**Training Program for Industrial Design Sketching**

by

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A thesis submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Master of Industrial Design

Auburn, Alabama
May 7, 2022

Keywords: industrial design, sketching, Gracie Combatives, Brazilian Jiu-Jitsu

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Abstract

This thesis explores a new way to teach industrial design sketching (IDS) based on The Gracie Combatives Program (GC), a training program originally designed to teach the art of Gracie Jiu-Jitsu, also known as Brazilian Jiu-Jitsu (BJJ), to members of The United States Army. In this thesis, teaching methods in GC are adapted to teach IDS, resulting in a unique training program. The application of this thesis is demonstrated through the creation of a training program handbook.

Acknowledgments

Firstly, my deepest appreciation goes to my Lord and Savior Jesus Christ, without whom I would not have had the strength to finish this research. David said it best when he wrote: "You, Lord, keep my lamp burning; my God turns my darkness into light." – Psalm 18:28 NIV

Thank you to my beautiful wife and fellow designer Sarah Hayworth for your love and support. Your encouraging voice and insight into design where absolutely key to the completion of this thesis.

I would like to offer sincere thanks to my Major Professor, Tin-Man Lau, for your dedication to myself and all of the Master of Industrial Design Students at Auburn. I would also like to thank my thesis committee: Professors Rusty Lay, Jerrod Windham, and Benjamin Bush. Having the opportunity to work with and learn from you has been an opportunity that I will always cherish. My deep appreciation goes to thank the Industrial Design faculty and staff for your guidance over the last three years. Each professor and staff member in the Industrial Design department contributed to this thesis in helpful ways to help make it a reality.

I would like to thank my father, Dr. Joel Hayworth for your encouragement and help with this thesis. Your experience with the research and writing process is truly unmatched. Thank you to my mom, Amy Hayworth, who has supported me in so many ways. Finally, my thanks go to my brothers, Sam and Will, for your friendship and encouragement. Your hard work inspires me to stay the course.

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**General Terms**

BJJ              Brazilian Jiu-Jitsu

IDS              Industrial Design Sketching

**Gracie Combatives**

DRD             Dynamic Reflex Development

FSD              Fight Simulation Drill

GA               The Gracie Academy

GC               Gracie Combatives

GCOH          *Gracie Combatives Official Handbook*

GCPD           Gracie Combatives Proficiency Drill

GU               Gracie University

MC               The Master Cycle

RDD             Reflex Development Drill

**Industrial Design Sketching Program**

DSD              Design Sketching Drill

DSPC           Design Sketching Practice Cycle

DSPT           Design Sketching Proficiency Test

IDSP            Industrial Design Sketching Program

TSD              Technical Sketching Drill

**Chapter 1: Introduction**

**Problem Statement**

Some industrial design students struggle to sketch in many ways. This difficulty is nominally referred to as sketch inhibition (Thurlow et al. 2019, p.485). Research suggests that there are many potential causal factors that can be categorized into four causal domains: 1) Psycho-social; issues related to fear, laziness, and other psychological factors 2) Intellectual; a lack of understanding in how sketching relates to the design process, 3) Skillset; a lack of requisite skills to sketch effectively, 4) Technological; factors related to the widespread availability of and interference from technological tools such as CAD (Thurlow et al. 2019, p.486). Researchers conclude by suggesting several potential solutions to the issue including: 1) Improved teaching structure; through the introduction of a structured, full-course approach featuring skill maintenance features and emphasizing quantity of output, 2) Increased student confidence; through art exercises which improve motor skills and the use of "non-precious" materials, and 3) Increased awareness of the role of sketching in the design process; through increased understanding of its functions, purposes, and component processes. (Thurlow et al., 2019, p.488). Researchers also call for more qualitative research exploring sketch inhibition.

**Need for Study**

Researchers call for need for a research based "fully tested pedagogical framework" for teaching IDS (Thurlow et al. p. 488). This framework would serve as a practical resource for the design community to use when teaching and learning design sketching. Although there are plentiful design sketching resources in the form of books and classes, there is a need for a structured framework for teaching IDS.

Researchers also call for more general research on the subject of teaching IDS. Many of the studies researching IDS do not offer any detailed or practical solutions for design educators to employ in the classroom. This study is designed to be a base for practical research involving teaching various industrial design skills.

Industrial design is a key component in the development and improvement of products and systems, making it an important factor to consider in the economic sphere. This makes a study exploring a better way to teach design process skills a practical subject which could have tangible effects in realms of business, economics, and society as a whole.

**Objectives of Study**

The main objective of this study is to take a practical step towards addressing challenges facing the design community concerning teaching and learning IDS through the creation of a practical pedagogical framework for teaching IDS. This framework can used by researchers to test their theories and ideas for teaching IDS and other design skills. In other words, this study should serve as a useful tool for researchers to implement future ideas and discoveries.

Additionally, this research aims to imcorporate suggested solutions for the effective management of sketch inhibition such as: 1) Improved teaching structure, 2) Increased student confidence, and 3) Increased student awareness of the role of sketching in the design process (Thurlow et al., 2019, p.488) into a practical tool that can be used in the field and in future research.

**Definition of Terms**

The following list contains a series of terms relevant to the understanding of this research. This list does not compromise a complete list of all of the terms used in this thesis and is intended to serve as a general guide when reading this work.

Drawing, n; "That which is drawn; a delineation by pen, pencil, or crayon; a representation in black and white, or in monochrome; a sketch." ("Drawing, n.," n.d.).

Gracie Jiu-Jitsu, n. or Brazilian Jiu-Jitsu, n; A self-defense system and sport originally developed by Helio Gracie designed to enable practitioners to survive attacks against and defeat opponents who are much larger and stronger than themselves (Gracie, 2008 p. 3).

Horizon, n. horizon-line; "The boundary-line of that part of the earth's surface visible from a given point of view; the line at which the earth and sky appear to meet. In strict use, the circle bounding that part of the earth's surface which would be visible if no irregularities or obstructions were present (called the apparent horizon, natural horizon, sensible horizon, physical horizon, or visible horizon, as distinguished from 3), being the circle of contact with the earth's surface of a cone whose vertex is at the observer's eye. On the open sea or a great plain these coincide." ("Horizon, n.," n.d.).

Ju-jitsu, n. jiu-jitsu; "A Japanese system of wrestling and physical training, characterized by the use of certain techniques and holds to overcome an adversary." ("Ju-Jitsu, n.," n.d.)

Perspective, n; "The art of drawing solid objects on a plane surface so as to give the same impression of relative position, size, or distance, as the actual objects do when viewed from a particular point." ("Perspective, n.," n.d.)

Render, v; "To create or complete (a painting, sculpture, or other artwork)." ("Render, v.," n.d.)

Rendering, n; "Representation or reproduction in an artistic form; an instance or result of this, an artistic depiction." ("Rendering, n.," n.d.)

Sketch, n; "A rough drawing or delineation of something, giving the outlines or prominent features without the detail, esp. one intended to serve as the basis of a more finished picture, or

to be used in its composition; a rough draught or design. Also, in later use, a drawing or painting of a slight or unpretentious nature." ("Sketch, n.," n.d.)

Sketch, v; "To draw the outline or prominent features of (a picture, figure, etc.), esp. as preliminary or preparatory to further development; to make a sketch or rough draught of (something); to draw or paint in this manner." ("Sketch, v.," n.d.)

Vanishing, n. vanishing point; "in perspective, the point in which receding parallel lines, if continued, appear to meet; also figurative. Similarly vanishing line, vanishing plane." ("Vanishing, n.," n.d.)

**Assumptions**

*Assumption 1: The Nature of Learning to Sketch*

It is assumed that a vast majority of students can be taught how to draw, absent a severe cognitive or physical impairment. This is opposed to the idea that drawing is an ability only attainable by few gifted people, or that drawing cannot be taught.

*Assumption 2: The Definition of a Good Sketch*

It is assumed that there is an objective standard delineating the difference between a good and bad sketch, where a good design sketch effectively accomplishes the purpose set for it by the designer, and a bad sketch does not accomplish the purpose it was made for. In other words, the standard of success and failure is different according to the original intent of the designer. If a designer intends to make a hasty sketch in their notebook to record an idea, that sketch would be successful if it allowed the designer to remember the idea they wished to record. The hastily drawn sketch would not be deemed unsuccessful or bad due to its lack of visual appeal. However, if a designer intended to create a neat and orderly drawing of a design, and instead

created an unorderly sketch that appeared to be hastily drawn, that sketch would be considered an unsuccessful or bad sketch.

**Scope and Limits**

This study focuses on teaching IDS exclusively. It does not address teaching sketching for other disciplines such as graphic design and studio art. Given that there is finite amount of time dedicated to this study, including these disciplines would significantly increase the length of time necessary to complete this research.

This study does not aim to prove that any individual method of teaching IDS developed herein is factually superior to another method of teaching IDS. The main goal of this study is to provide practical resources for the design community. The effectiveness of this system in the field can be tested in future research.

**Procedures and Methods**

*Feature Identification*

In Chapter 4, aspects of GC are defined and adapted to teach IDS, creating a training program structure. Aspects of GC were identified by reviewing several GC and Gracie University (GU) resources such as *The Gracie Combatives Standard DVD Package* (including the fight map poster and the *Gracie Combatives Official Handbook*), The Gracie University Website, the Gracie University YouTube channel, and the Gracie Breakdown YouTube channel.

Program features were summarized and organized into 7 feature categories: 1) Foundations, 2) Curriculum, 3) Structure, 4) Methods, 5) Schedule, 6) Testing, and 7) Tools. Feature categories were created by the researcher for the purpose of organizing the various features of GC and clarifying the overall structure of GC. Summaries of each feature do not necessarily include all of the information contained within the GC program; instead, they are meant to

summarize and outline the structure of GC, facilitating the adaptation of the training program structure. Some of the program features identified are not explicitly stated as such in GC, but were identified during the study.

### *Feature Adaptation*

Each aspect or feature of GC was adapted by logically determining the essence of each feature, and then logically configuring a close equivalent feature for use in teaching IDS. Thus, the structure and essence of each GC program feature is adapted to teach IDS, rather than aspects that would be irrelevant for teaching IDS. For example, students who successfully pass the Gracie Combatives receive a Gracie Combatives Belt and successfully complete GC. A literal adaptation of this program feature would mean that students in IDSP would receive a physical Jiu-Jitsu belt when they complete the program. Of course, this feature adaptation would be too literal. In IDSP, the purpose of the belt in Jiu-Jitsu is considered, and thus a feature that embodies the purpose of the belt is used.

## Anticipated Outcome

The outcome of this study is a training program structure known formally as The Industrial Design Sketching Program (IDSP) and informally as Sketch-Jitsu (SJ). This program is designed to provide guidance for students, teachers, and professionals in the process of learning or teaching sketching. This tool leverages pedagogical frameworks and techniques used in GC and aims to adapt and employ them to teach IDS.

## Chapter 2: Literature Review

**Introduction**

Industrial design is defined by the Oxford English dictionary as "design as applied to industrial products" (industrial design, n.d.). Auburn University defines industrial design as: "the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer" (Auburn Industrial Design, n.d.). People who practice industrial design are commonly known as industrial designers (industrial designer, n.d.).

Industrial designers use different many different skills when designing products and systems. One of the primary skills that designers utilize is sketching. The Bureau of Labor Statistics lists sketching as one of the duties of an industrial designer in their occupational outlook handbook (*Industrial Designers*, n.d.). Companies like Frog Design and Volvo also cite sketching as a critical and valued skill that they are looking for when hiring industrial designers ("(37) Industrial Designer | frog | LinkedIn," n.d.; ("(37) Industrial Designer | Volvo Group | LinkedIn," n.d.).

Teaching sketching for industrial design is the focus of this research. In this research, sketching, drawing, industrial design sketching, etc. all refer to sketching specifically in the context of the field of industrial design. The word *sketch* can be defined as:

> A rough drawing or delineation of something, giving the outlines or prominent features without the detail, esp. one intended to serve as the basis of a more finished picture, or to be used in its composition; a rough draught or design. Also, in later use, a drawing or painting of a slight or unpretentious nature ("Sketch, n.," n.d.).

This definition highlights the nature of a sketch, in that it exists in the overall context of another work. In the case of industrial design, this work is a design project. The sketch can serve the designer in several ways.

Sketching has been described simply as "the designer's visual language" in popular design sketching literature (Olofsson & Sjölén, 2007, p. 5). Eric Anderson echoes this idea, saying that drawing's core value is "to help shape ill-defined data into visual statements that support and advance conversations" (Baskinger & Bardel, 2013, p. 63).

In the Book *Drawing Ideas,* the roles of drawing are discussed in detail. The roles of drawing are described in three key behaviors: "(1) drawing to record ideas or examine things from real life; (2) drawing to clarify and explore ideas further and expand upon previous ideas; (3) drawing to explain ideas to others" (Baskinger & Bardel, 2013, p. 8). These three key behaviors show what the designer's visual language, sketching, is used for. The authors later describe these key behaviors in terms of more concrete techniques, such as "notational sketching, exploratory sketching and ideation, explanatory sketching, diagramming and visual narratives" (2013, p. 134).

These techniques are put into action by the designer in many unique ways. For example, designers can use sketching to: 1) Visually illustrate complex step by step processes, while showing examples at each step; 2) Show floorplans of different conceptual buildings; 3) Create complex patterns; 4) Explore typography; 5) Explore Ergonomics; or 6) Draw a product concept (Baskinger & Bardel, 2013, p. 46, p. 11, p. 2, p. 5, p. 23), (Lin, 2018, p.174-177).

In many cases, characteristics from the final design of a product can be traced back to a sketch drawn by the designer. The following example from *Creative Sketching in Product Design* illustrates how sketching can inform a final product design (Lin, 2018, p.9-10).

**Figure 1**

*Drawings of an Olive Plant for Natura Imitatis*
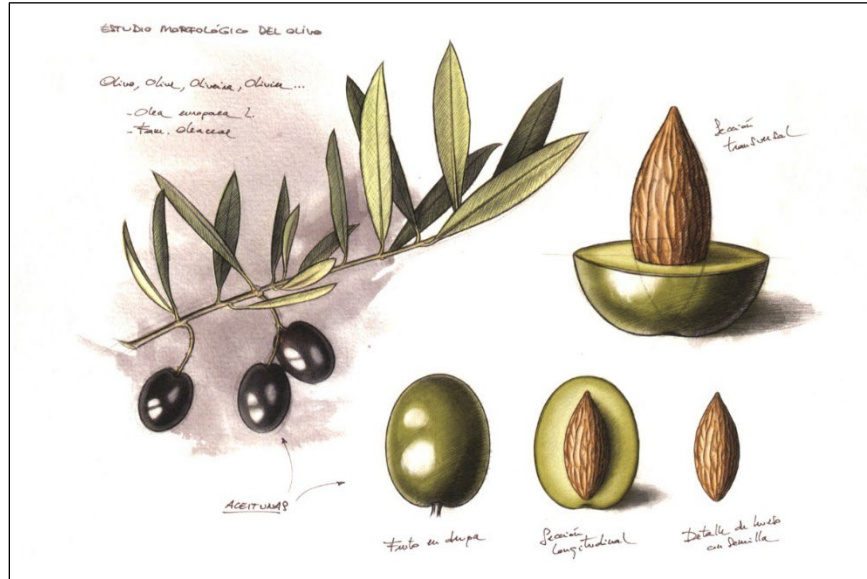


Note: The designer uses sketching to document the form, color, and texture of the olive plant.

**Figure 2**

Idea Sketches for Natura Imitatis
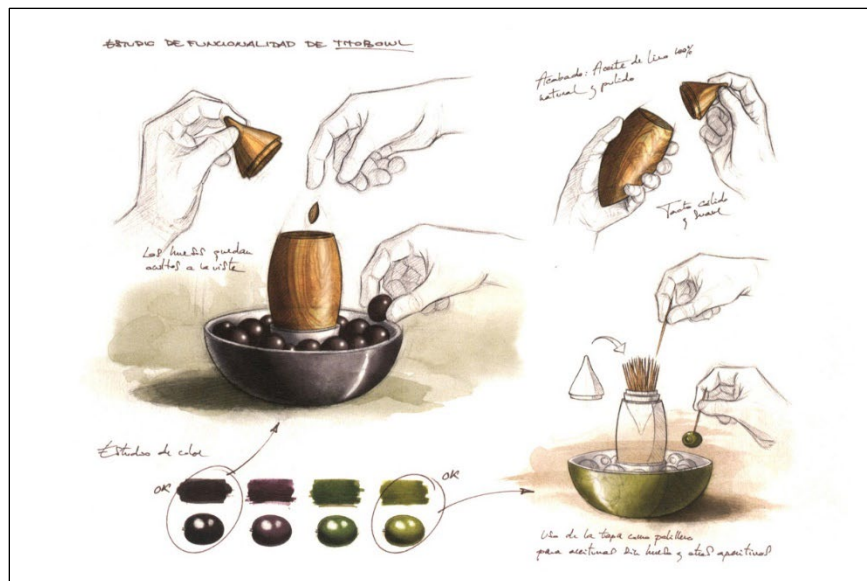
Note: This sketch is titled in part *Estudio de Functionalidad,* or Functionality Study. The designer uses sketching to explore the functionality of the object.

**Figure 3**

*A Final Product from Natura Imitatis*



Note: Sketching helped the designer determine the product's functionality, form, and color.

**The History of Teaching Sketching for Industrial Design**

One of the first ways art students formally learned to draw was through an apprenticeship (Houghton, 2016, p.109). The Master of a craft or art form would teach his unique style and craft to the apprentices, while also providing them with food and lodging (Houghton, 2016, p.109).

Later, students learned drawing not just from an apprenticeship, but at the early formal art schools known as art academies. At an art academy, students made a great effort to learn drawing through copying and life drawing (Houghton, 2016, p.110). Art academies in France taught

drawing to craftsman at the dawn of the industrial revolution (Efland, 1990, p.39-40). Many of these academies were still based around a core of instruction in life drawing (Efland, 1990, p. 55). This gave the French an advantage in the marketplace at the dawn of the Industrial Revolution (Efland, 1990, p.39-40). Later, other countries began to see the advantages of artistic training, specifically drawing, and began to advocate and teach drawing with the manufacturing of goods in mind (Efland, 1990, p.45 p.50). Eventually, the art academies could not accommodate the influx of new students, and thus, new schools focused on teaching art for industry were created (Efland, 1990, p.52 p.56).

In Germany, schools known as *Gewerbeschulen* and *Kunstgewerbeschule* were developed, where students were trained with practical ends in mind, and where drawing was taught outside of the traditional academic model (Efland, 1990, p.56). In the wake of German and French schools, England began to form design schools that also taught drawing with a more utilitarian approach, without an emphasis on figure drawing (Efland, 1990, p.59-60). Visual arts programs where eventually introduced into both British and American Universities, where the methods and goals of teaching visual arts varied from school to school (Efland, 1990, p.71-72).

The apprenticeship, art academy, and utilitarian approach to teaching drawing all influence how drawing is taught today. Elements from each of these phases of teaching drawing can be seen in the Bauhaus drawing curriculum, summarized by Walter Gropius as:

> free-hand sketching from memory and imagination, drawing and painting of
> heads, live models, and animals, drawing and painting of landscapes, figures,
> plants, and still lives, composition, execution of murals, panel pictures, and
> religious shrines, design or ornaments, lettering, construction and projection

drawing, design of exteriors, gardens, and interiors, design of furniture and

practical articles. (Gorman, 2003)

In conclusion, design educators today can draw upon a rich and complex design drawing

heritage when teaching their students. The traditional art of figure drawing, as well as a more

utilitarian approach to drawing, have both been used to teach designers to sketch and are still

used today.

**Teaching Sketching for Industrial Design Today**

The art of sketching can be learned today through many different avenues such as books,

videos, or schools. Although these resources for teaching IDS exist, many design students

struggle to learn sketching.

One of the main challenges facing design education at the college level is what researchers

call "sketch inhibition" (Thurlow et al., 2019, p.478). This term describes students' tendency to

avoid sketching and their "reluctance to physically place pen onto substrate" in the design

process (Thurlow et al., 2019, p.478, p.485).

This problem is characterized by factors such as: 1) Choosing temporary drawing tools over

more permanent ones, 2) Drawing small sketches, 3) Avoiding class and the studio, 4) Having

little relationship between developmental work and final design, and 5) Turning in very few

drawings for assignments (Thurlow et al., 2019, p.485).

Research suggests that there are many potential causal factors that can be categorized into

four causal domains: 1) Psycho-social: issues related to fear, laziness, and other psychological

factors, 2) Intellectual: a lack of understanding in how sketching relates to the design process, 3)

Skillset: a lack of requisite skills to sketch effectively, and 4) Technological: factors related to

the widespread availability of and interference from technological tools such as CAD (Thurlow

et al. 2019, p.486). Researchers call for more qualitative research exploring sketch inhibition and suggest several potential solutions to the issue, including 1) Improved teaching structure, 2) Increased student confidence, and 3) Increased student awareness of the role of sketching in the design process (Thurlow et al., 2019, p.488).

In addition to these factors, there are also cognitive factors that make it difficult for students to draw realistic images from observation. Researchers in the fine art world have identified factors such as: 1) A "deficiency in visual short term memory"; the ability to hold visual information in the mind's eye and 2) The "shape consistency perceptual processes"; the ability, or lack thereof, to draw an object as it appears, regardless of its actual dimensions and relation to the viewer (Manifold, 2019, p.20, p.21). Researchers suggest that "by presenting instruction in sequential increments over long periods of practice", these problems could be addressed by art educators (Manifold, 2019, p.21).

In conclusion, although there are resources and time-tested techniques for teaching sketching today, some design students still find it very difficult to sketch with confidence, speed, and effectivity. Researchers agree that pedagogical structuring could be of some value to addressing this issue. The creation of a basic structure utilizing research suggestions could be useful for design students and educators.

**Main Hypothesis**

One training program that addresses similar needs to those of design students is The Gracie Combatives Program. The Gracie Combatives Program (GC) was originally developed to teach the art of Brazilian Jiu-Jitsu (BJJ) to members of the United States Military (*Welcome to Jiu-Jitsu (Gracie Combatives)*, 2016). In order to develop their hand-to-hand combat training, the military employed the Gracie family to create a training program to teach the most essential

aspects of Jiu-Jitsu to soldiers quickly (*Gracie Combatives - The 36 Self-Defense Techniques Every BJJ Beginner MUST Learn!*, 2020). Eventually, this military training program was adapted for civilian use, so anyone could learn the most essential BJJ techniques for self-defense use. An adaptation of GC, designed to leverage years of advances made by the Gracie family and Jiu-Jitsu, could be the ideal tool for teaching design students to sketch.

The features and structure of GC could be adapted to teach IDS. This hypothesis addresses the need for increased structure in the process of learning IDS. It also has the potential to address other needs that have not yet been identified by the design community regarding IDS, due to the fact that similar or unidentified needs may have already been addressed by GC. The small breadth of research concerning the issues surrounding teaching and learning IDS gives further credence to the likelihood of this observation (Thurlow et al. p. 488).

One of the key ways GC addresses challenges faced by BJJ students is through its focus on "program structure and curriculum design" (Welcome to Jiu-Jitsu (Gracie Combatives), 2016). This "program structure and curriculum design" and the structures which enable it is the focus of adaptation, rather that superficial details the do not necessarily pertain to IDS, such as physical BJJ belts.

GC simplified and gave structure to a complex art form with a rich tradition, making it understandable and accessible for people all over the world. A training program for design sketching that accomplishes the same goals of simplification and structure could be of great value to the design community.

Because of the lack of literature available in this subject, case studies were conducted in order to analyze GC and develop a sketching program curriculum.

**Chapter 3: Case Studies**

GC is based around teaching an essential curriculum of 36 distinct BJJ techniques to students as efficiently as possible, preparing them for real world self-defense situations. Likewise, the goal of the IDSP is also to teach the most essential sketching techniques to students. The main purpose of this chapter is to identify these essential drawing techniques to be used in IDSP. Slices (known as sub-techniques in IDSP) are also identified in Chapter 3.

**Case Selection**

To create the curriculum for GC, the GC team reviewed footage of Jiu-Jitsu being used in real sparring sessions. They discovered that out of over 600 potential Jiu-Jitsu techniques, 36 were used "more often and with greater success than all the others combined." (*Gracie Combatives - The 36 Self-Defense Techniques Every BJJ Beginner MUST Learn!*, 2020). GC teaches these 36 essential techniques first in order to give students a holistic self-defense system in as little time as possible (*Gracie Combatives - The 36 Self-Defense Techniques Every BJJ Beginner MUST Learn!*, 2020). Essentially, the GC team reviewed real BJJ use cases to determine which techniques where the most essential. Techniques and lessons in GC are presented to students as a linear progression, creating a linear curriculum structure.

Like GC, the technique identification process for IDSP uses a case study approach to identify essential IDS techniques. One option for identifying essential IDS techniques was to review footage of IDS, identifying the various distinct techniques during the sketching process and creating tallies of the most frequently used and therefore the most essential techniques. However, nuances in the sketching process make this approach impractical.

For example, both an expert and a beginner BJJ practitioner may exhibit a foundational technique, such as the trap and roll, with that technique being readily identified in a video

recording. An advanced IDS practitioner, however, may not visually exhibit some actions when sketching. Techniques such as perspective constructions and proportional calculations may be occurring in the designer's mind, but be completely unidentifiable on tape or in a finished work. This concept also presents itself in the field of mathematics, where a mathematician may work a problem using certain techniques mentally, making them impossible to detect on camera. Evaluating resources such as a books or instructional videos would avoid this dilemma. For this reason, IDS books where selected and evaluated to determine the techniques to include in the IDSP.

Four IDS books were selected by the researcher after conducting a general online search. Each book selected is a readily available and basic resource for learning design sketching. The four selected books were:

1. *Drawing Ideas: A Hand-Drawn Approach for Better Design* by Mark Baskinger and William Bardel; Published by Watson-Guptill Publications, Nov. 19, 2013

2. *How To Draw: Drawing and Sketching Objects and Environments From Your Imagination* by: Scott Robertson and Thomas Bertling; Published by Design Studio Press Dec. 15, 2013

3. *Sketching: The Basics* by: Koos Eissen and Roselien Steur; Published by Laurence King Publishing, Aug. 25, 2011

4. *Sketching: Drawing Techniques for Product Designers* by: Koos Eissen and Roselien Steur; Published by Laurence King Publishing, Apr. 1, 2009

**Case Analysis**

IDS books were reviewed using a three-step process designed to discover a pattern of similar themes among the four drawing books without eliminating unique and valuable insights from

each book. The three steps where: 1) Curriculum Organization, 2) Theme Identification, and 3) Technique Classification.

***Curriculum Organization***

First, all book sections and sub-sections were listed in a single level list. Sections that did not focus on teaching drawing techniques, such as sketching examples sections or sketching case studies sections, were excluded from this initial list. Primary book sections that summarized or organized book content were also not included in this list. Tertiary book sections were then listed alongside secondary book sections, forming a single level list of book sections. This list formed what was essentially a reorganized and filtered table of contents spanning all four books. Figure 4 illustrates how each drawing book is organized.

**Figure 4**

*Curriculum Organization*
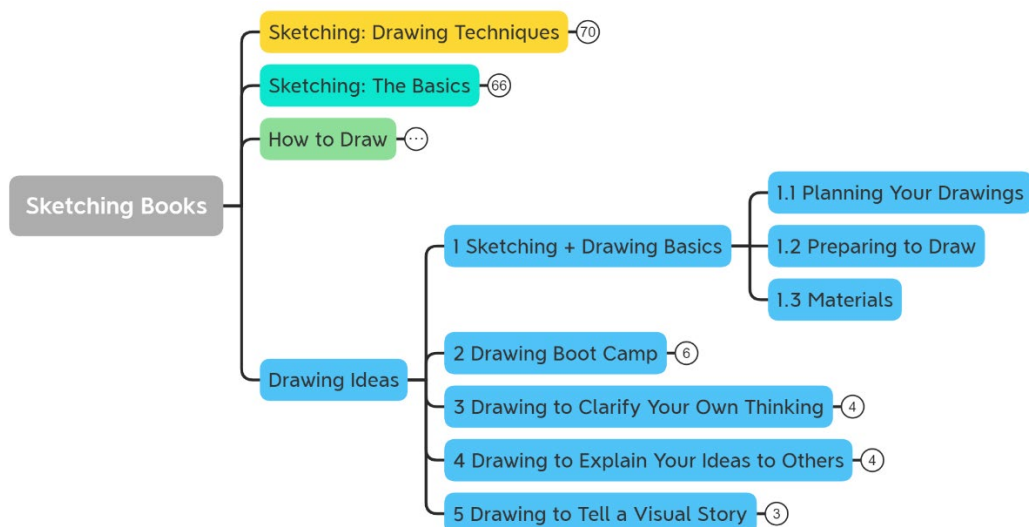


Note: Only one complete branch of the map is shown. Book titles are abbreviated for increased clarity.

### *Theme Identification*

Next, groups of book sections were formed and named using the mind mapping technique. Using a mind map allowed book sections to be organized organically by the researcher. Groups of book sections were formed by grouping sections with similar content and/or a similar main theme. If a book section's main theme was difficult to identify, or if it contained many different types of techniques, it was categorized in the group that describes the most obvious or prominent theme featured in that section. As groups emerged, each was assigned a title that identified the main theme of and summarized each group. These themed groups correspond to primary techniques in the IDSP. If a themed group contained clear sub-themes (components or variations) that each had a clear value and distinction, that group was divided into two to five sub-groups. These sub-groups correspond to sub-techniques in the IDSP. Sub-techniques are an adaptation of technical slices in GC.

### *Technique Classification*

Distinct BJJ technique are grouped according to their essential function, establishing different technique types. For example, submission techniques all have the same essential function: they are used to finish a fight. Likewise, IDSP primary techniques similar in essence were grouped according to their similarity, establishing sketching technique types. Figure 5 illustrates the theme identification and technique classification process mind map.

**Figure 5**

*Theme Identification and Technique Classification*
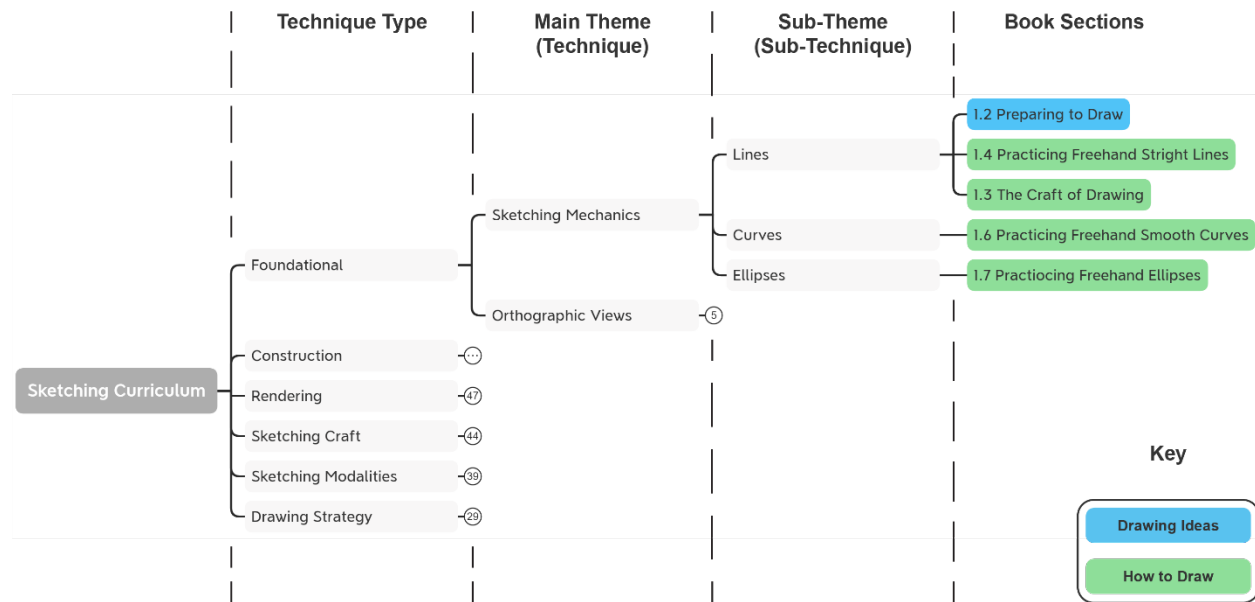


Note: Only one full technique branch (Sketching Mechanics) is pictured.

**Case Study Results**

This case study process resulted in a clear hierarchal tree structure. The cases studied yielded 6 distinct types of techniques: 1) Foundational Techniques; basic techniques that support other technique types 2) Construction Techniques; techniques using perspective to construct things 3) Rendering Techniques; techniques used to depict things in a life-like way 4) Craft Techniques; techniques focused on the craft of sketching 5) Modality Techniques; techniques involving using specific sketching processes to accomplish different goals relative to design and 6) Strategy Techniques; involving specific strategies for drawing distinct and complex objects. A total of 28 primary techniques were identified. A total of 16 primary techniques contained sub-techniques. Table 1 illustrates the case study results and the final curricula for the DSP.

**Table 1**
*Industrial Design Sketching Program Curriculum*

| Technique [a] | Title |
| --- | --- |
| 1 | Sketching Mechanics |
| 1.1 | Lines |
| 1.2 | Curves |
| 1.3 | Ellipses |
| 2 | Orthographic Views |
| 3 | Perspective Systems |
| 3.1 | Basic Perspective |
| 3.2 | Establishing Perspective |
| 4 | Rectilinear Forms |
| 5 | Perspective Tools |
| 5.1 | Dividing and Multiplying |
| 5.2 | Scaling |
| 5.3 | Mirroring |
| 6 | Radial Forms |
| 6.1 | Ellipses |
| 6.2 | Cylinders |
| 6.3 | Ellipses in Construction |
| 7 | Organic Forms |
| 7.1 | Curves |
| 7.2 | Surfaces |
| 7.3 | Sections |
| 8 | Manipulating Forms |
| 8.1 | Blending |
| 8.2 | Details |
| 9 | Complex Objects |
| 10 | Basic Rendering |
| 10.1 | Shading |
| 10.2 | Surface Quality |
| 11 | Line Quality |
| 12 | Views |

**Table 1**

*Industrial Design Sketching Program Curriculum*

| Technique [a] | Title |
|---|---|
| 12.1 | Exploded Views |
| 12.2 | Section Views |
| 12.3 | Ghost Views |
| 13 | Light and Shadow |
| 13.1 | Cast Shadows |
| 13.2 | Light Sources |
| 14 | Backgrounds |
| 15 | Materials |
| | Craft Techniques |
| 16 | Traditional Media |
| 16.1 | Selection |
| 16.2 | Dry Media |
| 16.3 | Wet Media |
| 16.4 | Mixed Media |
| 17 | Underlays |
| 18 | Digital Sketching |
| 19 | Planning |
| 20 | Research |
| | Modality Techniques |
| 21 | Generative Sketching |
| 21.1 | Ideation |
| 21.2 | Thumbnail Sketching |
| 21.3 | Intuitive Sketching |
| 22 | Concept Sketching |
| 22.1 | General Principles |
| 22.2 | Context |
| 22.3 | Structure |
| 23 | Recording Information |
| 24 | Story Telling |
| | Strategy Techniques |

***Table 1***
*Industrial Design Sketching Program Curriculum*

| Technique [a] | Title |
| --- | :---: |
| 25 | Environments |
| 26 | Aircraft |
| 26.1 | Aircraft Architecture |
| 26.2 | Aircraft Construction Strategy |
| 27 | Wheeled Vehicles |
| 27.1 | Wheeled Vehicle Architecture |
| 27.2 | Wheeled Vehicle Construction Strategy |
| 28 | Figures |
| 28.1 | Hands |
| 28.2 | Construction Strategy |

[a] Rational numbers such as 1.1, 1.2 etc. indicate sub-techniques.

Figure 6 illustrates the resulting hierarchical tree structure, establishing sketching technique type, primary techniques, and sub-techniques.

**Figure 6**

*Design Sketching Curriculum Hierarchical Tree Structure*
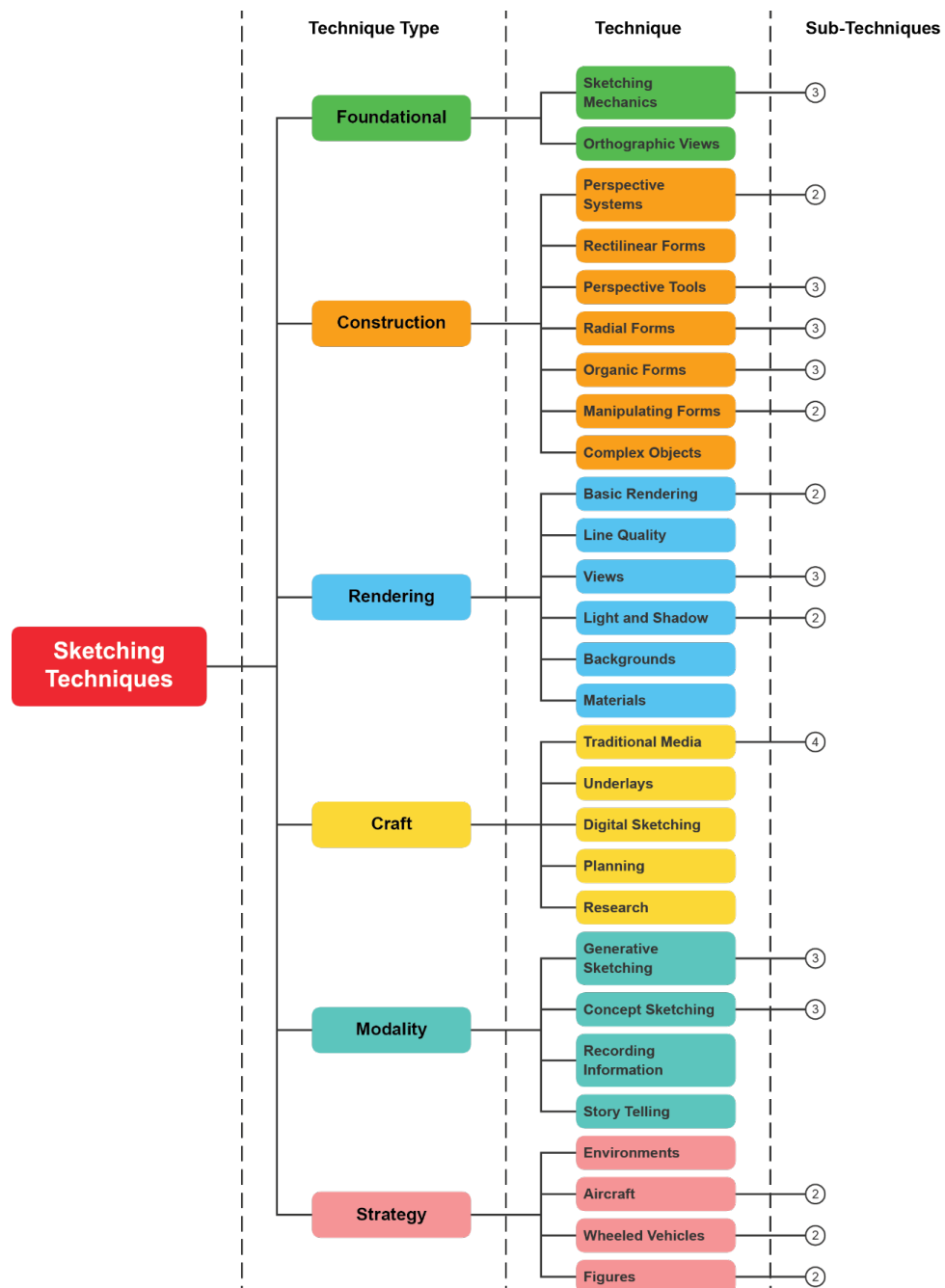


Note: This figure is meant to illustrate the hierarchical structure of the curriculum. The complete curriculum is found in Table 1.

**3.3 Case Study Tables**

Tables 2 through 5 list each book section along with the primary and secondary theme assigned to each book sub-section. The starting page number of each book sub-section is also listed. These page numbers were easily collected from each book's table of contents. Each book sub-section ends when it reaches a new sub-section. Note that not all book sub-sections were used in this study, but only book sub-sections that are mainly informative or educational. A numeric prefix was assigned to each sub-section if one was not already used in the original text.

**Table 2**
*Curricula Case Study: Drawing Ideas*

| Section | Title | Main Theme | Secondary Theme | Page |
|---------|-------|------------|-----------------|------|
| 1.1 | Planning Your Drawings | Concept Sketching | General Principles | 14 |
| 1.2 | Preparing to Draw | Mechanics | Lines | 22 |
| 1.3 | Materials | Traditional Media | Selection | 33 |
| 2.1 | Rectilinear Forms | Rectilinear Forms | - | 52 |
| 2.2 | Curvilinear Forms, Planes + Arrows | Organic Forms | Organic Surfaces | 72 |
| 2.3 | Rotational Forms | Radial Forms | Cylinders | 86 |
| 2.4 | The Human Figure | Figures | Figures | 98 |
| 2.5 | Hands + Interaction | Figures | Hands | 112 |
| 2.6 | Rendering Forms | Basic Rendering | Shading | 116 |
| 3.1 | Recording + Exploring Ideas with Notational Sketching | Recording Information | - | 139 |
| 3.2 | Seeing with Notational Sketching | Recording Information | - | 140 |
| 3.3 | Thinking with Notational Sketching | Recording Information | - | 150 |
| 3.4 | Best Practices for Effective Notational Sketches | Recording Information | - | 156 |
| 4.1 | Planning Your Explanatory Sketches | Planning | - | 174 |

**Table 2**

*Curricula Case Study: Drawing Ideas*

| Section | Title | Main Theme | Secondary Theme | Page |
|---------|-------|------------|-----------------|------|
| 4.2 | Choosing Graphic Structure | Concept Sketching | Structure | 190 |
| 4.3 | Composing a Visual Layout | Concept Sketching | Structure | 213 |
| 4.4 | Detail Features of an Effective Explanatory Sketch | Concept Sketching | General Principles | 236 |
| 5.1 | Planning Visual Narratives | Planning | - | 274 |
| 5.2 | Preparing to Draw Visual Narratives | Story Telling | - | 286 |
| 5.3 | Approaches to Structuring Visual Narratives | Story Telling | - | 294 |

**Table 3**

*Drawing Curricula Case Study: How to Draw*

| Section | Title | Main Theme | Secondary Theme | Page |
|---------|-------|------------|-----------------|------|
| 1.1 | Choosing Your Drawing Materials | Traditional Media | Selection | 12 |
| 1.2 | Choosing Pens and Paper | Traditional Media | Selection | 13 |
| 1.3 | The Craft of Drawing | Mechanics | Lines | 14 |
| 1.4 | Practicing Freehand Straight Lines | Mechanics | Lines | 15 |
| 1.5 | X-Y-Z Coordinate System | Perspective Systems | Basic Perspective | 16 |
| 1.6 | Practicing Freehand Smooth Curves | Mechanics | Curves | 17 |
| 1.7 | Practicing Freehand Ellipses | Mechanics | Ellipses | 18 |
| 1.8 | Drawing an Ellipse on the Minor Axis | Radial Forms | Ellipses | 19 |
| 2.1 | Defining the Perspective by the Viewing Position | Perspective Systems | Basic Perspective | 22 |
| 2.2 | Cone of Vision - COV | Perspective Systems | Basic Perspective | 23 |
| 2.3 | Finding Vanishing Points on the Picture Plane | Perspective Systems | Establishing Perspective | 24 |

**Table 3**

*Drawing Curricula Case Study: How to Draw*

| Section | Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 2.4 | Physical Parallel Lines Converge to a Common Vanishing Point | Perspective Systems | Basic Perspective | 26 |
| 2.5 | Horizontal line Relative to Position | Perspective Systems | Basic Perspective | 27 |
| 3.1 | Division and Multiplication of Dimensions in Perspective | Perspective Tools | Dividing and Multiplying | 30 |
| 3.2 | Multiplying and Dividing Rectangles | Perspective Tools | Dividing and Multiplying | 32 |
| 3.3 | Dividing into Odd-Numbered Proportions | Perspective Tools | Dividing and Multiplying | 33 |
| 3.4 | Mirroring in Perspective | Perspective Tools | Mirroring | 34 |
| 3.5 | Mirroring Tilted Planes | Perspective Tools | Mirroring | 36 |
| 3.6 | Mirroring Rotated, Tilted Planes | Perspective Tools | Mirroring | 37 |
| 3.7 | Mirroring 2D Curves | Perspective Tools | Mirroring | 40 |
| 3.8 | Mirroring a 2D Curve on a Tilted Surface | Perspective Tools | Mirroring | 42 |
| 3.9 | Mirroring 3D Curves in Perspective: The 2-Curve Combo | Perspective Tools | Mirroring | 43 |
| 4.1 | Perspective Grid Types | Perspective Systems | Establishing Perspective | 46 |
| 4.2 | Perspective Grid Construction | Perspective Systems | Establishing Perspective | 48 |
| 4.3 | Diagonal Vanishing Point, Station Point Method | Perspective Systems | Establishing Perspective | 49 |
| 4.4 | 2-Point Grid Construction with Vanishing Points on the Page | Perspective Systems | Establishing Perspective | 50 |
| 4.5 | Rotated 2-Point Grids with Same Sized Squares | Perspective Systems | Establishing Perspective | 51 |
| 4.6 | Transferring Scale in Perspective | Perspective Tools | Scaling | 53 |

**Table 3**

*Drawing Curricula Case Study: How to Draw*

| Section | Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 4.7 | The Brewer Method: Constructing a Grid with Vanishing Points off the Page | Perspective Systems | Establishing Perspective | 54 |
| 4.8 | Creating a Grid of Squares, without Diagonal Vanishing Points | Perspective Systems | Establishing Perspective | 57 |
| 4.9 | When to Use a Computer-Generated Underlay | Underlays | - | 58 |
| 4.10 | Other Benefits and Ways to Use an Underlay | Underlays | - | 61 |
| 4.11 | Not all Perspective Grids Are Created Equal | Perspective Systems | Establishing Perspective | 62 |
| 4.12 | Assembly and Exploded Views | Object Views | Exploded View | 68 |
| 5.1 | Ellipse Basics and Terminology | Radial Forms | Ellipses | 72 |
| 5.2 | Placing a Circle in Perspective or Drawing Ellipses | Radial Forms | Ellipses | 73 |
| 5.3 | Creating a Cube Using Ellipses | Radial Forms | Ellipses in Construction | 74 |
| 5.4 | Offsetting Ellipses | Radial Forms | Ellipses | 74 |
| 5.5 | Hinging and Rotating Flaps and Doors | Radial Forms | Ellipses in Construction | 75 |
| 5.6 | Subdividing Ellipses | Radial Forms | Ellipses | 76 |
| 5.7 | Shortcuts to Dividing Ellipses | Radial Forms | Ellipses | 78 |
| 5.8 | Placing a Circle on a Sloped Surface | Radial Forms | Ellipses | 79 |
| 6.1 | Planning Before Perspective | Planning | - | 82 |
| 6.2 | Orthographic Views, a.k.a. Orthogonal Views or Draft Views | Orthographic Views | - | 84 |
| 6.3 | Transferring a Side View into Perspective | Organic Forms | Curves | 85 |
| 6.4 | Putting it all Together: X-Y-Z Section Drawing | Organic Forms | Sections | 86 |
| 6.5 | Extending the Sections | Organic Forms | Sections | 88 |
| 6.6 | 2-Curve Combo | Organic Forms | Constructing Curves | 89 |

**Table 3**
*Drawing Curricula Case Study: How to Draw*

| Section | Title | Main Theme | Secondary Theme | Page |
|---------|-------|------------|-----------------|------|
| 6.7 | Cutting Volumes | Organic Forms | Sections | 90 |
| 6.8 | Adding Radii and Fillets | Organic Forms | Sections | 92 |
| 6.9 | Wrapping Graphics | Manipulating Forms | Details | 93 |
| 6.10 | Detailing and Sculpting Surfaces | Organic Forms | Surfaces | 94 |
| 6.11 | More Tips for Modifying Complex Volumes | Organic Forms | Sections | 96 |
| 6.12 | Contour Lines, Overlapping and | Line Quality | - | 100 |
| 6.13 | X-Y-Z Section Drawing Applied | Organic Forms | Sections | 102 |
| 7.1 | Photo Underlay | Underlays | | 108 |
| 7.2 | Site Planning | Environments | - | 110 |
| 7.3 | Thumbnail Sketching | Generative Sketching | Thumbnail Sketching | 112 |
| 7.4 | Non-Photo Blue, Then Ink | Traditional Media | Mixed Media | 115 |
| 7.5 | Sci-Fi Environment Step-by-Step | Environments | - | 116 |
| 7.6 | Wrap That Grid with a Wide Angled Lens! | Perspective Systems | Establishing Perspective | 118 |
| 7.7 | Outdoor Environment Sketch Step-by-Step | Environments | - | 120 |
| 8.1 | Airplane Anatomy | Aircraft | Architecture | 124 |
| 8.2 | Visual Research | Research | - | 126 |
| 8.3 | Drawing from Observation | Recording | - | 128 |
| 8.4 | Loose Concept Sketching | Concept Sketching | General Principles | 130 |
| 8.5 | "Paper Plane" Ideation | Generative Sketching | Ideation | 132 |
| 8.6 | "Paper Plane" Perspective Grid | Perspective Systems | Establishing Perspective | 133 |
| 8.7 | Drawing a Paper Plane, Step-by-Step | Aircraft | Construction Strategy | 137 |
| 8.8 | using a 3D Underlay | Underlays | - | 142 |

**Table 3**

*Drawing Curricula Case Study: How to Draw*

| Section | Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 8.9 | Final Airplane Drawing Step-by-Step | Aircraft | Construction Strategy | 146 |
| 9.1 | Visual Research | Research | - | 154 |
| 9.2 | Have an Idea or a Goal Before Starting to Sketch | Planning | - | 157 |
| 9.3 | Some Basics on Vehicle Packaging and Architecture | Wheeled Vehicles | - | 160 |
| 9.4 | Flexing Your Creativity | Generative Sketching | Ideation | 164 |
| 9.5 | Grids, Grids, Grids! | Wheeled Vehicles | Construction Strategy | 166 |
| 9.6 | Drawing a Side View in Perspective | Perspective Systems | Basic Perspective | 169 |
| 9.7 | Drawing a Stylized Side View in Perspective | Orthographic Views | - | 170 |
| 9.8 | Basic Body Sculpting | Wheeled Vehicles | Construction Strategy | 174 |
| 9.9 | Drawing the Windshield and Greenhouse | Wheeled Vehicles | Construction Strategy | 175 |
| 9.10 | Wheel Wells, Wheels, and Tires in Perspective | Wheeled Vehicles | Construction Strategy | 176 |
| 9.11 | Common Automotive Lines | Wheeled Vehicles | Architecture | 178 |
| 9.12 | Car Drawing Construction, Step-by-Step Grid | Wheeled Vehicles | Construction Strategy | 180 |
| 9.13 | Vehicle Sketching with a Wide-Angle Lens | Wheeled Vehicles | Construction Strategy | 186 |
| 10.1 | Ballpoint Pen | Traditional Media | Wet | 190 |
| 10.2 | Copic Marker + ballpoint Pen | Traditional Media | Wet | 191 |
| 10.3 | Graphite Pencil | Traditional Media | Dry | 192 |

**Table 3**

*Drawing Curricula Case Study: How to Draw*

| Section | Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 10.4 | Colored Pencil | Traditional Media | Dry | 193 |
| 10.5 | Pilot HI-TEC Pen on Newsprint | Traditional Media | Wet | 194 |
| 10.6 | Copic Marker + Pilot HI-TEC Pen | Traditional Media | Mixed | 195 |
| 10.7 | Non-Photo Blue Colored Pencil + Marker + Brush Pen | Traditional Media | Mixed | 196 |
| 10.8 | Pentel Pocket Brush Pen | Traditional Media | Wet | 197 |
| 10.9 | Copic Marker + Pen + Gouache | Traditional Media | Wet | 198 |
| 10.10 | Gouache on Illustration Board | Traditional Media | Wet | 199 |
| 10.11 | Toned Paper + Mixed Media | Traditional Media | Mixed | 200 |
| 10.12 | Digital: Sketchbook PRO | Digital Sketching | - | 201 |

**Table 4**

*Curricula Case Study: Sketching: The Basics*

| Section | Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 1.1 | Ideation/ Brainstorming | Generative Sketching | Ideation | 12 |
| 1.2 | Sketching and Design Phases | Concept Sketching | General Principles | 15 |
| 1.3 | Sketching in Design; How to Practice | Concept Sketching | General Principles | 18 |
| 2.1 | Introduction; Drawing Approach | Perspective Systems | Basic Perspective | 28 |
| 2.2 | Blocks | Rectilinear Forms | - | 30 |
| 2.3 (2.2.1) | Perspective in Lines | Perspective Systems | Establishing Perspective | 30 |

**Table 4**

*Curricula Case Study: Sketching: The Basics*

| Section | Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 2.4 (2.2.2) | The Viewpoint | Perspective Systems | Basic Perspective | 33 |
| 2.5 (2.2.3) | Shading and Cast Shadow | Light and Shadow | Cast Shadows | 34 |
| 2.6 (2.2.4) | Marker Technique and Color | Traditional Media | Wet Media | 36 |
| 2.7 | Ellipses | Radial Forms | Ellipses | 38 |
| 2.8 | Upright Cylinders | Radial Forms | Cylinders | 40 |
| 2.9 | Horizontal Cylinders | Radial Forms | Cylinders | 42 |
| 2.10 | Planes & Sections | Organic Forms | Sections | 44 |
| 2.11 | Spheres | Radial Forms | Cylinders | 46 |
| 2.12 | How to Practice | Basic Rendering | Shading | 47 |
| 2.13 | Drawing Approach; Finally | Concept Sketching | General Principles | 48 |
| 2.14 | More Sketching Tips | Traditional Media | Wet Media | 49 |
| 3.1 | The Informative Viewpoint | Perspective Systems | Basic Perspective | 56 |
| 3.2 | Side-View Drawings | Orthographic Views | - | 61 |
| 3.3 | Ellipses and Viewpoints | Radial Forms | Ellipses | 64 |
| 3.4 | Eye Level Perspective | Perspective Systems | Establishing Perspective | 70 |
| 3.5 (3.4.1) | From Bird's Eye Perspective to Eye Level Perspective | Perspective Systems | Basic Perspective | 70 |
| 3.6 (3.4.2) | Central Perspective at Eye Level | Perspective Systems | Basic Perspective | 74 |
| 3.7 (3.4.3) | Drawing Directly at Eye Level | Perspective Systems | Establishing Perspective | 76 |
| 3.8 | Ground-level Frog's Eye Perspective | Perspective Systems | Basic Perspective | 78 |
| 3.9 | Viewpoint; How to Practice | Perspective Systems | Basic Perspective | 80 |

**Table 4**

*Curricula Case Study: Sketching: The Basics*

| Section | Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 3.10 | More Tips | Perspective Systems | Basic Perspective | 81 |
| 4.1 | Starting with a Block? | Complex Objects | - | 88 |
| 4.2 | Singular Rounding | Manipulating Forms | Details | 90 |
| 4.3 | Multiple Rounding | Manipulating Forms | Details | 94 |
| 4.4 | Tubes | Manipulating Forms | Blending | 98 |
| 4.5 | Planes and Sections | Organic Forms | Sections | 100 |
| 4.6 | Sketching Progress; How to Practice | Complex Objects | - | 104 |
| 5.1 | Suggesting Depth | Basic Rendering | Shading | 114 |
| 5.2 (5.1.1) | White or Colored Background | Backgrounds | - | 114 |
| 5.3 | Color Basics | Materials | - | 118 |
| 5.4 | Colored Background | Backgrounds | - | 120 |
| 5.5 | Digital Sketching | Digital Sketching | - | 125 |
| 5.6 (5.4.1) | Step-by-Step Digital Sketching | Digital Sketching | - | 126 |
| 5.7 | Material Expression | Materials | - | 128 |
| 5.8 (5.5.1) | Glossy and Matt | Basic Rendering | Surface Quality | 128 |
| 5.9 (5.5.2) | Transparency | Materials | - | 130 |
| 5.10 (5.5.3) | Metal | Materials | - | 134 |
| 5.11 | Product Graphics | Materials | - | 138 |
| 5.12 | How to Practice | Materials | - | 142 |
| 6.1 | Lines | Line Quality | - | 150 |
| 6.2 (6.1.1) | Tracing | Underlays | - | 151 |
| 6.3 | Drawing Freely; Shape Optimizing | Complex Objects | - | 153 |

**Table 4**

*Curricula Case Study: Sketching: The Basics*

| Section (6.1.2) | Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 6.4 | Marker Use / After the Line | Traditional Media | Wet Media | 156 |
| 6.5 | Underlay | Underlays | - | 160 |
| 6.6 | Intuitive Sketching | Generative Sketching | Intuitive Sketching | 162 |
| 6.7 | How to Practice | Complex Objects | - | 164 |
| 7.1 | Adding Product Details | Manipulating Forms | Details | 172 |
| 7.2 | Scale and Size | Concept Sketching | Context | 175 |
| 7.3 | Background Images | Backgrounds | - | 178 |
| 7.4 | Tracing the Human Shape | Underlays | - | 180 |
| 7.5 (7.4.1) | Hands | Figures | Hands | 182 |
| 7.6 (7.4.2) | People | Figures | Construction Strategy | 184 |
| 7.7 | Steps and Sequences | Concept Sketching | Context | 190 |
| 7.8 | Focal Point | Views | Ghost Views | 192 |
| 7.9 | Product Context; How to Practice | Complex Objects | - | 196 |

**Table 5**

*Curricula Case Study: Sketching: Drawing Techniques for Product Designers*

| Numeric Prefix | Section Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 1.1 | Introduction; Side View Sketches | Orthographic Views | - | 9 |
| 1.2 | Getting Started | Orthographic Views | - | 10 |
| 1.3 | Details | Manipulating Forms | Details | 16 |

**Table 5**

*Curricula Case Study: Sketching: Drawing Techniques for Product Designers*

| Numeric Prefix | Section Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 1.4 | Drop Shadows | Light and Shadow | Cast Shadows | 20 |
| 1.5 | Displays | Materials | - | 25 |
| 2.1 | Perspective Drawing; Introduction | Perspective Systems | Basic Perspective | 27 |
| 2.2 | Scale | Perspective Tools | Scaling | 28 |
| 2.3 | Perspective Convergence | Perspective Systems | Basic Perspective | 29 |
| 2.4 | Distortion | Perspective Systems | Basic Perspective | 30 |
| 2.5 | Foreshortening | Perspective Systems | Basic Perspective | 32 |
| 2.6 | Viewpoint | Perspective Systems | Basic Perspective | 36 |
| 2.7 | Eye-Level Perspective | Perspective Systems | Establishing Perspective | 42 |
| 2.8 | Extreme Perspective | Perspective Systems | Basic Perspective | 43 |
| 2.9 | Arial Perspective | Environments | - | 50 |
| 3.1 | Simplifying Shape; Introduction | Complex Objects | - | 55 |
| 3.2 | Analyzing | Complex Objects | - | 56 |
| 3.3 | The Drawing Approach | Complex Objects | - | 59 |
| 4.1 | Elementary Geometrical Shapes; Introduction | Radial Forms | Cylinders | 67 |
| 4.2 | Block Shapes | Rectilinear Forms | - | 67 |
| 4.3 | Cylinders, Spheres, and Cones | Radial Forms | Cylinders | 74 |
| 5.1 | Special Attention for Ellipses; Introduction | Radial Forms | Ellipses | 81 |
| 5.2 | Vertical (Upright) Cylinders | Radial Forms | Cylinders | 83 |
| 5.3 | Horizontal Cylinders | Radial Forms | Cylinders | 92 |
| 5.4 | Shape Combinations | Manipulating Forms | Blending | 96 |

**Table 5**

*Curricula Case Study: Sketching: Drawing Techniques for Product Designers*

| Numeric Prefix | Section Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 5.5 | Joining Cylinders | Manipulating Forms | Blending | 100 |
| 5.6 | Tubes with Curvature | Manipulating Forms | Blending | 104 |
| 6.1 | Rounding; Introduction | Manipulating Forms | Details | 109 |
| 6.2 | Singular Rounding | Manipulating Forms | Details | 110 |
| 6.3 | Multiple Rounding | Manipulating Forms | Details | 118 |
| 6.4 | Staring at The Surface | Organic Forms | Surfaces | 129 |
| 6.5 | Estimating | Manipulating Forms | Details | 132 |
| 7.1 | Cross Sections; Introduction | Organic Forms | Surfaces | 133 |
| 7.2 | Curving a Surface | Organic Forms | Surfaces | 136 |
| 7.3 | Cross Section Spheres | Organic Forms | Sections | 138 |
| 7.4 | Drawing Curved Shapes | Organic Forms | Sections | 142 |
| 7.5 | Estimating | Organic Forms | Sections | 146 |
| 8.1 | Ideation; Introduction | Generative Sketching | Ideation | 153 |
| 9.1 | Explanatory Drawings; Introduction | Concept Sketching | General Principles | 179 |
| 9.2 | Exploded Views | Views | Exploded Views | 182 |
| 9.3 | Cut-Away | Views | Section Views | 188 |
| 9.4 | Ghosting | Views | Ghost Views | 189 |
| 9.5 | Instructional Drawings | Concept Sketching | General Principles | 191 |
| 10.1 | Surface and Textures; Introduction | Materials | - | 197 |
| 10.2 | Reflections | Materials | - | 201 |
| 10.3 | Guidelines for Reflections | Materials | - | 202 |
| 10.4 | Glossy | Basic Rendering | Surface Quality | 204 |

**Table 5**

*Curricula Case Study: Sketching: Drawing Techniques for Product Designers*

| Numeric Prefix | Section Title | Main Theme | Secondary Theme | Page |
|---|---|---|---|---|
| 10.5 | Mat | Basic Rendering | Surface Quality | 205 |
| 10.6 | Chromium | Materials | - | 210 |
| 10.7 | Glass | Materials | - | 214 |
| 10.8 | Textures and Graphics | Materials | - | 217 |
| 11.1 | Emitting Light; Introduction | Light and Shadow | Light Sources | 221 |
| 11.2 | Emitting Bright Light | Light and Shadow | Light Sources | 224 |
| 11.3 | Emitting Soft Light | Light and Shadow | Light Sources | 229 |
| 12.1 | Context; Introduction | Concept Sketching | Context | 235 |
| 12.2 | User Context | Concept Sketching | Context | 235 |
| 12.3 | Blending in Part of an Object | Underlays | - | 240 |
| 12.4 | Combining Pictures and Drawing | Concept Sketching | Context | 242 |
| 12.5 | Hands | Figures | Hands | 244 |
| 12.6 | People | Figures | Figures | 246 |

## Summary of Gracie Combatives

In this section, features of GC are identified and adapted into an IDS training program structure. GC is outlined using the 7 feature categories: 1) Foundations, 2) Curriculum, 3) Structure, 4) Methods, 5) Schedule, 6) Testing, and 7) Tools. For a detailed summary of feature identification and adaptation, see Procedures and Methods in Chapter 1.

## Feature Category 1: Foundations

This feature category contains foundational features that provide the basis for other program features.

### *GC Foundation 1: Distinct Techniques*

Specific processes are defined in BJJ and GC as distinct techniques or moves, each with their own name (Gracie, 2008). Defining techniques clearly and precisely allows aspects of BJJ to be better understood and organized. Without distinct techniques such as the trap and roll technique, or elbow escape, complex processes would be described in a longwinded way like: "grabbing the guy's leg" or "getting out from under the guy this one way with my elbow" and so on. These descriptions could be easily forgotten and misunderstood.

### *GC Foundation 2: Distinct Sub-Techniques*

GC consists of 36 total lessons, each of which provide instruction on a single BJJ technique. GC also organizes aspects of a technique into what are known as technical slices. A single Jiu-Jitsu technique is broken into 2 to 5 sub-techniques or technique stages, also known as slices. Technical slices are defined as: "individual drills that present the details of a particular technique or introduce a common variation on the standard application" (Gracie, 2008, p.16). In other words, technical slices can be described as a technique component or technique variation, each with a corresponding drill. Each slice drill is demonstrated by the instructors at the beginning of an instruction class (in person) or at the beginning of each lesson (DVD and Online). After each demonstration, students repeat the drill with their training partner.

A name is assigned to each slice. For example, in lesson one, the trap and roll technique, there are four slices: 1) Standard Variation, 2) Punch Block Variation, 3) Headlock Variation, and 4) Open Guard Pass (Gracie, 2008, p.17). Technical slices are one aspect of Dynamic Reflex Development (DRD), a GU proprietary training system discussed in *Feature Category 4: Methods*.

### *GC Foundation 3: Distinct Principles*

GC defines general strategies or principles used in GC as individual concepts called Gracie Guidelines or simply principles (Gracie, 2008, p.6-7). These principles describe strategies and ideas that apply generally to BJJ, such as the principle of energy efficiency (Gracie, 2008, p.7). By clearly defining general strategies, these ideas can be grappled with more easily. The comprehensive list of BJJ principles was created by Gracie University (GU) in 2021 with the release of *The 32 Principles of Jiu Jitsu* (32Ps) training program.

Although BJJ principles are taught and discussed in GC, they are not formally integrated into lesson plans as they are in the 32Ps. Rather, principles are shared throughout the program organically in lessons and other program sections, such as the introductory section and *Mindset Minute* section. The creation of the 32Ps presents future researchers with an opportunity to explore other training programs centered around principle-based learning.

### *GC Foundation 4: Distinct Process Stages*

GC defines specific stages of the activity, a fight, into four distinct fight stages. Each BJJ technique is contextualized in the activity by its relationship to these fight stages. It is worth noting that GU always encourages students of BJJ to avoid physical confrontations, if possible, before any of the four fight stages occurs. The four stages of a fight are:

1. "Close the Distance": reduce the distance with the attacker.

2. "Get the Takedown": take the attacker to the ground.

3. "Achieve the Dominant Position": grapple with and control the attacker.

4. "Finish the Fight": subdue the attacker with a leverage-based submission technique (Gracie, 2008, p.31-32).

The fight stages allow for each BJJ technique to be clearly contextualized in the dimension of time within the activity. This provides more information for structuring and teaching BJJ for use in the context of a real fight.

### GC Foundation 5: Technique Context

Another foundational aspect of GC is the contextualization of each GC technique in multiple dimensions. In GC, each technique is contextualized in the dimensions of 1) Space; physical position, 2) Time; stage within the fight, and 3) Use; technique type. Each of these contexts is leveraged within different features of GC to create various training program features.

## Feature Category 2: Curriculum

The curriculum of GC is key to its structure. For more information about the GC curriculum, see Chapter 3: Case Studies.

## Feature Category 3: Administration

### Administrative Formats

GC is administered in five different formats:

1. The Gracie Academy (GA): The GU headquarters located in Torrance, California.

2. Certified Training Centers: BJJ schools certified to teach Gracie Combatives and other official Gracie University material.

3. Gracie Garages: Groups on online Gracie University students working through the curriculum together.

4. Online Training Program: An interactive online learning platform.

5. DVD Series: A DVD series with supportive tools, such as The Fight Map Poster and the Official Gracie Combatives Handbook.

Gracie University students are encouraged to pursue both physical as well as online instruction. The school states: "There is a remarkable difference in the rate of progress between students who study in their off-time and those who don't" (*Master Cycle Forecast (Spring 2020)*, n.d.).

### *The Gracie Combatives Official Handbook*

*The Gracie Combatives Official Handbook* (GCOH) is a book that gives students a quick way to access and reference features of GC. The handbook consists of four sections: 1) Introduction, 2) Progress Tracking, 3) The Gracie Combatives Test, and 4) The Path to Black Belt. Each of these sections contains sub-sections which instruct students using GC.

Section One consists of introductory and supplemental context. It includes the following subsections: a) The Gracie Global Training Program, b) The Gracie Jiu-Jitsu Belt System, and c) The Founding Principles of Gracie Jiu-Jitsu.

Section Two consists of more detailed aspects of GC such as the RTS. It also provides the basic tools needed for individuals to track their progress as they move through the course. Section Two consists of the following subsections: a) The Key to Confidence, b) Recommended Training Schedule; c) Technique Troubleshooting; frequently asked questions and answers, d) Gracie Combatives Course Outline, and e) Gracie Combatives Fight Chart.

Section Three of the official handbook consists of the following subsections: a) Testing Instructions, b) Evaluation Criteria, c) Gracie Combatives Proficiency Drills, and d) Most Common Mistakes.

Section Four of the official handbook consists of the following subsections: a) The Master Cycle, b) Blue, Purple, Brown, and Black Belt Techniques, and c) Interactive Online Learning.

*Continual Training*

The Master Cycle (MC) refers to the training system used by GU apart from GC. In the MC, the more advanced techniques not covered in GC are organized into a curriculum that continues the GC curriculum. The MC is structured into what is known as The Seven Positional Chapters, referring to seven major positions in a grappling fight. Students spend a period of several months studying techniques in one chapter before moving onto the next chapter. Students eventually restart the cycle after working through all seven chapters. Students gain access to MC upon the successful completion of GC. Although the MC is not a part of GC itself, it is still related in that it serves as an integral way for students to continue their studies after completing GC. Thus, it is still considered part of the holistic structure of The GC program.

Figure 7 illustrates the MC.

**Figure 7**

*The Master Cycle*
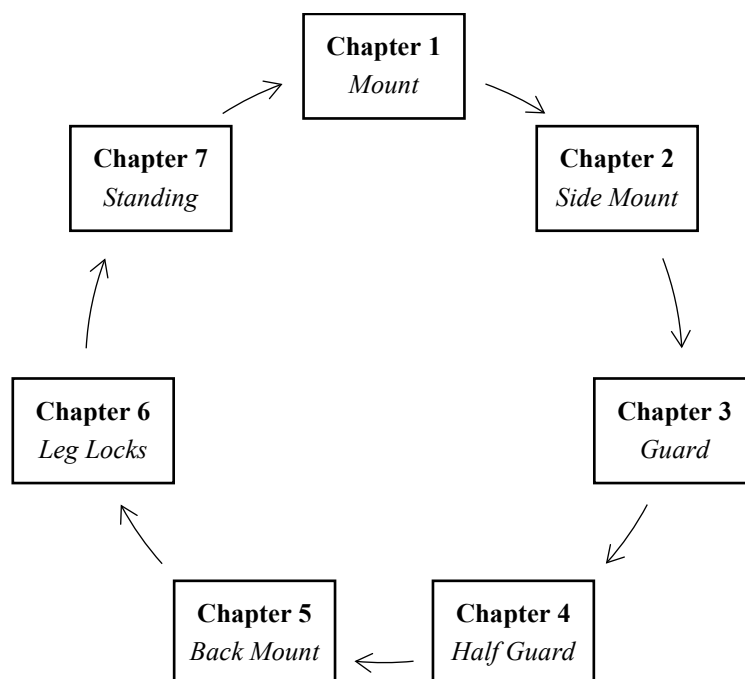
**Feature Category 4: Methods**

Possibly the most influential element of The Gracie Combatives program is the Dynamic Reflex Development system (DRD). DRD is a system designed to facilitate learning by developing student reflexes driven by an indicator: a movement, opportunity, or action that triggers the BJJ practitioner to use a certain technique. For example, the indicator for the trap and roll technique (lesson 1), punch block variation (slice 2), is being mounted by an aggressive attacker trying to strike your face. Ideally, when the BJJ practitioner sees the indicator, they automatically use the move with quick and precise reflexes, hence the name of the system, Dynamic Reflex Development.

DRD consists of three elements: 1) Technical Slices, 2) Reflex Development Drills (RDD), and 3) Fight Simulation Drills (FSD). Technical slices describe technique component parts and variations, each with a corresponding drill, creating three drill types. All GC lessons are accompanied by these drills; however, due to the nature of the drills, the first few lessons cannot contain a RDD or FSD, as the drills require the knowledge of multiple different techniques in order to be completed.

*Technical Slices*

The first component feature of DRD is technical slices. For more information about technical slices, see *GC Foundation 2: Distinct Sub-Techniques*.

*Reflex Development Drills*

The second training technique in DRD is the RDD. In this drill, students practice all variations of a new technique in combination with all variations of one to two previously learned techniques in predetermined, realistic sequences. For example, if a student completed the lesson

five instructional video, they have the option to move on to the lesson five RDD, where they rehearse a sequence of all variations of lesson four and lesson five techniques. Techniques in a RDD are sequenced in a logical progression, showing students how techniques relate to one another whilst training students to recognize indicators (*Gracie Combatives - The 36 Self-Defense Techniques Every BJJ Beginner MUST Learn!*, 2020). This gives students the opportunity to practice techniques in the context of other moves, developing their reflexes by using techniques in a realistic manner.

### *Fight Simulation Drills*

The Fight Simulation Drill (FSD) uses the same underlying logic as the RDD. Instead of practicing two to three techniques, sequences in a FSD can contain up to seven techniques. Techniques in a FSD specify a specific variation of each technique used, and are arranged in order to simulate the flow of techniques in a real fight. For example, the fight simulation drill at the end of lesson 10 rehearses 5 individual technique variations in order, each from a different lesson. Techniques rehearsed are from lessons 1, 3, 9, 8, and 10 (Gracie, 2008, p.26). This drill is designed to give students close to real world experience by simulating the chaotic nature of a fight.

### *Class Types*

GU students who are studying in person have access to another training resource in addition to drills: sparring classes. At GA, there are two different class types: 1) Technique Classes: where students learn new techniques in a controlled, cooperative environment and 2) Sparring Classes: where students drill techniques and spar with an opponent in a safe environment (*Master Cycle Forecast (Spring 2020)*, n.d.).

One of the main reasons that these different class types exist is to balance the benefits and drawbacks of both class types. This dichotomy of class types uses the same strategy as the RDD and FSD to create a balanced training experience, where students experience both technical and application-based training. Students who do too much sparring can be overwhelmed, discouraged, and injured, while students with no sparring experience can miss out on opportunities to test their skills against resisting opponents.

**Feature Category 5: Schedule**

***Gracie Combatives Recommended Training Schedule***

GC suggests a recommended training schedule (RTS) for the basic DVD version of GC. This schedule utilizes a cyclical pattern to work thorough the curriculum (Gracie, 2008). This cyclical way of working through the curriculum serve various functions in GC. Three of the main functions of this schedule are: 1) Exposing students to concepts multiple times, 2) Manipulating the length of the training program, and 3) Exposing students to new techniques at a slowed pace, and 4) Students have time between similar lessons rather than practicing the same skill consecutively, which can become monotonous.

***Schedule Anatomy and Terminology***

GC is structured as 36 essential techniques, each with their own lesson. Students work through all content associated with each lesson to complete a lesson. Students complete both the RDR and FSD to complete each GC lesson (except for initial lessons which do not contain a FSDs). The RTS works by grouping lessons into groups of 3, creating 12 lesson groups. Students progress through each lesson group using a simple two steps forward, one step back progression. The RTS tracks how many times a student has worked through a particular lesson. In this

research, this is referred to as a rate of exposure. Table 6 illustrates the RTS. The table is adapted

from the GC Handbook, page 11.

**Table 6**
*Gracie Combatives Recommended Training Schedule*

| Day | Lesson | Group | Exposure |
|-----|--------|-------|----------|
| 1 | 1 | 1 | 1st |
| 2 | 2 | 1 | 1st |
| 3 | 3 | 1 | 1st |
| 4 | 1 | 1 | 2nd |
| 5 | 2 | 1 | 2nd |
| 6 | 3 | 1 | 2nd |
| 7 | 4 | 2 | 1st |
| 8 | 5 | 2 | 1st |
| 9 | 6 | 2 | 1st |
| 10 | 1 | 1 | 3rd |
| 11 | 2 | 1 | 3rd |
| 12 | 3 | 1 | 3rd |
| 13 | 4 | 2 | 2nd |
| 14 | 5 | 2 | 2nd |
| 15 | 6 | 2 | 2nd |
| 16 | 7 | 3 | 1st |
| 17 | 8 | 3 | 1st |
| 18 | 9 | 3 | 1st |
| 19 | 4 | 2 | 3rd |
| 20 | 5 | 2 | 3rd |
| 21 | 6 | 2 | 3rd |
| 22 | 7 | 3 | 2nd |
| 23 | 8 | 3 | 2nd |
| 24 | 9 | 3 | 2nd |
| 25 | 10 | 4 | 1st |
| 26 | 11 | 4 | 1st |
| 27 | 12 | 4 | 1st |
| 28 | 7 | 3 | 3rd |
| 29 | 8 | 3 | 3rd |

**Table 6**

*Gracie Combatives Recommended Training Schedule*

| Day | Lesson | Group | Exposure |
|-----|--------|-------|----------|
| 30  | 9      | 3     | 3rd      |

Note: This table illustrates the first 30 days of training, and is designed to illustrate the curriculum cycle rather than the length of the entire training program.

Notice how on day 18, after completing group 1, group 2 and group 3, students revisit group 2 rather than progressing to group 4. In other words, students take two "forward steps" before taking another "back step". When using this schedule, students are exposed to new content only one third of the time they have a training session.

Another important factor to note is that there is no distinction between sparring classes and technique classes in the RTS. Sparring classes are a distinctive feature of the GA, and are not incorporated into the RTS (Gracie, 2008).

### *GA Schedule*

When administered at the GA, GC is administered in a monthly class structure. First, techniques in the curriculum of 36 techniques are organized in groups of 2. Some techniques are repeated, creating a total of 23 lesson groups. Each class day, students work through one lesson group, or two lessons. There are between three and five training class days per week, and lessons can be completed in any order. If a student attends every class, the process of working through the entire curriculum lasts one month. Students complete this monthly process two times, and then attend Reflex Development Classes, where students learn to "execute all variations of the 36 techniques in every possible combination" (*Gracie Combatives Calendar*, n.d.). Students practice each technique at least three times before moving on to the evaluative portion of the

training program. After the student completes two cycles of standard classes, they have the option to attend sparring classes, where students practice techniques at full speed.

**Feature Category 6: Testing**

The Gracie Combatives Test (GCT) is the evaluative portion of GC. In this section of the training program, students test their techniques by completing five Gracie Combatives Proficiency Drills (GCPDs). If all GCPDs are passed with a score of 90% or greater, the student earns their Gracie Combatives Belt and successfully completes the program.

### GCPD 1-4

The first four GCPDs are structured around four BJJ positions. Each BJJ technique can be categorized by the physical position of the practitioner when using the technique. This hierarchy allows someone learning a technique to quickly describe and determine where to use the technique. The four positions that contextualize every technique in GC are: 1) Mount, 2) Side-mount, 3) Closed Guard, and 4) Standing (Gracie, 2008 pp.17-54).

The first GCPD is based on the mount position. Students must demonstrate every mount technique in an exact predetermined sequence. This demonstration of the mount techniques is evaluated by the instructor. Students have a fixed testing time, five minutes, to demonstrate the required techniques. The goal of each GCPD is to demonstrate technical proficiency of individual techniques.

### GCPD 5

The final GCPD is known as the Freestyle Fight Simulation (FFS). The FFS is similar to a FSD in that it simulates a situation that is close to a real fight. Instead of demonstrating techniques in a technical way, students demonstrate as many GC techniques as possible in a free-flowing fight simulation that demonstrates good grappling flow. Each student has five minutes to

demonstrate their techniques. This drill is essentially a demonstration and simulation of a student's ability to smoothly use a variety of techniques in the context of a real fight.

### Testing Evaluation Criteria and Options

The GC Test is evaluated based on the following criteria (emphasis original): 1) Accuracy; the "*Precise and correct* execution of all techniques.", 2) Efficiency; "*Fluid, relaxed movements* and efficient use of energy.", and 3) Reflexes; "*Instinctive and speedy* responses to all indicators" (Gracie, 2008 p.58) Students can be evaluated by completing all five GCPDs in person or by submitting a video recording to GU.

**Feature Category 7: Tools**

*Tool 1 - Course Outline*

The course outline subsection gives students space to take notes in a structured and organized way. Each lesson has its own page where there is a blank space for taking notes on each slice of the technique. The RDD and FSD for that lesson is also outlined on the page. Figure 8 illustrates a lesson page from the OH.

**Figure 8**

*Gracie Combatives Official Handbook Lesson Page*



Note: Each lesson page gives students space to take notes according to each slice.

***Tool 2 - Progress Tracking Sheet and Combatives Card***

Another tool included in the OH is a progress tracking sheet. This sheet allows students to quickly evaluate their level of confidence for each technique slice. Students online are given space to take notes in the interactive course, while students learning in person or through the DVD series can use the official *Gracie Combatives Handbook* to track their progress. While studying in person, students use a *Combatives Card* a small card similar to a progress tracking sheet) to track their progress throughout the course. A scan of the progress tracking page in the GCOH is shown in Figure 9.

**Figure 9**

*Gracie Combatives Official Handbook Progress Tracking Sheet*

| | Lesson | | Location | | Confidence* | | |
|---|---|---|---|---|---|---|---|
| # | Technique | Position | Page | Disc | Low | Med | High |
| 1 | Trap and Roll Escape | Mount | 17 | 1 | | ✓ | |
| 2 | Americana Armlock | Mount | 18 | 1 | | | ✓ |
| 3 | Positional Control | Mount | 19 | 1 | | | ✓ |
| 4 | Take the Back | Mount | 20 | 2 | | ✓ | |
| 5 | Rear Naked Choke | Back Mount | 21 | 2 | | | ✓ |
| 6 | Leg Hook Takedown | Standing | 22 | 2 | | ✓ | |
| 7 | Clinch (Aggressive Opponent) | Standing | 23 | 3 | | | ✓ |
| 8 | Punch Block Series (Stages 1-4) | Guard | 24 | 3 | | ✓ | |
| 9 | Straight Armlock | Mount | 25 | 3 | | ✓ | |
| 10 | Triangle Choke | Guard | 26 | 4 | ✓ | | |
| 11 | Elevator Sweep | Guard | 27 | 4 | ✓ | | |
| 12 | Elbow Escape | Mount | 28 | 4 | ✓ | | |
| 13 | Positional Control | Side Mount | 29 | 5 | ✓ | | |
| 14 | Body Fold Takedown | Standing | 30 | 5 | | | ✓ |
| 15 | Clinch (Conservative Opponent) | Standing | 33 | 5 | | | ✓ |
| 16 | Headlock Counters | Mount | 34 | 6 | ✓ | | |
| 17 | Double Leg Takedown | Standing | 35 | 6 | | | |
| 18 | Headlock Escape 1 | Side Mount | 36 | 6 | | | |
| 19 | Straight Armlock | Guard | 37 | 7 | | | |
| 20 | Double Ankle Sweep | Guard | 38 | 7 | | | |
| 21 | Pull Guard | Standing | 39 | 7 | | | |
| 22 | Headlock Escape 2 | Side Mount | 40 | 8 | | | |
| 23 | Guillotine Choke | Standing | 41 | 8 | | | |
| 24 | Shrimp Escape | Side Mount | 41 | 8 | | | |
| 25 | Kimura Armlock | Guard | 43 | 9 | | | |
| 26 | Standing Headlock Defense | Standing | 44 | 9 | | | |
| 27 | Punch Block Series (Stage 5) | Guard | 45 | 9 | | | |
| 28 | Hook Sweep | Guard | 46 | 10 | | | |
| 29 | Rear Takedown | Standing | 47 | 10 | | | |
| 30 | Haymaker Punch Defense | Standing | 48 | 10 | | | |
| 31 | Take the Back | Guard | 49 | 11 | | | |
| 32 | Guillotine Defense | Standing | 50 | 11 | | | |
| 33 | Elbow Escape | Side Mount | 51 | 11 | | | |
| 34 | Standing Armlock | Standing | 52 | 12 | | | |
| 35 | Twisting Arm Control | Mount | 53 | 12 | | | |
| 36 | Double Underhook Guard Pass | Guard | 54 | 12 | | | |

| The Gracie Combatives Belt Test | | | | | | | |
|---|---|---|---|---|---|---|---|
| N/A | GC Proficiency Drill 1 | Mount | 59 | 13 | | | |
| N/A | GC Proficiency Drill 2 | Guard | 59 | 13 | | | |
| N/A | GC Proficiency Drill 3 | Side Mount | 60 | 13 | | | |
| N/A | GC Proficiency Drill 4 | Standing | 60 | 13 | | | |
| N/A | GC Proficiency Drill 5 | Freestyle | 60 | 13 | | | |

* See **Section 2** for recommended training schedule and confidence tracking guidelines.

Note: The progress tracking sheet acts as an interactive table of contents.

*Tool 3 - The Gracie Combative Fight Chart*

The Gracie Combative Fight Chart (GCFC) is a flow chart used to visualize the process of a fight. Nodes in the flow chart represent physical positions or techniques, and links represent the flow from technique to technique, technique to position, or position to technique. The GCFC illustrates each GC technique according to its context within the fight, contextualizing each GC technique in both time and space. It also illustrates the relationship between techniques. Figure 10 shows the fight map printed in the official GC Handbook (Gracie, 2008 p. 31-32).

**Figure 10**

*Gracie Combatives Fight Chart*
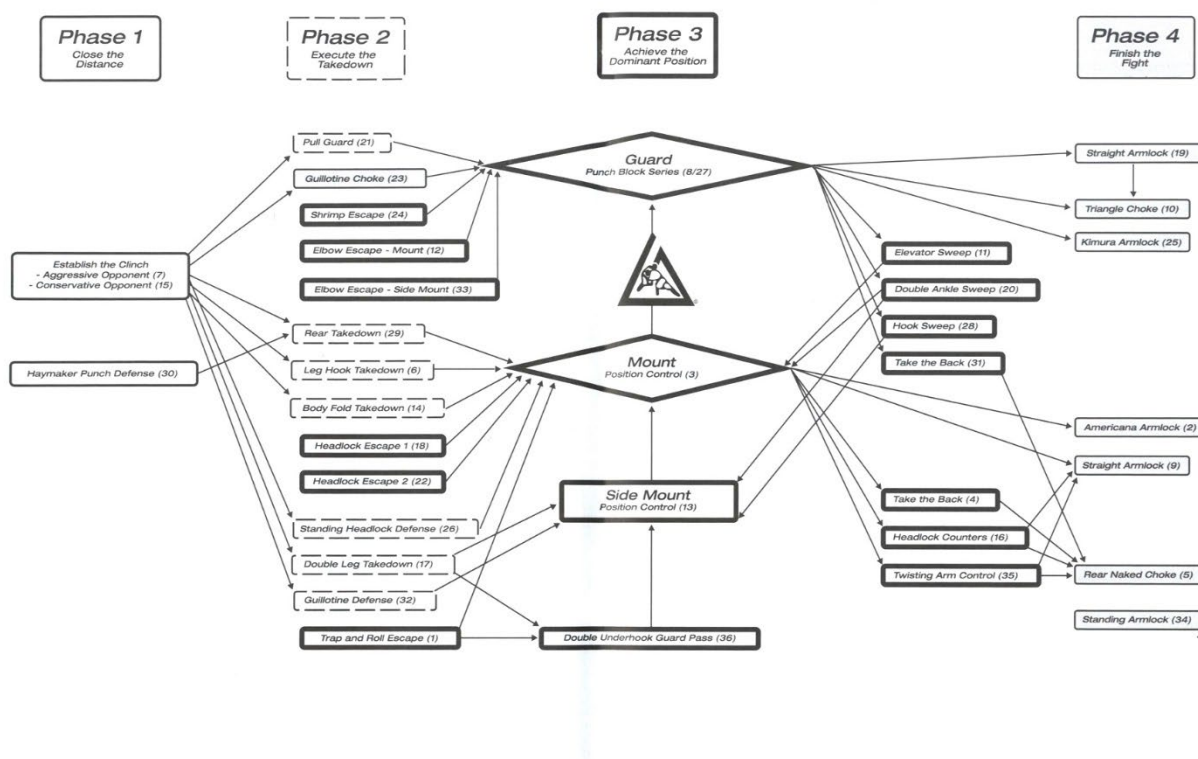
**Chapter 4: Design Tool**

This chapter details the structure and features of training program resulting from the adaptation of GC, known as The Industrial Design Sketching Program (IDSP). Each program structure is outlined using the 7 feature categories: 1) Foundations, 2) Curriculum, 3) Structure, 4) Methods, 5) Schedule, 6) Testing, and 7) Tools. For a detailed summary of feature identification and adaptation, see Procedures and Methods in Chapter 1. Figure 11 illustrates the how the features of GC relate to the features of IDSP.

**Figure 11**

*Program Adaptation*
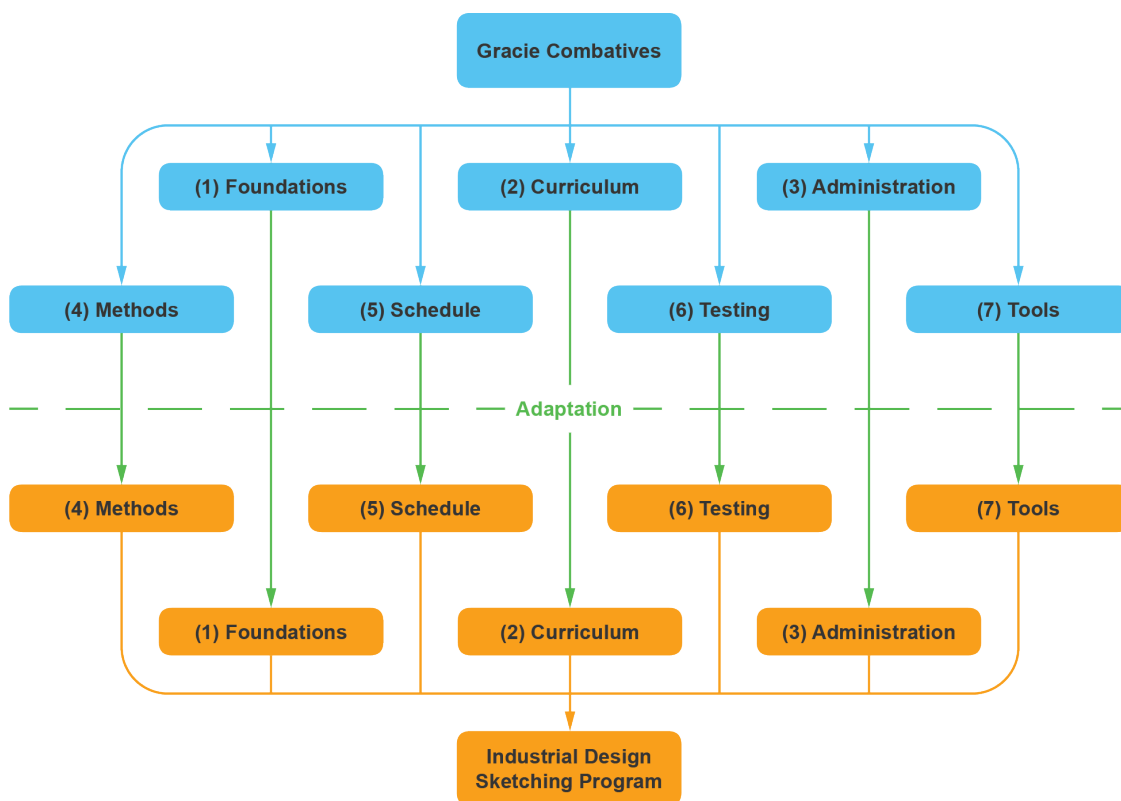


Note: This illustration is meant to show the relationship between the two programs, and is not a summary of all of the features of GC or IDSP.

*Program Adaptation Summary*

Table 7 summarizes IDSP and GC.

**Table 7**
*IDSP Features Summary*

| Feature | Program | |
|---|---|---|
| | Gracie Combatives | Industrial Design Sketching Program |
| Feature Category 1: Foundations | | |
| Distinct Techniques | Techniques, Moves | Techniques |
| Distinct Sub-Techniques | Technical Slices | Sketching Sub-techniques |
| Distinct Technique Components | Technical Slices | Sketching Sub-techniques |
| Distinct Technique Variations | Technical Slices | Sketching Sub-techniques |
| Principles | Gracie Guideline, Founding Principles, The 32 Principles of Jiu-Jitsu[a] | N/A[b] |
| Distinct Process Stages | Fight Stages | Sketching Process Stages |
| Technique Contexts | Name, Type, Fight Stage, Position | Name, Type, Process Stage |
| Feature Category 2: Curriculum | | |
| Techniques | 36 Essential BJJ Techniques | 28 Sketching Techniques |
| Curriculum Structure | Linear Progression | Linear Progression |
| Technique Identification Methodology | Case Studies, Gracie Challenge Matches | Case Studies, Drawing and Sketching Textbooks |
| Feature Category 3: Administration | | |
| Professional Administration | The Gracie Academy, Certified Training Centers | University Setting |
| Universal Administration | Gracie Garages, Online (Gracie University Website), DVD Series | N/A[c] |

**Table 7**
*IDSP Features Summary*

| Feature | Program | |
|---|---|---|
| | Gracie Combatives | Industrial Design Sketching Program |
| Post-Completion Training | The Master Cycle | Design Sketching Practice Cycle |
| *Feature Category 4: Methods* | | |
| Training Methodology | Dynamic Reflex Development | N/A[d] |
| Sub-technique Specific Drills | Technical Slices | Sub-techniques |
| Technique Combinatory Drills | Reflex Development Drills | Technical Sketching Drills |
| Stimulatory Drills | Fight Simulation Drills | Design Sketching Drills |
| Instruction Classes | Instruction Classes | Instruction Classes |
| Practice Classes | Sparring Classes | Practice Classes |
| *Feature Category 5: Schedule* | | |
| Academic Schedule | Gracie Academy Training Schedule | Collegiate Schedule; Fall and Summer |
| Universal Schedule | Recommended Training Schedule | Basic Schedule |
| *Feature Category 6: Testing and Evaluation* | | |
| Test | Gracie Combatives Test | Industrial Design Sketching Test |
| Testing Methodology | Gracie Combatives Proficiency Drills 1-4, Freestyle Fight Simulation | Design Sketching Proficiency Drills 1-7 |
| *Feature Category 7: Tools* | | |
| Handbook | *Gracie Combatives Official Handbook* | Industrial Design Sketching Program Handbook |
| Process Visualization Tool | The Fight Map | Sketching Process Map |
| Progress Tracking Tool | Progress Tracking Page, Combatives Card | Progress Tracking Sheet |

**Table 7**
*IDSP Features Summary*

| Feature | Program | |
|---------|---------|---|
| | Gracie Combatives | Industrial Design Sketching Program |

Notes: Abbreviations were not used in this table for increased clarity.

[a] The 32 principles of Jiu-Jitsu are not a part of GC, but exist within the MC.

[b] To maintain the focus on program structure, a series of sketching principles was not developed for IDSP.

[c] In order to focus on program structure and design, and to operate within time constraints, administrative features such as an IDSP DVD series, website, and training network were not created. Future studies could create and test these features for IDSP.

[d] Dynamic Reflex Development (consisting of Technical Slices, Reflex Development Drills, and Fight Simulation Drills) is a Gracie University proprietary training methodology. IDSP drills are subjective adaptations of DRD drills.

## IDSP Foundations

### *Distinct Sketching Techniques*

Distinct sketching techniques were identified using case studies in Chapter 3.

### *Distinct Sketching Sub-Techniques*

Distinct sketching sub-techniques were identified in Chapter 3. To adapt indicator actions, each technique also has a description which describes the use of that particular technique. Descriptions are written by the program administrator or teacher.

### *Distinct Sketching Principles*

Although principles are listed in the introductory section of *The GC Official Handbook*, a series of sketching principles was not identified and integrated into the structure of IDSP in order

to maintain the focus on program structure. General principles of IDS could be identified and integrated into the program in future studies.

### Distinct Sketching Process Stages

Distinct stages in the sketching process are incorporated into IDSP. Process stages were identified by arranging technique into a logical progression according to the nature of each technique, forming basic activity stages. Techniques were arranged by the researcher using the mind mapping technique.

### Sketching Technique Context

Techniques within IDSP contextualized in the same categorizes as techniques in BJJ, except for physical position. It is worth noting that these contexts may not be the only relevant dimensions that sketching techniques could be contextualized in. Table 8 illustrates the context of sketching techniques.

**Table 8**
*Technique Context*

| Context | Program | |
|---|---|---|
| | GC | IDSP |
| Name | Y | Y |
| Physical Position | Y | N |
| Type | Y; Technique Type | Y; Technique Type |
| Process Stage | Y; Fight Stage | Y; Sketching Process Stage |
| Rank | N [a] | N |

[a] Techniques are contextualized by rank in Gracie Academy's Advanced training program. The Master Cycle, however, ranking context does not exist within GC itself.

**IDSP Curriculum**

   The curriculum of 28 essential design sketching techniques was identified through case studies in Chapter 3. The IDSP curriculum is structured as a linear progression. The order of technique types was logically synthesized by the researcher from the most basic to the most advanced technique type. Technique types were arranged in the following order: 1) Foundation, 2) Construction, 3) Rendering, 4) Craft, 5) Modality, and 6) Strategy. Although techniques in the GC curriculum are not necessarily arranged by type, they are still arranged in a logical structure, where new techniques build upon the knowledge of other techniques. This structure is similar to GC in that techniques are also arranged logically, so that the student has a natural progression through the curriculum. One benefit of the case studies approach was that each technique and/or sub technique can be linked to a series of book references for supplemental study.

   Figure 12 shows the integration of the curriculum into The IDSP Handbook, a tool which integrates the training program into a usable format. For more information about the IDSP Handbook, see *IDSP Administration* in Chapter 4. For the complete IDSP Handbook, see *Appendix A: Industrial Design Sketching Program Handbook.*

**Figure 12**

*IDSP Handbook Curriculum*

### Curriculum

| # | Title | DI | HTD | STB | SDT |
|---|-------|-----|------|-----|-----|
| Foundation | | | | | |
| 1 | Sketching Mechanics | | | | |
| 1.1 | Lines | 22 | 14, 15 | | |
| 1.2 | Curves | | 17 | | |
| 1.3 | Ellipses | | 18 | | |
| 2 | Orthographic Views | | 84,170 | 61 | 9, 10 |
| Construction | | | | | |
| 3 | Perspective Systems | | | | |
| 3.1 | Basic Perspective | | 16, 22, 23, 24, 26, 27, 169 | 28, 33, 56, 70, 74, 78, 80, 81 | 27, 29, 30, 32, 36, 43 |
| 3.2 | Establishing Perspective | | 46, 48, 49, 50, 51, 54, 57, 118, 62, 133 | 30, 70, 76 | 42 |
| 4 | Rectilinear Forms | 52 | 23 | | 4.2 |
| 5 | Perspective Tools | | | | |
| 5.1 | Dividing and Multiplying | | 30, 32, 33 | | |
| 5.2 | Scaling | | 53 | | 28 |
| 5.3 | Mirroring | | 34, 36, 37, 40, 42, 43 | | |
| 6 | Radial Forms | | | | |
| 6.1 | Ellipses | | 19, 72, 73, 74, 76, 78, 79 | 38, 64 | 81 |
| 6.2 | Cylinders | 86 | | 40, 42, 46 | 67, 74, 83, 92 |
| 6.3 | Ellipses in Construction | | 74, 75 | | |
| 7 | Organic Forms | | | | |
| 7.1 | Curves | | 85, 89 | | |
| 7.2 | Surfaces | 72 | 6.10 | | 129, 133, 136 |
| 7.3 | Sections | | 86, 88, 90, 92, 96, 102 | 44, 100 | 138, 142, 146 |
| 8 | Manipulating Forms | | | | |
| 8.1 | Blending | | | 98 | 96, 100, 104 |
| 8.2 | Details | | 93 | 90, 94, 172 | 16, 109, 110, 118, 132 |

5

Note: Book Titles are summarized for legibility.

**IDSP Administration**

*Administrative Formats*

IDSP is also designed be packaged in different formats. In order to focus on program

structure and design and to operate within time constraints, administrative features such as the

DVD series, website, and training network were not adapted. Future studies could adapt these

features for IDSP. Chapter 4 provides an example for how IDSP can be applied through the

creation of a basic and foundational administrative tool which corresponds with a basic element

of GC: *The Gracie Combative Official Handbook.*

*IDSP Official Handbook*

Like The GCOH, The *IDSP Handbook* gives students a quick way to access and reference

program features and access program tools. The IDSP Handbook is a functional adaptation of the

GCOH. In other words, it is not structured in exactly the same way as the GCOH, nor does it

share the same format. The IDSP Handbook serves as a tool for design students and educators to

use IDSP. To maintain the focus on program structure, there is minimal supplementary

information in the IDSP handbook. Foundational program features do not have their own section

in the handbook, as they are foundational to other program features. Program features within the

handbook are arranged in a logical progression.

*Post-Completion*

IDSP also incorporates a cycle for continued practice after successful program completion.

This cycle is known as the Design Sketching Practice Cycle (DSPC). In GC, techniques are

grouped according to their position to establish cycle chapters, but because physical positioning

within a fight does not apply to IDS (see Table 6), technique type groups are used to organize the

DSPC. Another differentiator between the MC and DSPC is the curriculum used in the cycle.

The MC curriculum differs from that of GC in its greater length and scope. The IDSP uses the standard curriculum for continued training use. This allows IDSP to use the structure of the MC without an advanced training curriculum.

Like GC, techniques within each group are practiced for a set period of time. Each group is practiced at the student's leisure for one month. After one month of training, students move to the next technique type group. When students complete the cycle, the cycle restarts. Figure 13 illustrates the IDSP Practice Cycle pictured in the IDSP Handbook.

**Figure 13**

*IDSP Handbook Design Sketching Practice Cycle*
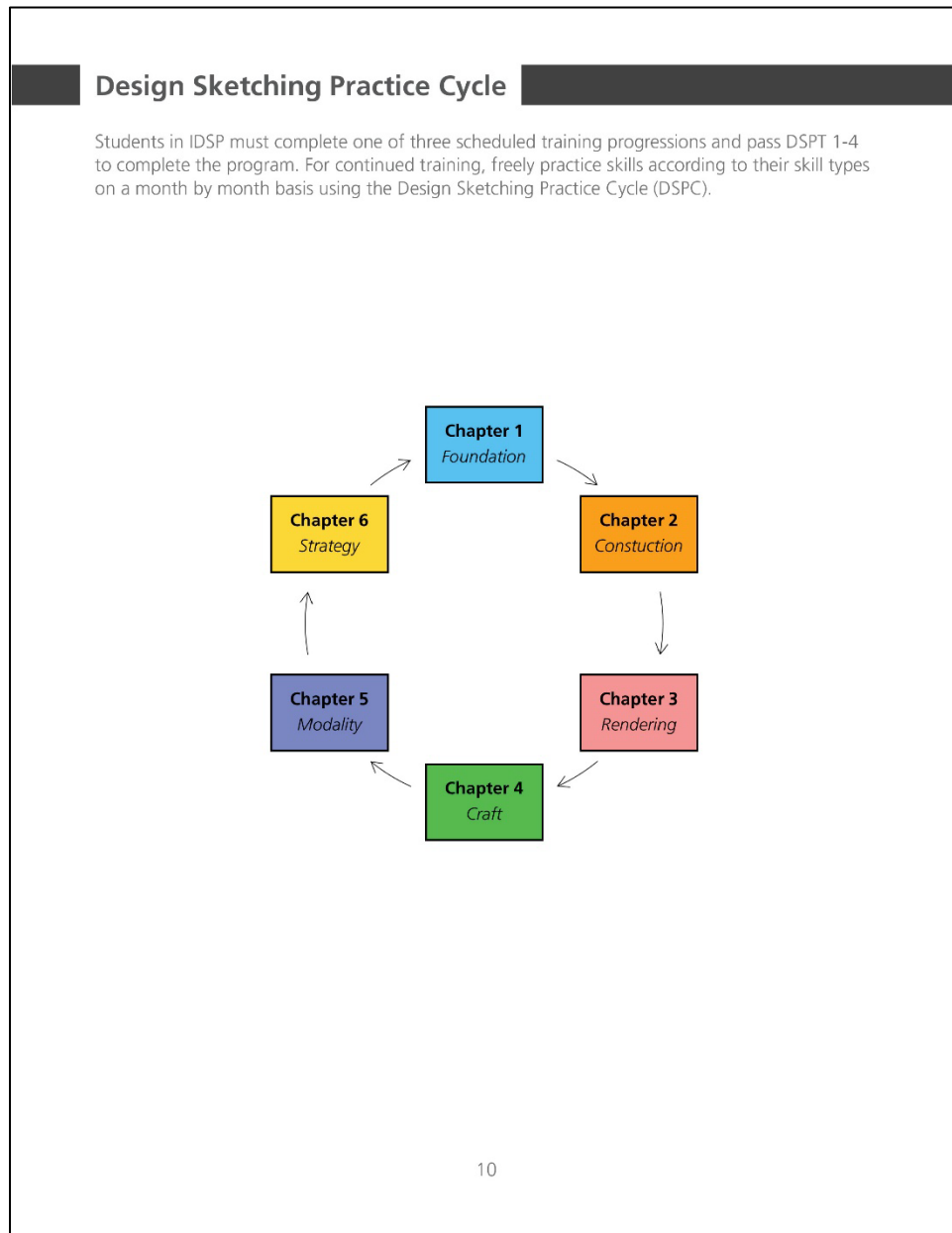
**IDSP Training Methods**

***Technical Sketching Drills***

In IDSP, an adaptation of a RDD known as a Technical Sketching Drill (TSD) is used. A TSD based on the premise of practicing sub-techniques pertaining to one sketching technique in combination with sub-techniques of 1 to 2 other techniques. This creates a matrix of sketching exercises from which instructors can select "sketches" to assign to their students. This assignment limits the complexity of each exercise by limiting the parameters of each sketching exercise to 2-3 techniques. A TSD is administered by choosing a subject and number of iterations for each sketch. Iterations are accounted for based on the number of forms drawn, not the number of pages used.

In each TSD, students practice all variations of each technique in combination with all variations of another technique or a specific variation of another technique. This allows for some flexibility when creating technique combinations. For example, if all variations of technique 6 (radial forms) where practiced with all variations of technique 10 (shading), a resulting combination could be shading (sub-technique 10.1) and ellipses (sub-technique 6.1) which does not result in a useful technique combination. These combinations were simply not included in the IDSP Handbook. Some combinations within TSDs do not have a subject, as the subject matter is defined by sub technique itself i.e., sub-technique 6.1, ellipses.

The nature of the resulting forms (subject) is chosen by the instructor. A TSD directs students to practice skills in the context of other techniques, but with a limited scope. For this reason, these assignments are called technical sketching drills. Because TSDs are technical assignments, elements such as the manufacturability of the object drawn are not factored into the grade.

Figure 14 shows TSDs in the IDSP Handbook.

**Figure 14**

*IDSP Handbook Technical Sketching Drills*

## Technical Sketching Drills

| # | Combination | Description | Subject | Iterations |
|---|---|---|---|---|
| | | TSD5 | | |
| 1 | T4XT5.1 | Dividing and Multiplying Rectilinear Forms | | |
| 2 | T4XT5.2 | Scaling Rectilinear Forms | | |
| 3 | T4XT5.3 | Mirroring Rectilinear Forms | | |
| | | TSD6 | | |
| 4 | T6.1XT5.1 | Dividing and Multiplying Ellipses | - | |
| 5 | T6.1XT5.2 | Mirroring Ellipses | - | |
| 6 | T6.1XT5.3 | Scaling Ellipses | - | |
| 7 | T6.2XT5.1 | Dividing and Multiplying Cylinders | - | |
| 8 | T6.2XT5.2 | Mirroring Cylinders | - | |
| 9 | T6.2XT5.3 | Scaling Cylinders | - | |
| 10 | T6.3XT5.1 | Dividing and Multiplying Radial Forms (Ellipses in Construction) | | |
| 11 | T6.3XT5.2 | Mirroring Radial Forms (Ellipses in Construction) | | |
| 12 | T6.3XT5.3 | Scaling Radial Forms (Ellipses in Construction) | | |
| | | TSD7 | | |
| 1 | T7.1X5.1 | Dividing and Multiplying Organic Curves | - | |
| 2 | T7.1X5.2 | Scaling Organic Curves | - | |
| 3 | T7.1X5.3 | Mirroring Organic Curves | - | |

12

*Design Sketching Drills*

In IDSP, a drill known as a Design Sketching Drill (DSD) is adapted from the FSD. DSDs are designed to allow students to simulate the use of sketching techniques in the context of a finished sketch.

An instructor administers a DSD by choosing a subject that corresponds with the technique sequence for each DSD. The sequence serves as a guide when completing a DSD, showing students a clear path toward assignment completion. This drill is slightly more structured than a sketching task within a design project, where there is not a guide for completing the task.

This increased structure potentially increases student confidence through reducing the amount of information students have to recall from memory when starting the sketch. This structure may also enhance student understanding of how sketching is used in the design process by providing clear examples of how a design professional utilizes specific techniques to create a finished sketch. This drill has the added benefit of potentially kickstarting real design projects and portfolio pieces.

A DSD is different from a TSD in that it is not necessarily technical in nature, but represents a student's ability to incorporate techniques into a sketch in creative and effective ways. Therefore, DSDs are evaluated and graded according to the intended purpose of the sketch, just as a design manager would evaluate the sketch of a junior designer. The general purpose and target goal of each DSD is defined by the technique sequence. For example, take the following technique sequence from TSD21:

1.  T18 Conduct Visual Research

2.  T21.2 Generate Thumbnail Sketches

3.  T21.1+21.3 Develop Forms (Ideation+Intuitive)

4. T3.1 Choose View

5. T3.2 Establish Perspective

6. T9 Construct Complex Object

7. T12.1 Create Exploded View

8. T12.2 Create Section View

9. T12.3 Create Transparent View

10. T15 Render Materials

All of the items related to the completion of this sketch, including form development sketches, would be evaluated by the instructor. The relationship between research, form development, and the final design would all be factored into the student's grade. For more simple sequences, the general goal of each DSD is to communicate the subject clearly. Factors such as technical accuracy are not necessarily taken into account when grading unless they necessarily effect the intended purpose of the sketch itself. For more information about good and bad sketches, see Chapter 1, Assumption 2: The Definition of a Good Sketch. Because DSDs are application based assignments, elements which are related to the sketches purpose such as cleanliness, conciseness, clarity, and style can be considered by the instructor when grading. There are no specific guidelines for page layout for DSDs. There is also no limit for the number of pages used to complete the assignment, nor is there a specification for the number of pages a student should submit to the instructor. Figure 15 shows DSDs in the IDSP Handbook.

**Figure 15**

*IDSP Handbook Design Sketching Drills*

## Design Sketching Drills

| Drill | Sequence | Subject |
|---|---|---|
| DSD5 | 1. Design In Orthographic<br>2. Divide Object into Proportion of a Square<br>3. T3.1 Choose View<br>4. T3.2 Establish Perspective<br>5. T4 Replicate Proportion<br>6. T4 Construct Rectilinear Form<br>**7. T5.1 Multiply Object**<br>**8. T5.2 Scale Object**<br>**9. T5.3 Mirror Object** | |
| DSD6 | 1. Design In Orthographic<br>2. Divide Object into Proportion of a Square<br>3. T3.1 Choose View<br>4. T3.2 Establish Perspective<br>5. T4 Replicate Proportion<br>**6. T6 Construct Cylindrical Form** | |
| DSD7 | 1. Design In Orthographic<br>2. Divide Object into Proportion of a Square<br>3. T3.1 Choose View<br>4. T3.2 Establish Perspective<br>5. T4 Replicate Proportion<br>**6. T7 Construct Organic Form** | |
| DSD8 | 1. T2 Design In Orthographic<br>2. T5.2 Divide into Proportions of a Square<br>3. T3.1 Choose View<br>4. T3.2 Establish Perspective<br>5. T4 or T6 or T7 Construct Form<br>**6. T8.1 Blend Forms**<br>**7. T8.2 Add Details** | |
| DSD9 | 1. T2 Design In Orthographic<br>2. T5.2 Divide into Proportions of a Square<br>3. T3.1 Choose View<br>4. T3.2 Establish Perspective<br>5. T5.1 Replicate Proportions<br>**6. T9 Construct Complex Object** | |
| DSD10 | 1. T2 Design In Orthographic<br>2. T5.2 Divide into Proportions of a Square<br>3. T3.1 Choose View<br>4. T3.2 Establish Perspective<br>5. T5.1 Replicate Proportions<br>6. T9 Construct Complex Object<br>**7. T10.1+T10.2 Shade Surfaces** | |

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***Guidelines for Creating Technical Sketching and Design Sketching Drills***

Both TSDs and DSDs are designed to complement each other, giving students technical and practical training experience, and thus a more well-rounded understanding of design sketching. Instructors can choose their own subject for both TSDs and DSDs. TSDs and DSDs are assigned at the end of each lesson, and are due at the start of the next lesson.

For this study, combinations of techniques were generated by considering how sketching techniques are used in the context of other techniques while referencing the program curriculum. Theoretically, a master combination matrix could be created which contained all of the 1 to 1 combinations of every sub-technique in the curriculum. Because there are many potential technique combinations and sequences, a sample of combinations and sequences rather than all potential combinations (or a master matrix) was synthesized by the researcher. This aligns with the structure of RDDs and FSD in GC, where there are a limited number of combinations used. Future studies could explore other methodologies for generating new technique sequences and combinations. Future studies should synthesize and test different technique combinations for IDSP. The combinations and sequences synthesized for this thesis demonstrate the drills themselves, and do not necessarily embody the ideal combinations or sequences for each drill.

***Class Types***

Similar to how GU divides in person classes into different class types, IDSP also has two class types: 1) Instruction, and 2) Practice.

In instruction classes, instructors demonstrate and/or discuss each sub-technique. The students follow along with the instructor: where students work on assignments or simply practice their skills. Table 9 summarizes training methods in GC and IDSP where students work through a

lesson or lesson group. General summaries of class types, TSDs, and DSDs are included in the

IDSP Handbook.

**Table 9**
*Training Methods Summary*

| Aspect | Drill | | | |
|---|---|---|---|---|
| | GC | | IDSP | |
| | RDD | FSD | TSD | DSD |
| Drills/ Lesson | 1 | 1 | 1 | 1 |
| Techniques/ Drill | 2-3 | 3-5 | 2-3 | ≥3 |
| Difficulty | Basic | Advanced | Basic | Advanced |
| Nature | Technical | Contextual | Technical | Contextual |
| Grading | N/A | N/A | Technical | Application |

**IDSP Schedule**

*Basic Schedule*

A basic schedule for IDSP is also designed for students studying with little to no restrictions. In this schedule, the same "two steps forward, one step back" progression is used. Because there are 28 total lessons in IDSP, lessons are grouped into 14 groups of 2 rather than 12 groups of 3. All elements of the GC RTS remain the same in the basic IDSP schedule, except that lessons are grouped in groups of two instead of groups of three. Like GC, only a single class type is included in this basic schedule. This schedule is designed to leverage the same benefits of the RTS.

*Colligate Schedule*

IDSP also uses a different schedule known as The Collegiate Schedule (CS) when the program is used to train students in a traditional academic setting. This schedule is designed to integrate into an academic calendar, and can be adapted to fit a range of time constraints. A university schedule is a close equivalent of the schedule used in GA, as both institutions have similar traits such as set class times, days off, holidays, etc. Because there are multiple times when IDSP could be administered at a university level (multiple semesters with different time constraints), two variations of the CTS were developed: The Fall Schedule and The Summer Schedule.

*Potential Training Time*

Like the academy schedule in GC, factors such as potential training time influence the CTS. For exemplary purposes, Auburn University's academic calendar was used as a baseline for determining potential training time in an academic setting. Specifically, Auburn Industrial Design's course structure (the time already allotted to teach design sketching) was used to determine a fixed amount of potential training time. By using this schedule, Auburn would not

have to modify class times to integrate the IDSP into its curriculum. The 2020 academic calendar was used to determine a year of potential training time. Potential training times are illustrated in Table 10 (*Auburn University Calendar 2020-2021*, n.d.).

**Table 10**
*Available Training Time*

| *Training Time Factor* | Semester | |
|---|---|---|
| | Fall | Summer |
| Semester Length (Days) | 151[a] | 75[b] |
| Class Days | Tue, Thurs | Mon, Wed, Fri |
| Class Days/ Week | 2 | 3 |
| Potential Meeting Days | 30[c] | 30[d] |
| | Class Information | |
| Hours/ Class | 1.5 | 7.5[e] |

Note: Length of Auburn semesters was based on the first day of class to the first day of final exam period. This table does not account for break periods.

[a] Based on the length of the 2020 fall semester (August 17- December 1).

[b] Based on the length of the 2020 summer semester (May 20-August 2).

[c] 31 potential class days with one class day off.

[d] 33 total potential class days with three class days off.

[e] 8:30am-12pm and 1pm-5pm

*Fall Schedule*

In the Fall Schedule, techniques are grouped consecutively 2 by 2 according to their number, creating 14 technique groups. This is identical to the grouping strategy used in GC for in-person learning. Instructors teach one lesson group per training day, every other training day. Class types are incorporated into the fall schedule. Students alternate between instruction and practice

classes throughout the schedule. This schedule mimics the GA schedule and allows students to experience the benefits of both class types. In this schedule, each technique is formally taught once in an instruction session and practiced in a controlled setting once in a practice session.

### *Summer Schedule*

In the Summer Schedule, techniques are grouped consecutively 2 by 2 according to their number, creating 14 technique groups. Instructors teach one group per class, every class, immediately repeating the same technique group once. Repeating techniques allows for instructors to teach a basic variation in the first class, and a more advanced variation in the second class. Because classes during the summer are nearly eight hours in length, students have plenty of time to practice during the afternoon. Therefore, classes in the summer are broken into two parts, with instruction in the morning and practice in the afternoon. In other words, a single summer class is a combination of one instruction and one practice class. In this schedule, each technique is formally taught twice, and practiced in a controlled setting twice. Table 14 shows the relationship between the schedules in GC and IDSP. Table 11 summarizes the schedules in GC and IDSP.

**Table 11**

*Training Schedules Summary*

| Aspect | Schedule | | | | |
|---|---|---|---|---|---|
| | Gracie Combatives | | IDSP | | |
| | Recommended (RTS) | Academy | Basic | Colligate; Fall | Colligate; Summer |
| Lessons/ Instruction Class | 1 | 2 | 1 | 2 | 2 |
| Lessons/ Lesson Group | 3 | 2 | 2 | 2 | 2 |
| Drills/ Lesson | 2; 1 RDR, 1 FSD | N/A | 2; 1 TSD, 1DSD | 2; 1 TSD, 1DSD | 2; 1 TSD, 1DSD |
| Progression | 2F, 1B | Linear | 2F, 1B | Linear | Linear |
| Cycles | 2 | 3 | 2 | 1 | 1 |
| Additional Time | 30-60 days | - | 30-60 days | - | - |
| Schedule Length | 8-12 mo. | Contextual | | | |

Table 12 contains the detailed schedule for the first 30 days of IDSP.

**Table 12**

*IDSP Detailed Schedule*

| Day | Schedule | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fall | | | Summer | | | Basic | | |
| | LS[a] | GP[b] | EXP[c] | LS | GP | EXP | LS | GP | EXP |
| 1 | 1, 2 | 1 | 1st | 1, 2, 1P, 2P | 1 | 1st | 1 | 1 | 1st |
| 2 | 1P, 2P | 1 | 2nd | 1, 2, 1P, 2P | 1 | 2nd | 2 | 1 | 1st |
| 3 | 3, 4 | 2 | 1st | 3, 4, 3P, 4P | 2 | 1st | 1 | 1 | 2nd |
| 4 | 3P, 4P | 2 | 2nd | 3, 4, 3P, 4P | 2 | 2nd | 2 | 1 | 2nd |
| 5 | 5, 6 | 3 | 1st | 5, 6, 5P, 6P | 3 | 1st | 3 | 2 | 1st |

**Table 12**

*IDSP Detailed Schedule*

| Day | Schedule | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fall | | | Summer | | | Basic | | |
| | LS[a] | GP[b] | EXP[c] | LS | GP | EXP | LS | GP | EXP |
| 6 | 5P, 6P | 3 | 2nd | 5, 6, 5P, 6P | 3 | 2nd | 4 | 2 | 1st |
| 7 | 7, 8 | 4 | 1st | 7, 8, 7P, 8P | 4 | 1st | 1 | 1 | 3rd |
| 8 | 7P, 8P | 4 | 2nd | 7, 8, 7P, 8P | 4 | 2nd | 2 | 1 | 3rd |
| 9 | 9, 10 | 5 | 1st | 9, 10, 9P, 10P | 5 | 1st | 3 | 2 | 2nd |
| 10 | 9P, 10P | 5 | 2nd | 9, 10, 9P, 10P | 5 | 2nd | 4 | 2 | 2nd |
| 11 | 11, 12 | 6 | 1st | 11, 12, 11P, 12P | 6 | 1st | 5 | 3 | 1st |
| 12 | 11P, 12P | 6 | 2nd | 11, 12, 11P, 12P | 6 | 2nd | 6 | 3 | 1st |
| 13 | 13, 14 | 7 | 1st | 13, 14, 13P, 14P | 7 | 1st | 3 | 2 | 3rd |
| 14 | 13P, 14P | 7 | 2nd | 13, 14, 13P, 14P | 7 | 2nd | 4 | 2 | 3rd |
| 15 | 15, 16 | 8 | 1st | 15, 16, 15P, 16P | 8 | 1st | 5 | 3 | 2nd |
| 16 | 15P, 16P | 8 | 2nd | 15, 16, 15P, 16P | 8 | 2nd | 6 | 3 | 2nd |
| 17 | 17, 18 | 9 | 1st | 17, 18, 17P, 18P | 9 | 1st | 7 | 4 | 1st |
| 18 | 17P, 18P | 9 | 2nd | 17, 18, 17P, 18P | 9 | 2nd | 8 | 4 | 1st |
| 19 | 19, 20 | 10 | 1st | 19, 20, 19P, 20P | 10 | 1st | 5 | 3 | 3rd |

**Table 12**

*IDSP Detailed Schedule*

Day                                                    Schedule

| | Fall | | | Summer | | | Basic | | |
|---|---|---|---|---|---|---|---|---|---|
| | LS[a] | GP[b] | EXP[c] | LS | GP | EXP | LS | GP | EXP |
| 20 | 19P, 20P | 10 | 2nd | 19, 20, 19P, 20P | 10 | 2nd | 6 | 3 | 3rd |
| 21 | 21, 22 | 11 | 1st | 21, 22, 21P, 22P | 11 | 1st | 7 | 4 | 2nd |
| 22 | 21P, 22P | 11 | 2nd | 21, 22, 21P, 22P | 11 | 2nd | 8 | 4 | 2nd |
| 23 | 23, 24 | 12 | 1st | 23, 24, 23P, 24P | 12 | 1st | 9 | 5 | 1st |
| 24 | 23P, 24P | 12 | 2nd | 23, 24, 23P, 24P | 12 | 2nd | 10 | 5 | 1st |
| 25 | 25, 26 | 13 | 1st | 25, 26, 25P, 26P | 13 | 1st | 7 | 4 | 3rd |
| 26 | 25P, 26P | 13 | 2nd | 25, 26, 25P, 26P | 13 | 2nd | 8 | 4 | 3rd |
| 27 | 27, 28 | 14 | 1st | 27, 28, 27P, 28P | 14 | 1st | 9 | 5 | 2nd |
| 28 | 27P, 28P | 14 | 2nd | 27, 28, 27P, 28P | 14 | 2nd | 10 | 5 | 2nd |
| 29 | - | - | - | - | - | - | 11 | 6 | 1st |
| 30 | - | - | - | - | - | - | 12 | 6 | 1st |

Note: This table illustrates the first 30 days of training.

[a] Lesson

[b] Lesson Group

[c] Student Exposure

[d] P Indicates a practice session.

Figure 16 shows the first 19 days of the schedule in the IDSP Handbook. Each lesson is color

coded. In the basic schedule, green lights represent a lesson group advancement, and red lines

represent a lesson group regression. Note that there are no lesson regressions in the fall and summer schedules due to time constraints.

**Figure 16**

*IDSP Handbook Schedule*

## Schedule

| Day | Fall | | | Summer | | | Basic | | |
|---|---|---|---|---|---|---|---|---|---|
| | LS[a] | GP[b] | EXP[c] | LS | GP | EXP | LS | GP | EXP |
| 1 | 1, 2 | 1 | 1st | 1, 2, 1P, 2P | 1 | 1st | 1 | 1 | 1st |
| 2 | 1P, 2P | 1 | 2nd | 1, 2, 1P, 2P | 1 | 2nd | 2 | 1 | 1st |
| 3 | 3, 4 | 2 | 1st | 3, 4, 3P, 4P | 2 | 1st | 1 | 1 | 2nd |
| 4 | 3P, 4P | 2 | 2nd | 3, 4, 3P, 4P | 2 | 2nd | 2 | 1 | 2nd |
| 5 | 5, 6 | 3 | 1st | 5, 6, 5P, 6P | 3 | 1st | 3 | 2 | 1st |
| 6 | 5P, 6P | 3 | 2nd | 5, 6, 5P, 6P | 3 | 2nd | 4 | 2 | 1st |
| 7 | 7, 8 | 4 | 1st | 7, 8, 7P, 8P | 4 | 1st | 1 | 1 | 3rd |
| 8 | 7P, 8P | 4 | 2nd | 7, 8, 7P, 8P | 4 | 2nd | 2 | 1 | 3rd |
| 9 | 9, 10 | 5 | 1st | 9, 10, 9P, 10P | 5 | 1st | 3 | 2 | 2nd |
| 10 | 9P, 10P | 5 | 2nd | 9, 10, 9P, 10P | 5 | 2nd | 4 | 2 | 2nd |
| 11 | 11, 12 | 6 | 1st | 11, 12, 11P, 12P | 6 | 1st | 5 | 3 | 1st |
| 12 | 11P, 12P | 6 | 2nd | 11, 12, 11P, 12P | 6 | 2nd | 6 | 3 | 1st |
| 13 | 13, 14 | 7 | 1st | 13, 14, 13P, 14P | 7 | 1st | 3 | 2 | 3rd |
| 14 | 13P, 14P | 7 | 2nd | 13, 14, 13P, 14P | 7 | 2nd | 4 | 2 | 3rd |
| 15 | 15, 16 | 8 | 1st | 15, 16, 15P, 16P | 8 | 1st | 5 | 3 | 2nd |
| 16 | 15P, 16P | 8 | 2nd | 15, 16, 15P, 16P | 8 | 2nd | 6 | 3 | 2nd |
| 17 | 17, 18 | 9 | 1st | 17, 18, 17P, 18P | 9 | 1st | 7 | 4 | 1st |
| 18 | 17P, 18P | 9 | 2nd | 17, 18, 17P, 18P | 9 | 2nd | 8 | 4 | 1st |
| 19 | 19, 20 | 10 | 1st | 19, 20, 19P, 20P | 10 | 1st | 5 | 3 | 3rd |

8

**IDSP Testing**

*Design Sketching Proficiency Tests 1-4*

A series of technical tests adapted from GCPD one to four are used in IDSP. These tests are

called Design Sketching Proficiency Tests (DSPT). Because IDS techniques do not have a

physical position to contextualize them, each DSPT is contextualized by technique type. In

DSPT one through four, students demonstrate technical proficiency for four technique

categories: 1) Foundation, 2) Construction, 3) Rendering, and 4) Strategy. Students demonstrate

their proficiency by demonstrating each technique in the category, each on its own sheet of

paper. The standard time interval of 5 min for each GCPD was increased to 10 min in the IDSP

to accommodate the nature of the skill being demonstrated. Modality and Craft technique

categories do not correlate to a specific DSPT in order to reduce the overall testing time.

Students are encouraged to use these techniques in order to bolster their performance in DSPT 5,

which is about using techniques in an application based way.

*Design Sketching Proficiency Test 5*

DSPT 5 is an adaptation of GCPD 5. Although technical accuracy is not completely ignored,

this test focuses of the application of sketching skills, rather than technical proficiency. This

balance between technical skills and application can be seen throughout GC and IDSP, and is

one of the fundamental aspects of both training programs. In this test, students have a fixed time

of one hour to create a series of sketches that demonstrate what they have learned throughout the

program. How techniques are applied and linked is the focus of this test.

For students using the basic schedule, students complete the all DSPTs after the instruction

period. Like GC, students would need to submit their sketches to a school or other resource for

evaluation. For students using the fall and summer schedules, students complete all DSPTs

during the final exam period. For students using the basic schedule and practicing outside of the jurisdiction of a university, students must pass the test with a score of 90% or greater overall accuracy for each DSPT to pass. This is the same passing rate for GC, and is designed to insure that students who complete the program are confident and competent in their skills. This high standard of passing is also made possible by the potential training time for those studying using the basic schedule. For students using the academic schedule, the aggregate score of DSPT 1-5 is graded using the schools grading scale.

In order to maintain a focus on program structure, a certification for program completion was not specified for IDSP. In future studies, certifications for IDSP could be designed and implemented. Testing instructions are summarized in the IDSP Handbook. Table 13 summarizes testing in GC and IDSP.

**Table 13**

*Testing Summary*

| Feature | Test | | | |
|---|---|---|---|---|
| | GC | | | |
| | Techniques | Time | Passing Grade | Grading |
| GCPD 1 | Mount | 5 min | ≥90% | Technical |
| GCPD 2 | Side Mount | 5 min | ≥90% | Technical |
| GCPD 3 | Closed Guard | 5 min | ≥90% | Technical |
| GCPD 4 | Standing | 5 min | ≥90% | Technical |
| GCPD 5 | All | 5 min | Pass/ Fail | Technical/ Application |
| | IDSP | | | |
| DSPT 1 | Foundational | 10 min | ≥90%[a] | Technical |
| DSPT 2 | Construction | 10 min | ≥90% | Technical |
| DSPT 3 | Rendering | 10 min | ≥90% | Technical |
| DSPT 4 | Strategy | 10 min | ≥90% | Technical |
| DSPT 5 | All | 60 min | Pass/ Fail | Technical/ Application |

[a] Students using the academic schedule pass or fail according to their school's grading scale.

**IDSP Tools**

*IDSP Tool 1: Course Outline*

The course outline subsection gives students space to take notes in a structured and organized way. Each lesson has its own page where there is a blank space for each slice of the technique for taking notes. Each lesson page can be used as a reference for students when completing assignments. Figure 17 shows a basic lesson page from the course outline in the IDSP Handbook.

**Figure 17**

*IDSP Handbook Course Outline*



**L1**  **Sketching Mechanics**

**Sub-Technique 1.1: Lines**

Sketch

Notes

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***IDSP Tool 2: Progress Tracking Sheet***

Another tool included in the GCOH is a progress tracking sheet. This sheet allows students to quickly evaluate their level of confidence for each technique slice. Students online are given space to take notes in the interactive course, while students learning in person or through the DVD series can use the official *Gracie Combatives Handbook* to track their progress. While studying in person, students use a *Combatives Card* (a small card similar to a progress tracking sheet) to track their progress throughout the course.

Figure 18 shows the progress tracking sheet in the IDSP handbook. The progress tracking sheet acts as an interactive table of contents.

**Figure 18**

*IDSP Progress Tracking Sheet*

## Progress Tracking

| Technique | | Sketch | | Confidence | | |
|---|---|---|---|---|---|---|
| # | Title | Technical | Design | Low | Med | High |
| 1 | Sketching Mechanics | | | | | |
| 2 | Orthographic Views | | | | | |
| 3 | Perspective Systems | | | | | |
| 4 | Rectilinear Forms | | | | | |
| 5 | Perspective Tools | | | | | |
| 6 | Radial Forms | | | | | |
| 7 | Organic Forms | | | | | |
| 8 | Manipulating Forms | | | | | |
| 9 | Complex Objects | | | | | |
| 10 | Basic Rendering | | | | | |
| 11 | Line Quality | | | | | |
| 12 | Views | | | | | |
| 13 | Light and Shadow | | | | | |
| 14 | Backgrounds | | | | | |
| 15 | Materials | | | | | |
| 16 | Traditional Media | | | | | |
| 17 | Underlays | | | | | |
| 18 | Digital Sketching | | | | | |
| 19 | Planning | | | | | |
| 20 | Research | | | | | |
| 21 | Generative Sketching | | | | | |
| 22 | Concept Sketching | | | | | |
| 23 | Recording Information | | | | | |
| 24 | Story Telling | | | | | |
| 25 | Environments | | | | | |
| 26 | Aircraft | | | | | |
| 27 | Wheeled Vehicles | | | | | |
| 28 | Figures | | | | | |

***IDSP Tool 3: Design Sketching Process Map***

An adaptation of the GCFC known as The Design Sketching Process Map shows the general

flow of the sketching process. Nodes in the flow chart represent sketching techniques, and links

represent the flow from technique to technique. This chart visually displays the general temporal

context of each IDSP technique. It also displays the general flow of techniques in the sketching

process. Figure 19 shows the Design Sketching Process Map pictured in the IDSP Handbook.

**Figure 19**

*Sketching Process Map*
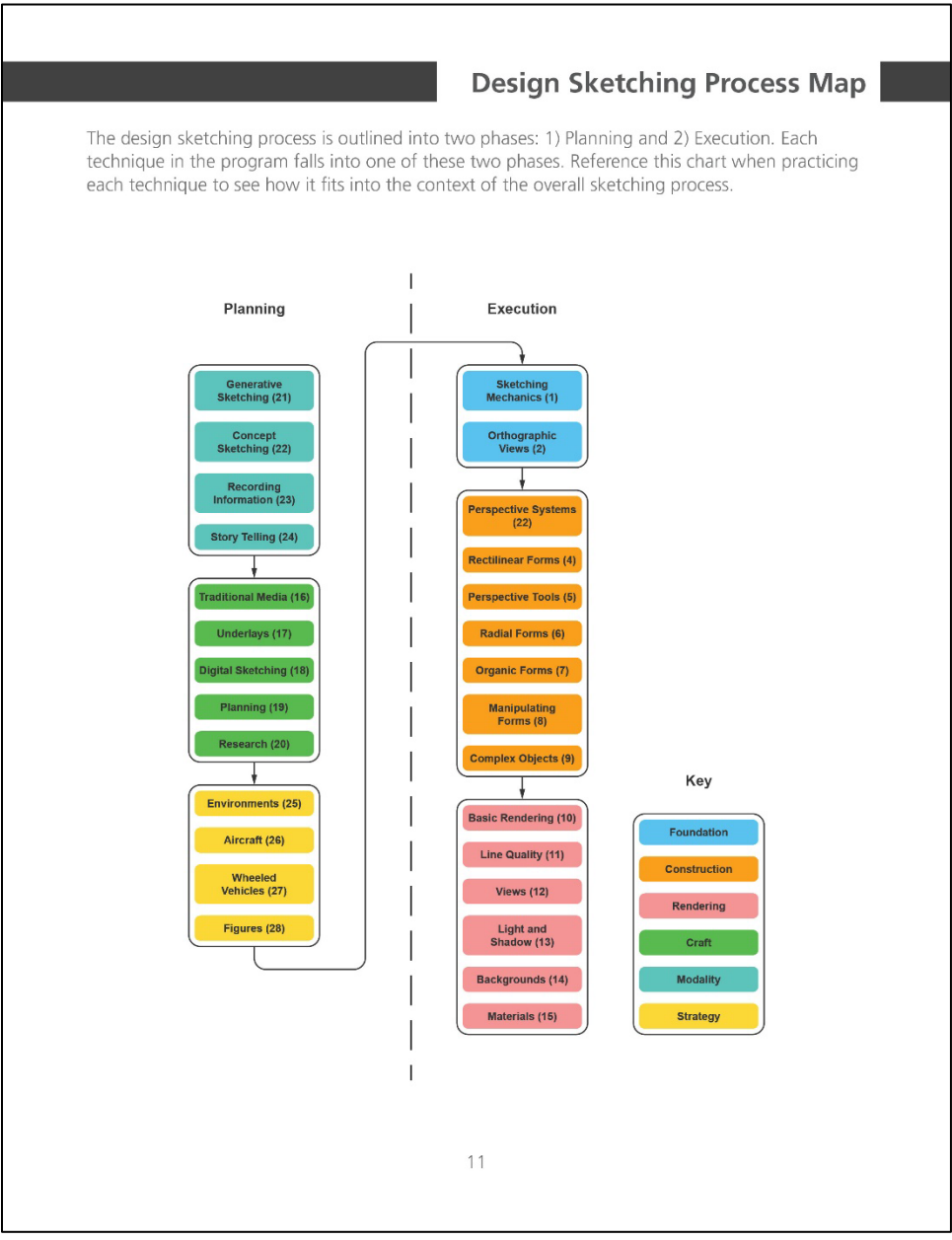
**Conclusion**

*Increased Awareness*

There is a need for increased awareness of the roles and benefits of sketching in the design process. Specifically, the awareness that sketching does not exist in a vacuum, but rather exists as a tool to be leveraged within in iterative and collaborative process (Thurlow et al., 2019, p.488). Researchers suggest that a course which directs students to produce a high quantity of sketches could help student see sketching as a tool (Thurlow et al., 2019, p.488).

The first way that IDSP could increase student awareness to the role of sketching in the design process is by defining each technique within the context of the system as a whole (technique name, technique type, technique process stage). This creates a system where every technique learned has a clearly defined use.

The second way IDSP could increase student awareness is by providing resources which clearly illustrate how techniques relate to each other, as well as the system as a whole (DSPM, *IDSP Handbook*). The DSPM illustrates the sketching process in a technical way, while technique sequences in the *IDSP Handbook* provide examples of how sketching techniques are used in the context of a finished sketch.

Together, these features potentially increase student awareness of the role of sketching in the context of design by providing a clear vision for the purposes of sketching.

### *Increased Confidence*

There is also a need for increased student confidence when sketching. Suggested solutions include motor skill development through art exercises as well as the use of inexpensive materials (Thurlow et al., 2019, p.488).

In IDSP, there is a clear distinction between application-based assignments (DSD and DSPT 5) and tests and technical assignments and tests (TSD and DSPT 1-4). This distinction potentially creates several benefits for the design students and instructors.

The dichotomy of assignments in IDSP could cause a reduction of pressure on students. When working on either an application-based or a technical-based assignment, students can focus on that particular portion of their skillset without being overwhelmed by factors that otherwise would be present. This narrowed scope could potentially aid in skill acquisition and development by alleviating student stress and increasing student focus.

The nature of assignments in IDSP may also benefit instructors. This is based on the anecdote that it is easier to observe technical and perspective errors on clean, technical assignments, and more difficult to detect with certainty technical errors on a finished work, where construction lines are potentially obscured. This allows the instructor to get a more accurate picture of a student's technical ability, and reduces the complexity of the grading process.

The advantage is also present when the instructor grades an application-based assignment. Because students are also working on technical assignments, instructors do not need to get bogged down examining the intricacies of finished sketches or recreate perspective systems to judge a student's technical ability. Instead, they can leverage their experience to quickly and efficiently grade assignments by asking the question: "does this sketch serve the purpose for which it was created?" This simplifies the grading process for the instructor.

The progress tracking sheet could also increase student confidence by giving students an easy way to evaluate their own skillset.

### Improved Structure

Researchers suggest that increased pedagogical structure could benefit design students struggling to sketch. Specifically, researchers suggest a that course where the specific skills are considered throughout in the context of an entire course could benefit design students (Thurlow et al., 2019, p.488).

In IDSP, Skills are recycled throughout the course by way of recurring lessons, as well as assignments (TSD and DSD), which recycle certain skills learned previously in the program.

IDSP structures the overall pedagogical process by introducing various program features. See Table 7 for a summary of all of the features of IDSP.

### Future Research

In future studies, IDSP should be implemented, evaluated, and modified by design educators, to test the effectiveness of the program in the field. Program features should be isolated to test what effect they have individually, and corporately on the learning process.

# Chapter 5: Example

Figure 20 shows how the course outline would be used by the student when taking notes.

**Figure 20**

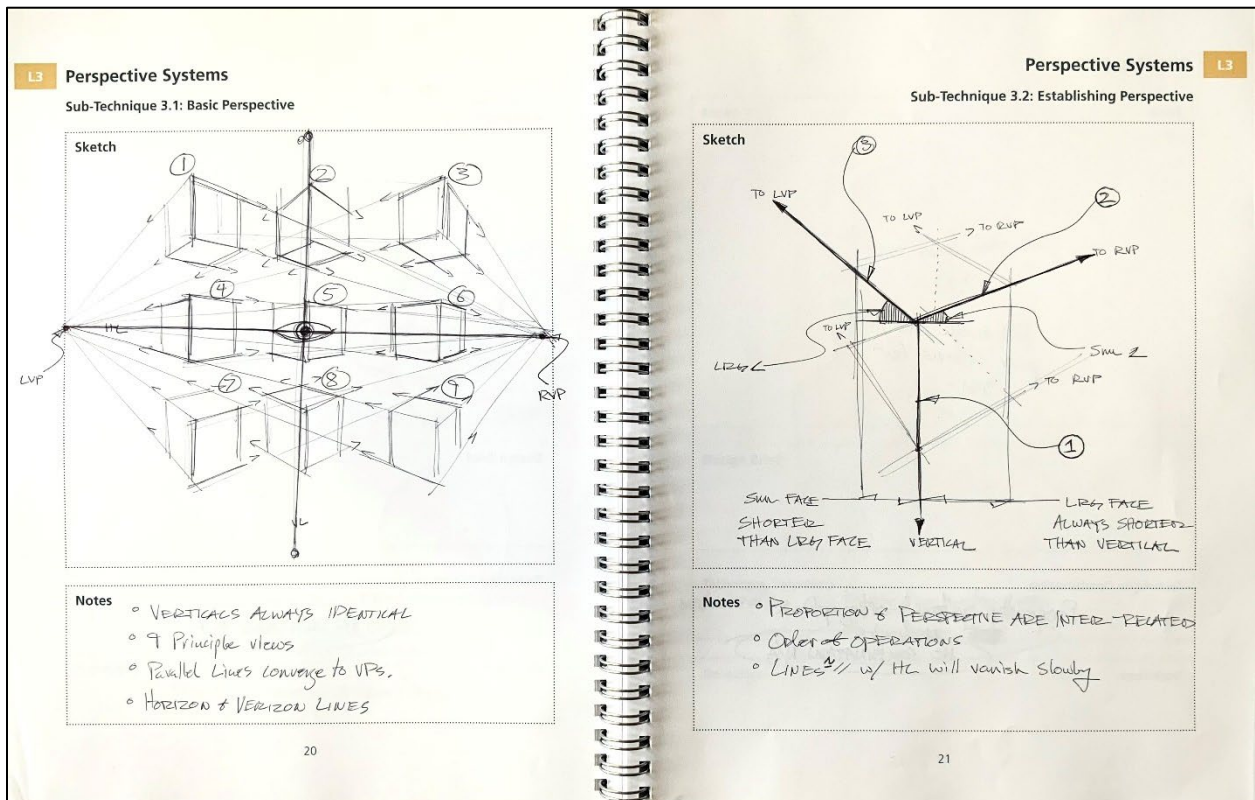*IDSP Handbook Course Outline Exemplary Use*

Figure 21 shows how the progress tracking sheet could be used.

**Figure 21**

*IDSP Handbook Progress Tracking Sheet Exemplary Use*

| | | Technique | Sketch | | Confidence | | |
|---|---|---|---|---|---|---|---|
| | # | Title | Technical | Design | Low | Med | High |
| | 1 | Sketching Mechanics | 4/1/21 | 4/1/21 | | ✓ | |
| | 2 | Orthographic Views | 4/2/21 | 4/2/21 | | | ✓ |
| | 3 | Perspective Systems | 4/3/21 | 4/3/21 | ✓ | | |
| | 4 | Rectilinear Forms | 4/6/21 | 4/6/21 | | ✓ | |
| | 5 | Perspective Tools | | | | | |
| | 6 | Radial Forms | | | | | |
| | 7 | Organic Forms | | | | | |
| | 8 | Manipulating Forms | | | | | |
| | 9 | Complex Objects | | | | | |
| | 10 | Basic Rendering | | | | | |
| | 11 | Line Quality | | | | | |
| | 12 | Views | | | | | |
| | 13 | Light and Shadow | | | | | |
| | 14 | Backgrounds | | | | | |
| | 15 | Materials | | | | | |
| | 16 | Traditional Media | | | | | |
| | 17 | Underlays | | | | | |
| | 18 | Digital Sketching | | | | | |
| | 19 | Planning | | | | | |
| | 20 | Research | | | | | |
| | 21 | Generative Sketching | | | | | |
| | 22 | Concept Sketching | | | | | |
| | 23 | Recording Information | | | | | |
| | 24 | Story Telling | | | | | |
| | 25 | Environments | | | | | |
| | 26 | Aircraft | | | | | |
| | 27 | Wheeled Vehicles | | | | | |
| | 28 | Figures | | | | | |

Figure 22 shows how TSD assignments are recorded by the student or planned by the instructor.

**Figure 22**

*IDSP Handbook Technical Sketching Drill Section Exemplary Use*

| # | Combination | Description | Subject | Iterations |
|---|---|---|---|---|
| 67 | T15X(T9+T12.2) | Complex Object with Rendered Material and Section View | BOAT | 1 |
| 68 | T15X(T9+T12.3) | Complex Object with Rendered Material and Transparent View | BOAT | 1 |
| TSD16 | | | | |
| 69 | T16.2X(T4+T14) | Rectilinear Form with Pastels and Background | FREE FORM | 3 |
| 70 | T16.2X(T9+T14) | Complex Object with Pastels and Background | CHAIR | 1 |
| 71 | T16.3X(T4+T14) | Rectilinear Form with Watercolor and Background | FREE FORM | 3 |
| 72 | T16.3X(T9+T14) | Complex Object with Watercolor and Background | CHAIR | 1 |
| 73 | T16.4X(T4+T14) | Rectilinear Form with Mixed Media and Background | FREE FORM | 3 |
| 74 | T16.4X(T9+T14) | Complex Object with Mixed Media and Background | CHAIR | 1 |
| TSD17 | | | | |
| 75 | T17X(T2+T9) | Complex Object with Matching Orthogrpahic Views from Computer Generated Underlay | BOAT | 3 |
| TSD18 | | | | |
| 76 | T18X(T9+T15) | Digital Sketch of Complex Object with Rendered Materials | BOAT | 3 |
| TSD19 | | | | |
| 77 | T19X(T2+T9) | Digital Sketch of Complex Object and Plan | COMPUTER MOUSE | 3 |
| TSD20 | | | | |
| 78 | T20X(T9+T17) | Complex Object from Photographic Underlay | COMPUTER MOUSE | 3 |
| TSD21 | | | | |
| 79 | T21.1XT9 | Ideation of Complex Objects | LAMP | 7 |

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**Figure 23**

*IDSP Handbook Design Sketching Drill Section Exemplary Use*

## Design Sketching Drills

| Drill | Sequence | Subject |
|---|---|---|
| DSD17 | 1. T3.1 Choose View<br>**2. T17 Create Underlay**<br>3. T3.2 Establish Perspective<br>4. T9 Construct Complex Object<br>5. T15 Render Materials<br>6. T13.1 Cast Shadows<br>7. T14 Add Background | *Coffee Maker* |
| DSD18 | **1. T18 Create Digital Sketching Toolkit**<br>2. T12.2 Create Slice Section View<br>3. T3.1 Choose View<br>4. T17 Create Underlay<br>5. T3.2 Establish Perspective<br>6. T9 Construct Complex Object<br>7. T12.1 Create Exploded View<br>8. T12.2 Create Section View<br>9. T12.3 Create Transparent View<br>10. T15 Render Materials | BICYCLE |
| DSD19 | **1. T19 Create Plan**<br>2. T17 Create Underlay<br>3. T3.2 Establish Perspective<br>4. T9 Construct Complex Object<br>5. T15 Render Materials<br>6. T13.1 Cast Shadows<br>7. T14 Add Background | POWER TOOL |
| DSD20 | **1. T18 Conduct Visual Research**<br>2. T19 Create Plan<br>3. T17 Create Underlay<br>4. T3.2 Establish Perspective<br>5. T9 Construct Complex Object<br>6. T15 Render Materials<br>7. T13.1 Cast Shadows<br>8. T14 Add Background | HAND TOOL |
| DSD21 | 1. T18 Conduct Visual Research<br>**2. T21.2 Generate Thumbnail Sketches**<br>**3. T21.1+21.3 Develop Forms (Ideation+Intuitive)**<br>4. T3.1 Choose View<br>5. T3.2 Establish Perspective<br>6. T9 Construct Complex Object<br>7. T12.1 Create Exploded View<br>8. T12.2 Create Section View<br>9. T12.3 Create Transparent View<br>10. T15 Render Materials | KITCHEN APPLIANCE |

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**Appendix 1: Industrial Design Sketching Program Handbook**