowed grading of complex designs such as vertical curves, transitions and super-elevated curves without stakes, stringlines or surveyors. This system provided increased accuracy, enhanced production and the elimination of conventional construction staking methods.

High-Occupancy Vehicle (HOV) Lanes

Initially, all lanes were to be general purpose. Later, NCDOT decided to have both inside northbound and southbound lanes serve as high-occupancy vehicle (HOV) lanes (Judy 2003). With concern about increasing congestion, NCDOT wanted to encourage the public to carpool and use mass transit vehicles (NCDOT 2013). The use of HOV lanes would ease the congestion in the urban areas and address the Department's desires to adopt plans for mass transit HOV lanes and other congestion mitigation practices in preparation for the future.

In December 2001, NCDOT completed an I-77 Sub-Area Study which analyzed the feasibility of including HOV lanes as the inside lanes of the current project, resulting in three general-purpose lanes plus one HOV lane in each direction (NCDOT 2013). Based on the recommendations of this study, in January 2002, the Mecklenburg-Union Metropolitan Planning Organization added a HOV project along I-77 to the urban area's Immediate Project Needs list. With the availability of additional funds, the Department decided to include the HOV lanes in the

ongoing project. In July 2002, the Federal Highway Administration (FHWA) approved an environmental document prepared by NCDOT which proposed designating two of the additional lanes constructed north of the I-85 interchange as HOV. The HOV lane on southbound I-77 was to extend from I-85 through the Brookshire Freeway (I-277) interchange for a total HOV lane length of ten miles, while the northbound HOV lane was to extend north of the I-85 interchange through W. T. Harris Boulevard for a total HOV lane length of about five miles.

The addition of the HOV lane created construction challenges at the I-85/I-77 interchange (Fisher 2004). As the project progressed it was discovered there was insufficient room to get all the lanes under the I-85 overpass. As a result, the project team and NCDOT decided to separate the southbound I-77 HOV lane out into an elevated structure aligned over the northbound HOV lane that would pass over I-85. With the original project requirements, Rea had planned to just widen the existing northbound bridge over I-77 southbound, but the addition of the HOV lane meant Rea had to reconstruct the entire bridge, add a new structure for the HOV traffic over the I-77 southbound ramp, and add a new structure for the HOV traffic over I-85. The actual bridge structures were in a confined space, and as a result Rea had to construct mechanically stabilized earth walls for both the I-77 northbound bridge and the ramp bridge. The supplemental agreement for the HOV change added approximately $11.38 million to the project.

Guardrail

There was a long-term maintenance issue on this project that a member of the Department indicated could have been better scoped (Engineer G). Double lines of guardrail were used in the median instead of concrete barrier rail as preferred by the owner. Although the guardrail met the product scope, it was not NCDOT's preferred product for long-term maintenance because a section of the median is narrow and on a steep slope which makes it

difficult to maintain requiring workers to use weed eaters to cut the grass between the two guardrails.

Bankruptcy

The project was hindered by the financial struggles of the contractor's parent company, J.A. Jones (Quirk 2004, Powers et al. 2003, Judy 2003). For reasons unrelated to this project, the company went bankrupt during the project and was sold to Lane Construction Company. Despite high-level organizational changes, the contractor was able to complete the project with many of the participants on the project remaining the same (Engineer G). In addition, the design-build team lost their major grading subcontractor who went bankrupt independently in the middle of the project.

Resources

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INTERSTATE 85 RECONSTRUCTION

Location: Mecklenburg County, North Carolina
Owner: North Carolina Department of Transportation (NCDOT)
Contractor: Blythe Construction Inc.
Designer: LPA Group
Initial Cost Estimate: $76.1 million
Contract Amount: $87.7 million
Final Cost: $92.3 million
Timeframe: August 2002 to June 2005
Brief Project Description: Widening and rehabilitation of approximately 8.1 miles of Interstate 85 from south of the U.S. 29/NC 49 connector in Mecklenburg County to the Speedway/Concord Mills Boulevard in Cabarrus County

Need

The capacity of Interstate 85 (I-85) no longer met the needs of the community which led to the need to widen it (Pernie 2003).

Design-Build Project Delivery Decision

Legislation in 1998 allowed the Department to do three design-build projects a year, but in 2003, the Department went back to the legislature and obtained the authority to do up to 25 projects per year (Engineer G). The Department chose to use design-build for this project because it could get the product back to the public quicker and at a lower cost than design-bid-build with it estimated the project would be completed four years faster than the normal DOT process—the design process saved at least three years and the construction process at least one year (Pernie 2003).

Work Required

The project involved I-85 from south of the U.S.29/NC49 Connector in Mecklenburg County to Speedway/Concord Mills Boulevard (SR-2467) in Cabarrus County, a distance of approximately 8.1 miles (Pernie 2003). I-85 was widened to eight lanes with a 22-foot median from the U.S.29/NC49 Connector to I-485 and widened to three lanes northbound and four lanes

southbound from I-485 to Speedway/Concord Mills Boulevard. The widening between I-485 and Speedway/Concord Mills Boulevard was intended as an interim improvement, a future project was to widen I-85 to eight or more lanes with the widening occurring mostly in the median.

The project involved the construction of the new lanes and rehabilitation of the existing pavement (Lane Construction 2009). The pavement was full depth asphalt for both the outside and median shoulders and an asphalt base with 14-inch Portland Cement Concrete Pavement for mainline lanes and ramps. The project also included construction of a new bridge structure over I-85, a flyover ramp, reconstruction of an existing bridge over Mallard Creek, widening of an existing bridge, and constructing new ramp tie-ins with five existing interchanges. A concrete median barrier was also constructed for the entire length. The project involved lighting and signage and the construction of an informational traffic system.

The widening of lanes occurred mostly in the median of I-85 (Pernie 2003). One auxiliary lane per direction, for a total of ten lanes, was added to the outside of I-85 between several interchanges within the project limits. In addition to the proposed widening of I-85, the existing US 29/NC 49 connector entrance ramp onto southbound I-85 was reconfigured from a left-hand entrance ramp to a right-hand entrance ramp.

The project was divided into three sections: Northern, Middle, and Southern (Pernie 2003). The Northern section was from the future I-485 to north of Speedway Boulevard and was worked on from February 2003 to May 2004. The Middle section was from the City Boulevard Interchange to the future I-485 and work occurred from March 2003 to December 2004. The Southern section was from of West of the US 29/49 Connector to the City Boulevard Interchange and work took place from April 2003 to December 2004.

Procurement Process

NCDOT began by advertising the project. Of the twenty-five teams who responded to the RFQ, the Department short-listed three. The short-listed teams were required to submit separate price and technical proposals.

The technical proposals were evaluated on how well they addressed the following specified evaluation factors (NCDOT 2001):

- Responsiveness to RFP (45 pts.)
- Schedule and Milestones (20 pts.)
- Innovation (10 pts.)
- Maintenance of Traffic and Safety Plan (17 pts.)
- Oral Interview (9 pts.)

The low bidder was determined by a "Quality Adjusted Price" (NCDOT 2001). Based on the technical score, a Quality Credit Percentage was assigned to each proposal. The maximum percentage for this project was 25%, so a technical score of 100 would receive 25.00%, a technical score of 99 would receive 24.17%, a technical score of 98 would receive 23.33%, and so on. The contract was awarded to the team with the lowest quality adjusted price calculated as shown below (RFP).

$$\text{Quality Adjusted Price} = \text{Price Proposal} - \underbrace{(\text{Price Proposal} * \text{Quality Credit})}_{\text{"Quality Value"}}$$

Project Details

<u>Reconfigured Design</u>

The original plan presented by the Department showed the U.S.29/NC49 traffic merging onto I-85 from under the interstate which meant two bridges needed to be built on I-85 to go over

U.S.29/NC49 and there would be a right-hand merge of traffic into the fast lane of the interstate (Pernie 2003, Engineer G). However, the contractor suggested building one bridge on the U.S.29/NC49 Connector to carry traffic over the interstate. This innovation reduced the bridge schedule by six months and resulted in a more traditional and safer left-hand merge onto the interstate. In addition, traffic on I-85 and the U.S.29/NC49 Connector was not disrupted which also accelerated the construction process.

By choosing design-build, the Department was able to get the product to the public faster and at a lower cost. Building a bridge on the connector saved the Department money by eliminating the need to widen the proposed interstate bridges at a later date. In addition, the maintenance costs for the bridge over the interstate were expected to be considerably less than bridges on the interstate.

Acceleration/Deceleration Lane

A member of the Department indicated critical details were left out of the scope which required the Department to add approximately $1.5 million to the project due to capacity issues. The problem was a result of traffic counts which were not scoped well which resulted in a lane being added connecting an acceleration lane and deceleration lane for an exit ramp.

Resources

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Appendix C

Theory Refinement and Validation Using Triangulation

Supplemental Literature

"Numbers"

Game Theory

Game Theory was mentioned in "Numbers" as potentially useful for determining how to optimize participants. A brief discussion of games that could be applicable is provided below.

In game theory, the vertices are "players," and the players are typically referred to as sets of nodes (Jackson 2008). The full set of players is called the "grand coalition" and subsets are called "coalitions." Jackson (2008) describes cooperative game theory as starting with a society of players, just as a network setting does, but instead of thinking about how the players might be structured in terms of social networks, the foundation is built on simpler structures with the focus on how the players might be grouped into coalitions. There are three key areas of importance (Saad et al. 2009): the characteristic function, the partition function, and the graph form.

Saad et al. (2009) indicate the most common form of a coalitional game is the characteristic function form in which the value of a coalition depends solely on the members of that coalition, with no dependence on how the players are structured.

In the partition form introduced by Thrall and Lucas (1963) the value of a coalition depends on the partition of the coalition that is in place at any time during the game (Saad et al. 2009). Unlike the characteristic form, the value of a coalition has a strong dependence on how the players are structured.

Jackson (2008) says coalitions can only function to the extent they can communicate. In both the characteristic form and the partition form, the value of a coalition is independent of how

the members are connected. Coalitional games in graph form were introduced by Myerson (1977) with communication games based on the characteristic function where connected graphs were mapped into coalitions of players who communicate. This work was generalized by Jackson and Wolinsky (1996) who proposed a richer model than that of communication games, making the value of each coalition a function of the graph structure connecting the members where the value that a society generates depends explicitly and directly on the network structure and how agents are interconnected, not just who they are directly or indirectly connected to as with the communication games.

"Attitudes: Time"

Relational Time

Horizontal time

Focusing on interaction from a time perspective, Medlin (2004) identifies a distinction between "exchange" and "adaptation" mirroring what MacNeil (1974a, 1980a, 2001) refers to as "discrete" and "relational" transactions. Medlin (2004) describes time as either a product or process. In exchange, Medlin indicates time is a product, it is an attribute to be exchanged in the transaction. The exchange is a discrete transaction in which actors offer and agree to the "best" time. In adaptation, time is a process, a dimension of the interaction which defines what can be produced. It is an element within which interaction occurs.

Medlin (2004) says while interaction only occurs in the present, objects of cognition and focus of interaction can be considered at any point in time. For instance, an actor can consider an aspect of future time in the present to plan interaction or interact with an actor in the present to plan a future activity, and an actor can consider an aspect of past time in the present or interact with an actor in the present concerning a past activity, but he cannot interact in either the future

or past. Medlin (2004) says these distinctions about the location of the object and focus of interaction in time have two main implications. First, the location of objects in time separates economic and adaptive interaction. For economic exchange the object of interaction is the present, for adaptative interaction the focus is the future, descriptions that align with MacNeil's (1974a, 1974b, 1980a) descriptions of "presentiating" and "futuruizing." According to Medlin, exchange interaction is embedded in the present and structured by the coordination of resources, activities, and actors, this is presentiating. Adaptive interaction for a future time is planned through present interaction and collective decision-making about the future exchange; decisions are underwritten by actor bonds and dependent on past and possible future links in the relationship, this is futurizing. Second, Medlin says emergence, a continually unfolding future, creates a challenge for relationships because the many possibilities in the present can only be separated from each other by testing intentions and expectations, and intentions can only be determined over time as planned future interactions occur and are available for interpretation.

These ideas described by Medlin (2004) and MacNeil (1974a, 1974b, 1980a) are captured in what Butler (1996) describes as the "movability" of time. For an exchange, the contract is a way of moving time, the future can be "brought effectively into the present" with a presentiated contract, or the future can be left "waiting to happen" with a futurized contract (MacNeil 1980a).

Vertical time

At the heart of most decisions is what Schön (1983) describes as practitioners reflecting on their "knowing in the midst of action." According to Schön, a practitioner reflects on the understandings which have been implicit in his action, and he considers this when engaging in further action. Often Schön says practitioners do not focus on the performances that yielded the expected outcomes but instead tend to reflect on their actions when the outcome was not as

desired focusing on the action itself, the outcomes of the action, and the knowing implicit in the action. In this instance practitioners reflect on their "knowing-in-practice," in other instances practitioners reflect on practice while they are in the midst of it, "reflection-in-action."

When a practitioner reflects in and on his practice, Schön (1983) indicates the possible objects of his reflection can vary. He may reflect on the tacit norms underlying a judgment or on the implicit strategies and theories in behavior. He may reflect on the feeling in a situation which has led him to adopt a course of action, on the way in which he has framed the problem he is trying to solve, or on the role he has constructed for himself within a larger institutional context.

Among the practitioners referred to by Schön (1983) of interest here are the design professionals. Schön says past experiences are often brought to bear through reflection. A practitioner has built up a repertoire of examples that includes the whole of his experience and these examples not only contribute to the current project, but each new experience enriches the practitioner's repertoire. If a past decision produced unintended consequences the designer may consider the choices he made and make a different choice, the situation "talks back," and he responds to the situation's "back-talk."

Schön (1983) also addresses a practitioner's specialization saying while professional specialization may have benefits such as similar projects or cases which the practitioner becomes accustomed to dealing with, it can also have negative effects, breaking apart the wholeness of understanding with practitioners treating segments in isolation from the whole. This specialization typically leads to the need for interaction among the specialists.

Temporal symmetry and Temporal asymmetry

Ancona et al. (2001) and Zerubavel (1981) refer to the notion of temporal symmetry and asymmetry. Temporal symmetry is described as individuals who subscribe to "one particular

pattern of temporal conditions," where one person's perspective matches another's (Zerubavel 1981). This contrasts with temporal asymmetry where individuals act in coordination but subscribe to differing temporal orientations (Ancona et al. 2001). Temporal asymmetry can be used to describe differences in the temporal perspectives of a designer and contractor as illustrated below.

Time Illustration

The two axes of time discussed in literature can be easily applied to construction, the horizontal axis representing the lifecycle of a construction project and the vertical axis representing the perspectives of the parties involved. These concepts are illustrated below by first looking at the horizontal axis and indicating not only how the past, present and future are viewed in the context of a construction project but also how they affect a project. Then the vertical axis of time is illustrated by describing the organizational perspectives of the construction participants and the links to time. Finally, interaction between the parties is illustrated. It is important to mention that although the illustration takes place in parts, the concepts of horizontal and vertical time are integral to one another and therefore cannot be completely separated.

Horizontal Time

Construction industry practitioners would agree that horizontal time can be viewed as the lifecycle which all projects move through. If, however, one would allow time to be stopped at a particular moment, aspects of a project related to time can be analyzed. For instance, the point in time used here will be a moment in the present during the scoping process. This moment is the intersection of key aspects of time, and it is at this moment that aspects of a project influencing the planning process can be viewed all at once. For horizontal time, the present is the point located between the past and the future, it is at this moment during scoping that the future will be

planned, and the past will inform the process. For vertical time, a moment in the present during scoping is the point where the parties' perspectives regarding planning coexist, it is at this instant that the parties' different perspectives regarding planning can be seen.

First is the past which holds memories, experiences, and knowledge of previous time and interactions. It is in the present that the past is brought to the forefront of the actor's memory and influences the decisions made for the future of this project. The past includes not just yesterday for this project, but all other projects in various stages of their lifecycles on which the participants have been involved. As a result, the past may include an innumerable collection of projects which may all have a bearing in some way on the current project. For example, a designer may be far into the lifecycle of another project and dealing with the consequences of choices made on that project which may inform the choices he makes for the current project.

The present, which is ever evolving when looked at along the lifecycle, is static for this illustration to provide a timeframe to evaluate the complicated dynamics of a construction project. The present is the point at which all aspects of time merge and action occurs. It is here that parties come together to make common plans for the future of the project, it is here that the past is recalled, and the future is planned. Reflections on the past will directly influence the parties' visions for the future which will be prepared for with either implicit or explicit planning. Implicit planning involves an element of uncertainty in which things will be dealt with as they arrive, this is referred to in literature as futurizing. Explicit planning involves exact consideration and planning for the future to come. In this case, decisions are made which will set the course of the future for the project, this is referred to in literature as presentiating. In either case, choices made affect not only the future of the project, but also their relationships.

The last point along the horizontal timeline is the future, the time to come. Since the future is yet to happen, only plans can be made for it. There are decisions which can be made which will, as described in literature, set the course of the future. How the parties choose to plan will be a direct reflection of their perspectives. If the parties plan the future, the implementation stage of the project will involve only conforming to those plans, if the future is left to be determined, implementation will involve decisions along the way, each having an impact on the final product.

Members of a project often share only the current project in common and their experiences on the project will vary. While the present is a time shared by all members of this particular project, the past no members likely share in common, however, it is the past that will influence how the participants plan in the present for the future they will encounter. The near future, which for this project is shared by all members, will be experienced in different ways with each having different roles, responsibilities, and challenges they will encounter. In addition, some will be involved on the project longer than others, for example, the contractor will exit the project soon after its completion, typically within one or two years, the owner will continue to be involved on a project through the progression of its lifecycle often until the end of its useful life, as will the designer for issues regarding catastrophic events and functionality.

Vertical Time

The focus will now be on the vertical component of time in construction. It is in the present that the parties and their perspectives of and attitudes toward time can be seen and compared regarding planning. However, it is the temporal perspectives of the parties which are created by their pasts which explain why the parties to construction have different courses of action regarding planning. Their divergent views are better understood when considering which

lifecycle component of time the party is focused on, what aspect of the project they are involved in, and how long their involvement on the project will continue. Their attitudes are primarily the result of their pasts with the collection of projects on which the participants have been involved creating a layering effect of projects which all bear on the choices made on the current project and create a sphere of influence much larger than just the one project. Here, four major project participants, the contractor, designer, owner, and maintenance team, will be addressed, but with the realization that there are many others who play a role on any given project. The concepts described are easily scalable to all other members of the project.

The perspectives of all the parties are connected to the horizontal time axis. The recent pasts of the parties have projects in all phases of their lifecycles and the participants will bring the knowledge acquired from those projects to this project—they will see today through the lens of yesterday. As a result, the vertical time is essentially a reflection of how the participants view horizontal time with their knowledge from the past informing how they plan in the present for the future. As will be shown next, the part of the horizontal lifecycle participants view as most important defines their temporal perspective which is based on what the participants do and its link to a particular lifecycle element of time.

A designer focuses on the far future which equates to a long time horizon and an attitude towards time based on the fact that he has the task of planning the facility and a professional responsibility for the safety of the public causing his concerns to be related to how the facility will perform in the future. Given this and the designer's liability for catastrophic events and functionality of the facility, he focuses on aspects of the project like long-term viability and use, safety, lifecycle cost, functionality, and durability. The designer's focus on the product scope, features and functions of the facility, means he typically prefers a presentiated scope which

allows him to take his vision for the future of the facility as a whole and design it into parts which can be built. The designer's concerns associated with the far future mean his temporal perspective often leaps over construction resulting in little consideration of the implementation of the design and is directly linked to his extended attachment to a project.

A contractor focuses on the near future. This equates to a short time horizon which is often limited to the immediate with a short look into the future, his focus is often on today and tomorrow. A contractor's attitude towards time is based on his responsibility for constructing the facility leading to concerns about constructability, first cost, and project duration. He is therefore concerned primarily with the project scope, those activities required to produce the finished product, and would prefer a futurized scope in which he can provide input. As a result of the contractor's narrow focus on the immediate, he usually does not consider aspects related to the life of the facility, and in some instances, depending primarily on the delivery method used, this never has to be a concern for the contractor because these aspects of the project are incorporated into the plan provided to him, for example with design-bid-build the contract is presentiated. The contractor's short-term focus may also be because a contractor's involvement on a project ends soon after construction is complete.

An owner's time perspective, which is bimodal, focuses on both the near and far future, and he shares the perspective of both the designer and the contractor. Like the designer, he has concerns related to the life of the facility and like the contractor, he would also like to have the facility delivered as quickly and as efficiently as possible. Although most owners will be equally concerned about both aspects of time, in some cases one may dominate over the other. Owners who have a preference may consider structuring the interaction to best fit their needs by having a

certain party's time perspective control. When the owner does not have a dominant time perspective, he will be left with the dilemma of how to balance long- and short-term concerns.

The maintenance team's temporal perspective focuses on the far future. Like the designer, this equates to a long time horizon. The maintenance team's attitude towards time is based on the fact they will be involved in the maintenance and upkeep of the facility leading to concerns about how they can most efficiently and effectively maintain the product. Given this, the maintenance team is concerned primarily with the product scope and would like to have input in the decisions that will affect the features of the end product and its maintainability.

To summarize, parties have different temporal perspectives based on what they do and to which portion of the lifecycle it is linked. As a result, the parties will naturally each look to plan the project in a way that will accommodate them, and each party's time perspective will affect their performance and interactions.

Appendix D

Conceptual Model Applications

Application Worksheets

Table for identification of conceptual model components applicable to a procedure

Conceptual Model Factors	**Procedure**
Overall Relation Type	
Sources of Contractual Solidarity	
Power, Hierarchy, and Command	
Numbers	
Attitudes: Awareness of Conflicts of Interest	
Unity	
Time	
Trouble	
Commencement, Duration, Termination	
Transferability	
Planning	
Future Cooperation	
Measurement & Specificity	
Obligations	
Benefits & Burdens	
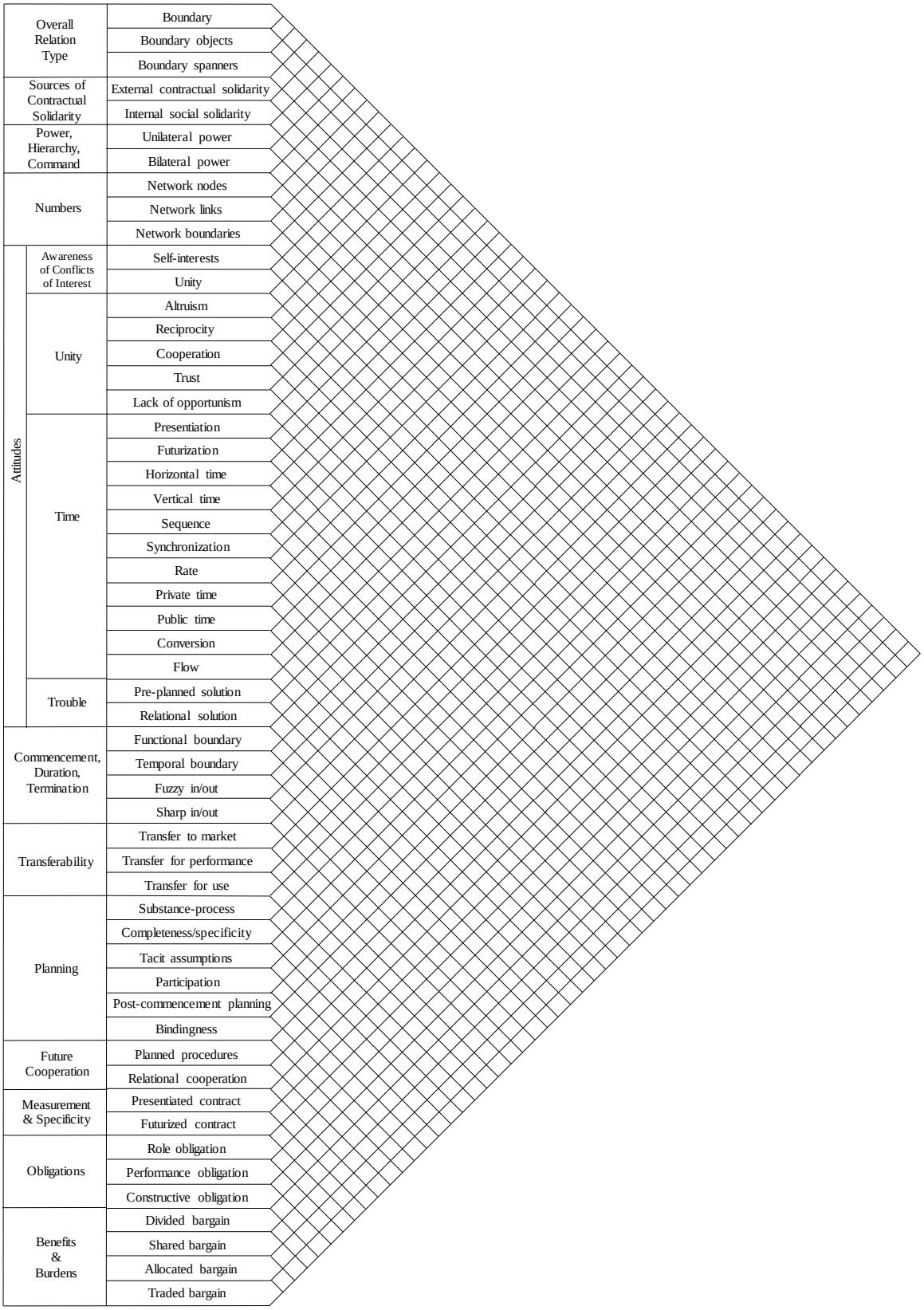
Figure for identification of conceptual model component interactions