INTERACTION DESIGN GUIDELINES FOR

INDUSTRIAL DESIGN PROCESS

by

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ABSTRACT

Principles have changed in era full of technological developments in the field of design and communication. Since design is focusing more and more on the role of the user, the 'design of interactivity' has become the 'design of experience'. Interaction design has become a language of communication between a user and his or her surroundings and this interaction is happening at every possible level of communication.

Interaction Design is the discipline of defining the behavior of products and systems that a user can interact with and experience these products or systems with a new level of satisfaction. These developed products or systems forces or allow the user to use them to their potential and in the desired way. The communication between the product and user enhances the final outcome and helps the user to develop Human-Product relations.

A well-designed product defines its use visually. Interactive simplicity can make a product intuitive and hence can be a response to the desired need / action. Human interaction with product or system can be simplified by enhancement of communication between product or system and its user. Application of interaction design principles in industrial design process and product design processes will elevate this design experience.

The aim of this thesis is to develop guidelines for industrial design processes. Guidelines proposed in this study give specific direction to the application of interaction design principles in industrial design process.

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1. INTRODUCTION

1.1 Problem Statement:

The design value of every product emerges from its background that is its environment, and users' feedback while communicating with the product. A successful design helps the user to experience a product, system or service to a new level of appreciation. The user appreciates the product even more if the analysis and understanding period of that particular product is reduced down to least by enhancement of human - product communication.

Understanding the communication background of a product or a system may help in developing the desired user experience process towards that product or system. If a design process represents qualities of its experience and productivity with respect to its communication with the user, then it must be studied from a new point of view.

In the design process of almost all products, various methodologies and principles are applied from product design to industrial design to the interaction design field. These considerations and applications are applied separately and are usually limited within their respective design processes.

This research focuses on:

1. Application of interaction design principles in the industrial design process for advantages that can be achieved by enhancement of communication between a product and its user.

2. To elevate communication and experience of a product or system by enhancement of its interactive background and,

3. To show how interaction design can be used to understand aspects of communication in industrial design process.

1.2 Need of Study

Before its birth, every product or system goes through several phases like research, conceptualization, design, development, analysis, manufacturing and branding. Design, which results in successful communication between a product or a system and its user, is the most important factor for any developed product or system.

"In the era of globalization and exchange of information, design has developed in every possible direction. New definition and theories are being used for design and development of products and systems. Design is refined towards 'user-centered design', where a user is the main point of concentration and the user environment plays a crucial role in every design process" (Slack 2006). For these reasons, a product or a system design process must cover almost every possible area regarding human and the feel of the design. After fulfilling the requirements of ergonomics and anthropometry, feel and experience are the other essential factors in the design of a product.

Furthermore, communication is a result of interaction with a product or system. In this communication, environment plays a crucial role that enables the user to analyze, understand and respond to a product or a system. Every communication is a give and take process, where a user receives particular information from a product or system and responds to it in accordance with

level and quality of product feedback.

Development of any product or system is studied from a particular design approach. Design principles are applied from a particular design faculty resulting in the enhancement of the product value and product appeal to the user. However, the process may lack in interdisciplinary design principle applications and may result in product miscommunication or lack of understanding of the product behavior.

Studying the application of interaction design principles in the industrial design process may expose new and unique qualities of that human interaction and communication with the product or system.

1.2.1Objective of study

- Interaction is a tool of communication. This research focuses on the simplification of communication between a product and user through better interaction.
- The study will include identification and research of interactive value, aesthetics and communication architecture. It will revolve around human interaction with interface-based products, environmental background of a product, communication design and interaction design principles.
- As interaction and experience are crucial elements of every design process studying the industrial design process with the incorporation of interaction design principles will be the goal of this thesis.
- In the end, this thesis will provide development of interaction design guidelines with which, industrial designers will be able to enhance human-product communication and interaction.

1.3 Definition of terms:

Activity:	Measurable amount of work performed to convert inputs into outputs.
Aesthetic:	Principles concerned with beauty or the appreciation of beauty.
Aesthetic sensitivity:	Aesthetic sensitivity is defined as an individual's perception of the beauty of objects in his or her immediate environment.
Anthropometry:	The scientific study of the measurements and proportions of the human body.
Communication Design:	Communication is an exchange of information. Communication design is development of this information exchange so as to make the process easy and understandable.
Ergonomics:	The study of people's efficiency in their working environment.
Forms:	The visible shape or configuration of object

Heuristics	Heuristic refers to experience-based techniques for problem solving, learning, and discovery. Heuristic methods are used to speed up the process of finding a satisfactory solution, where an exhaustive search is impractical.
Human Computer Interaction	Human computer interaction (HCI) is the study, planning and design of the interactions between people (users) and computer.
Interaction	It is a kind of action that occurs as two or more objects, people or entities act, which may or may not have an effect upon one another.
Interaction Design	It is a practice of designing interactive products, systems environments or services. The majority of time interaction design is related to digital products or products involving HCI.
Interface:	Interface is a point where two system, subjects, organizations etc., meet and interact. It is a process developed for communication between a user and a product or system.

Product Communication:	Communication is an exchange of information. Product communication is a way that products or systems communicate with their user in a particular environment.
Semantics:	Relating to meaning in language or logic.

1.4 Assumptions:

This research is based on the following assumptions:

1. In new age of globalization, design is a language of success. Design simplification is receiving increasing attention from all over the world.
2. Introduction of interaction design principles in every design process will increase the communication and success rate of a design.
3. Form and function are the crucial factors of the industrial design process, and introduction of interaction design principles in this process will elevate overall communicational value, giving a focused direction to the designer.
4. If the interactive value of a product or system is further refined to the environmental changes, the product or system popularity for that particular environment will increase.
5. Incorporation of interaction design principles in the design process of a product refines the user needs and user definition for that particular environment.

1.5 Scope and Limitations

This research will focus on interaction design principles and with an emphasis on application of these principles to industrial design process. The guidelines created in this study will be applied in the design process of a digital interface-based product. For every industrial design process, designers can use the information and the principles learned from this study. Guidelines developed from this study will give in-depth direction to industrial designers for interaction and interface-related problems and processes.

1.6 Anticipated Outcomes

The projected outcome from this study is a series of guidelines that will help industrial designers to learn and understand interaction design principles and application of these principles in industrial design processes. This application will enhance human – product interaction and communication. These developed guidelines will also help industrial designers to develop products, services or systems with better and superior design processes.

1.7 Literature Review

'Everyone designs who devises courses of action aimed

at changing existing situations into preferred ones'

- Herbert Simon

Humans are a social beings and adaptation is a property of every living organism. We unknowingly develop and design many products, strategies, and systems every day to overcome difficulties faced. Humans have been involved in evolution of many products and system which are conceived of need, where designers solve these problems in an analytical way to enrich the human to product or human to system communication. Hence the designer is a communicator of product values, product definitions and user skills to let the user experience the product or system. This research focuses on the simplification of communication between a product or system and user through applications of interaction design principles. The goal of this thesis is to research and develop guidelines for new generation designers, providing a possible new niche in the industrial design process.

"Design is communication. It waits patiently until it is read, and it understands this. In view of its and our understanding, it is a kind of communication that assumes communication even where there is none, namely between the two sides of an interface" (Bürdek, 2005, p. 11). In this book though the author speaks of communication and a possibility of two-sided interface communication, it does not really speak about how this communication can be enhanced or developed by means of design or by application of interdisciplinary design principles. Design is

a language of communication between a product and its user. This language can be simplified by development of human – product interaction and its experience with the user environment.

"Good design may not be a mere envelopment technique. It must express the individuality of the product in question through appropriate fashioning" (Bürdek, 2005 p.15). Upgrading design's interactive value can develop the product definition and the unique definition of the product makes the understanding process successful. This up-gradation can also be addressed by simplification of communication between a product and its user. The more simplified the interaction, the better the communication with the product. Product appearance and user behavior is the first communication between the product and user.

"Designed objects that use the visual language of affordance, can become efficient and intuitive for use by cutting the need to evaluate through analysis the potential interaction with that object to then respond with the desired action" (Horev, 2006, p.70). The author says that a well-designed product can define its use visually. Hover the author has not addressed the issue about how to develop guidelines or a design process to pursue a product or a system with aesthetic and communicative simplicity that makes a product intuitive and hence can be a response to the desired need or action.

The form definition, values and appeal can be honed with its better and exact communication with the user. It may include environmental affects, experiential benefits and aesthetic simplicity. Hence, the product can respond successfully if its form appeals to the user and conveys the product use and product properties through its communication with the user.

According to Richard Thomas, in his research paper 'A new dialog', "the capability and meaning of any form can be defined by the limits of people's ability to imagine what it can be physically or represent spiritually or intangibly." A two-dimensional or a three-dimensional from

communicates with the user and allows him or her to analyze its purposes and values. The more the communication with the form, the less complexity in analyzing it and, hence better the interaction.

Though Thomas speaks about capabilities of form and aesthetic sensitivity of user for better interaction, there is no process provided to achieve a better design process for desired action of the form or interaction design development.

"Our approach to interactivity is strongly informed by our background in product design" (Udagawa & Moeslinger, 2005, p. 07). Though we communicate with a product with the help of our past experiences and understanding behavior of our surroundings, we may experiment with the product or system and become adapted to its use / purpose. This experimentation may result in failure of using the product. The author does not address the issue of simplified communication, which can be helpful for understanding the analysis process. The author also states that "form has no meaning; it is an invitation, a window to possibility. Meaning resides, and is latent within us, the relationships we perceive and cultivate in our minds and through what we negotiate with others. Every form communicates with user in some or the other way resulting in human reaction for that form, which defines the human and not the product. "As products are dedicated to people, and people are invited to act because a design fits their physical measures and skills, it is to the responsibility of the designers to propose intuitive and context adapted systems for people, it is important to make the process easy and intuitive" (Guenand, Ampilhac & Uehara, 2005, p. 27). The process of understanding the product or function of product should be intuitive, a result that can be achieved by elevating the communication between the product / system and user through interaction; it can be supported with the design process development, aesthetic appeal and interactive value of the product or system. Generally a product should not

have a hidden meaning or a purpose that might confuse the user.

"Semantic interpretation is what a product is seen to say about its function, mode-of-use and qualities" (Moultrie, 2005, p. 05). However, this work does not really explain how semantic value of a product can be elevated. The semantic appeal is concentrated on the design or interaction of the product that communicates with user for its efficient use and product value. Interactive appeal is a first success of the product, which may help user to diagnose properties of the product easily. Making a product easy to communicate benefits its function and makes the process more intuitive. Product and user communication is a two-way process that defines values of both product and user. Sometimes it is possible that a product could render an image of its user or user qualities. The product may be the primary concern, which defines its own user.

"To foster (support) the transition towards sustainability we must look beyond mainstream positions, behavior and opinions and know how to recognize, in the complexity of signals that society sends us, those that are most promising." (Bala, Ciuccarelli, Collina, Leeuw, Jégou, Luiten, Manzini, Marras, Meroni, Sto, Strandbakken, Vadovics' 2007, p. 13). It is very easy to find and create a sustainable solution for a society if the connection and communication between the developed model and society is visible. The best way to find solution is analysis of these systems and societal communications. Understanding this may help in developing the desired sustainable design process towards that product or system.

"The Designer is a form of expression and products are currency of exchange. Products as a currency, generates revenue" (Slack, 2002, p.09). This explains the author's connection between design and a materialistic approach towards design. In the business-oriented world, design could be the best way for exchange of not only money, but also processes, thoughts and new methods. Exchange of design from different faculties and fields can result in the best

solutions in design.

"We are experiencing an era that goes beyond ease of use. We are now concerned with how an interface feels, how it behaves and the experience it offers" (Martin, 2005, p. 06). In this text, the author speaks about feeling and experience as factors considered after fulfillment of human ergonomics and anthropometry. The author does not address one of the most important issues of design process development: how interdisciplinary design principle exchange can elevate the communication and interaction value on new generation products.

"A technology becomes widely diffused when employed in many working contexts by professionals, and reaches mass diffusion when sold in consumer market and used in home and leisure contexts. For these two groups professional and laymen, it is vital that the new tools are designed to be easy to use" (Bagnara & Smith, 2006, p. xxiv). In this book the author talks about verities of user groups, application attitude and different user environments and theirs effects on the design process. The author also directs designers' attention towards need of a new approach of the design process. However, the book does not really discuss the design process or how the design process can be enhanced. Furthermore, the authors state that, "Many designers and enthusiasts are willing to put much energy into discovering what a new tool is good for and how it operates. But professionals, and consumers even more, are unwilling to spend efforts discovering its possibilities. They want it to be "usable" – a term usually denoting cognitive transparency and ergonomic facility: A tool without these characteristics will probably fail in market. So the usability of interfaces plays a crucial role in achieving real diffusion of interactive systems" (Bagnara & Smith, 2006, p. xxiv).

Although there is lot of information available about design as a tool of communication, none of it teaches about, how application of interaction design principles in the industrial design

process elevates the interaction between product and user. As a result, this thesis is an in-depth study of design processes and application of interdisciplinary design considerations for the industrial design process. These new design guidelines may help to achieve a better communication in a product resulting from that process and its user.

2. INTRODUCTION TO RESEARCH

2.1 Understanding interaction design

2.1.1 What is Interaction Design?

Interaction design is a tool of communication between a user and a product, service or system. It is a two-way process of information exchange where users to product, users to system, or users to service feedback plays a crucial role. Until recently interaction design was always related to human computer interaction. Bagnara and Smith (2006) points out "the complexity of interaction design's domain is evident in its parentage. On one side its family is human – computer interaction (HCI), whose history is the coming together of hardware and software engineering, and physiological and cognitive ergonomics; on the other, a range of design practices and discourses including those of industrial design, graphic design, architecture, and film – each of which has a medium requiring particular set of skills and mental attitudes" (p. xxiii). Information, principles and text from different design fields are broadly used in achieving a perfect interaction design process and hence can be a preferred method for human – product communication. In particular, it is about creating user experiences that enhance and extend the way people work, communicate and interact.

The field of Interaction Design is in its early infancy and has only been around for the past decade or so. Since the birth of computing, designing computing systems has mainly been the role of software engineers. Parallel to the field of architecture, where civil engineers focus on

designing the structure of the building while architects design how people live within that structure, in the world of computing, software engineers ensures the robustness of the software while interaction designers design how people interact with computing systems and products. The concept of computers used to be desktop computing; however, as technology advanced, computers have evolved beyond the desktop PC and permeate every aspect of our lives. Computers take the shape and form of everyday consumer electronic appliances such as MP3 players, car navigation systems, and Internet fridges. Thus the notion of designing for computer screen "interfaces" is no longer adequate. This is where Interaction Design crosses over to the field of Industrial Design. Bill Morridge, founder of IDEO, originally coined the term "Interaction" to describe the design of the behavior of products, its task flow and structure of information, making technology usable, understandable and pleasant for people to use. As Irene McAra-McWilliam, a forerunner of the interaction design field describes, "Interaction designers have to understand people, how they experience things, how they themselves interact, and how they learn" (Walker 2001).

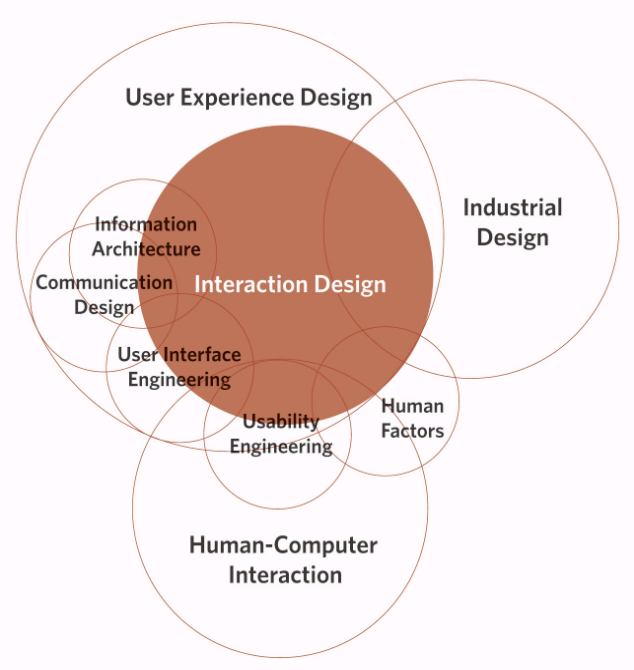


Figure 1: Interaction Design Venn diagram

The above figure describes the scope and foundation of the interaction design field. It is widely spread and is affected by several factors, practices, and the theories in fields of design, communication and engineering.

2.1.2 History of interaction design

HCI emerged, mostly in the1960s, to fill the lack of techniques and tools available for designing the digital world made possible by the development of computers. Its mating with design to produce interaction design, which can be probably dated to the 1980s, was because digital products were increasingly aimed at a lay consumer (rather than professionals), a diffusion later dramatically accelerated by the development of networks and telecommunications. The brief history of interaction design can thus be seen as a collective effort to translate the wealth of tools already available for designing the physical world to enrich the design of the digital world" (Bagnara & Smith, 2006).

"The history of interaction design really begins with the invention of the computer. Although the term did not yet exist, early computer designers, such as those who designed the giant IBM computers, had to incorporate a means through which human operators could input information and the computers could output results of the computations. This took the form of punch cards and primitive printouts or blinking lights. In 1973, the designers at Xerox PARC used interaction design to build one of the first personal computers, a desktop model with a keyboard and monochrome monitor. Later, technology giant Apple would incorporate many of these interaction designs into the early Macintosh computer.

It was not until the late 1980s when designers Bill Moggridge and Bill Verplank advocated the term interaction design. It was originally considered an adaptation of user interface

design, which was common in the field of industrial design. The term was meant to replace an earlier term coined by Moggridge, soft-face, which referred to applying user-controllable software to industrially designed machines" (**Interactiondesign.com.au, 2011)**.

2.1.3 Developments

"The initial problem was to design the computer, the machine itself and the interface. Later, when computing became distributed and embodied in many everyday appliances, people sought tools and models for designing digital devices that were easy to understand and use. More recently, the digital technology has transformed how we get food delivery, buy books, order and pay the bill at restaurant, so the need is for tools to design digital service. Nowadays, not just single components but whole environments may become digital, as happens in some immersive virtual entertainment environments, so the need is for tools that allow us to design complete digital experience. Indeed the design of experience, through the medium of interaction design, may be seen to represent a growing proportion of the design industries production.

However, interaction design is more than directing traditional design technique to new applications: Interactive technologies are a new medium that also requires its own techniques. Some it has borrowed, such as ethnographic observation and role-play scenario. Others it has developed for itself to model the interactive experience, like "paper prototyping," software simulations, and video scenario sketching.

There is another perspective from which one may look at interaction design, that is, the number and character of its users. It is well known that interactive systems (from now on, this term will refer to all interactive and digital machines, objects, services and experiences), unlike previous technologies, have become diffused very rapidly, and the type of user has changed

equally rapidly. The original expert users, who shared the expertise of technology's designers, were soon outnumbered by enthusiast users, who, although not sharing designers' background, like them enjoyed technological novelty and did not mind, and even enjoyed, the effort necessary to learn the systems. These two user groups experts and enthusiast, were not large and raised no problems for the designers The experts used the new tool in working situation similar to that of the designer. Between these groups was no cultural, cognitive, or competence gap" (Bagnara & Smith, 2006).

Interaction design developed with the technological developments and fast moving digital world. Achievements in applications of these various digital technologies changed the definition of human-product communication. Though the birth of this design field was the result of combining computer hardware and software engineering with cognitive ergonomics, various design fields like product design, industrial design, graphic design, and system and service design are involved in defining interaction design principles and attributes.

2.2 Philosophies / themes of interaction design

Interaction design is a fast-growing field, which has less evolution and invention compared to other fields of design. Bagnara and Smith (2006), identified the following seven themes of interaction design:

Activity: The name of this first theme makes reference to activity theory, a cultural–historical conceptual system first developed by psychologist Alexei Leontiev (1978), active in Soviet Union. The theory took on new life when further developed in 1980s by European and American

researchers to explain the mutual relation between the mind and artifacts. It maintains that any artifact is the outcome of a process by which the mind builds up objects having personal sense and cultural meaning. This process is social because, although subjective and intentional, it uses existing artifacts and its outcome is available in the social environment. Furthermore, the same process modifies the mind itself because it acquires, in building the artifact, the cognitive and social skills embedded in the artifact it constructs and the artifacts it uses to do so. Mind is social in nature. To be meaningful, any artifact has to be embedded in an activity system: a complex, interactive, organized set of actions, artifacts and people. Any activity system that adapts to and influences its living contexts are dynamic: They have a history. Intervening in an artifact means to intervene in the history of the context and in that activity system.

Emotion: Until very recently the HCI field never considered emotions, perhaps because one of its main influences, cognitive psychology, had devoted scant attention to affective phenomenon. Emotions were never seen as at best an unwelcome factor that could disturb the cognitive process involved in using the designed object. HCI sought effectiveness and efficiency, and unlike more established design fields, paid little attention to feelings and aesthetic response. In the past few years, however, emotion has become a topic of increasing interest to engineers, designers and HCI experts. They have conceded that there cannot be any experience without emotions.

Situatedness: As already considered, the notion that any object needs to be considered in its context of use is common throughout interaction design practice. Situation is commonly thought as of anchoring and providing sense to human knowledge when engaged with previously

distributed pieces of knowledge. Situatedness is the finding of oneself in a situation: This notion captures the invisible ties between the inner and the outer world on which understanding of meaning is based.

Conversation: Interaction is commonly understood as a prolonged and dynamic exchange of communication between human and artificial agent to reach a goal. Because most human exchanges are verbal, conversations are generally accepted as the metaphor, although difficult to imitate, for designing interactions.

Community: The idea of community introduced in the early nineteenth century by German sociologist, has gained new popularity at the end of the twentieth century. The word originally meant quasi-autonomous groups of people, usually living in one place that depended on and helped each other, whose roles, that is are complementary. The modern meaning is again a group of people, but now defined not by location but by a shared interest or activity: 'scientific community," for instance. People stay in a community because their shared interests are better served communally than alone.

Memories: When HCI started, human memory was a seen as a problem because of its untrustworthiness and the difficulty of accessing it. The first guidelines from designing interfaces underlined the spatial and temporal limitations within which memory operated, and stressed its unreliability in recalling complex procedures at the precise moment required. Interfaces greatly improved when designers realized that human memory is better accessed through images and

icons than by alphanumeric strings. Brandimonte (2006) discusses perspective memory, how we remember to act in the future. She recalls that Winograd (1988) noticed that if retrospective memory fails, the person's memory is seen as unreliable. So people have longtime designed tools for remembering actions to be done in the future: One might call this the origin of distributed cognition, which plays a crucial role in everyday life and, inevitably, in interaction design.

Market: Interaction design is also an activity that produces economic values because its outcomes are the products and services that are eventually sold in markets. The economists start from the notion of interaction cost, a fundamental dimension in economics for establishing the price of goods. Picci (2006) reminds "those designers whose missions is to do their very best in the service of the final user of a product" why the market intentionally designed goods badly; this line of reasoning is intriguing in that it may help explain why some high-quality interaction design products and services have not had commercial success.

2.3 Interaction design usability and goals

According to authors Frohlich and Murphy (1999), usability is generally regarded as ensuring that interactive products are easy to learn, effective to use, and enjoyable from the user's perspective. It involves optimizing the interactions people have with interactive products to enable them to carry out their activities at work, school, and in their everyday life. More specifically, usability is broken down into the following goals:

- Effective to use (effectiveness)
- Efficient to use (efficiency)
- Safe to use (safety)

- Have good utility (utility)
- Easy to learn (learnability)
- Easy to remember how to use (memorability)

Furthermore, the authors states that, the realization that new technologies are offering increasing opportunities for supporting people in their everyday lives has led researchers and practitioners to consider further goals. The emergence of technologies (e.g., virtual reality, the web, mobile computing) in a diversity of application areas (e.g., entertainment, education, home, public areas) has brought about a much wider set of concerns. Instead of focusing primarily on improving efficiency and productivity at work, interaction design is increasingly concerning itself with creating systems that are:

- Satisfying
- Enjoyable
- Fun
- Entertaining
- Helpful
- Motivating
- Aesthetically pleasing
- Supportive of creativity
- Rewarding
- Emotionally fulfilling

"The goals of designing interactive products to be fun, enjoyable, pleasurable, aesthetically pleasing and so on are concerned primarily with the user experience. By this, the author means what the interaction with the system *feels* like to the users. This involves explicating the nature of the user experience in subjective terms. For example, a new software package for children to create their own music may be designed with the primary objectives of being fun and entertaining. Hence, user experience goals differ from the more objective usability goals in that they are concerned with how users experience an interactive product from their perspective, rather than assessing how useful or productive a system is from its own perspective. The relationship between the two is shown in Figure 2.

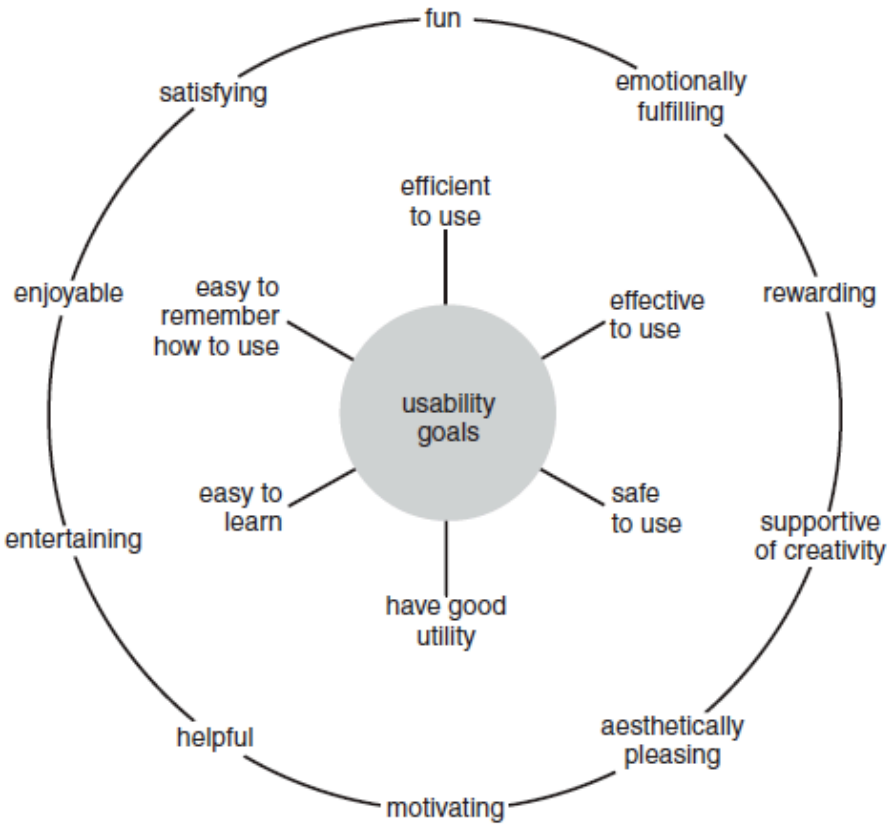


Figure 2: Usability and user experience goals. Usability goals are central to interaction design and are operationalized through specific criteria.

Much of the work on enjoyment, fun, etc., has been carried out in the entertainment and computer games industry, which has a vested interest in understanding the role of pleasure in considerable detail. Aspects that have been described as contributing to pleasure include attention, pace, play, interactivity, conscious and unconscious control, engagement, and style of narrative. It has even been suggested that in these pleasure contexts, it might be interesting to build systems that are *non-easy* to use, providing opportunities for quite different user experiences from those designed based on usability goals" Frohlich & Murphy (1999).

2.4 Interaction design principles

2.4.1 Usability heuristics

Heuristic evaluation is a variation of usability inspection where usability specialists judge whether each element of a user interface follows established usability principles. This method is the part of the so-called 'discount usability engineering' method" (*Nielsen 2005).*

Following are the ten general principles for user interface design discussed by *Nielsen, (2005)*. They are called "heuristics" because they are more in the nature of rules of thumb than specific usability guidelines.

Visibility of system status

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

Match between system and the real world

The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

User control and freedom

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Supports undo and redo.

Consistency and standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

Error prevention

Even better than good error messages is a careful design, which prevents a problem from occurring in the first place. Either eliminates error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

Recognition rather than recall

Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

Flexibility and efficiency of use

Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

Aesthetic and minimalist design

Dialogues should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

Help users recognize, diagnose, and recover from errors

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

Help and documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

2.4.2 Fundamentals of interaction design

Tognazzini (2003) discusses the following principles as fundamentals to the design and implementation of effective interfaces, whether for traditional Graphic User Interface environments or the web. Of late, many web applications have reflected a lack of understanding of many of these principles of interaction design, to their great harm. Just because an application

or service appears on the web or device, the principles do not change. If anything, applying these principles become even more important.

Effective interfaces are visually apparent and forgiving, instilling in their users a sense of control. Users quickly see the breadth of their options, grasp how to achieve their goals, and do their work.

Effective interfaces do not concern the user with the inner workings of the system. Work is carefully and continuously saved, with full option for the user to undo any activity at any time.

Effective applications and services perform a maximum of work, while requiring a minimum of information from users.

Following are the principles discussed by Tognazzini:

Anticipation

Applications should attempt to anticipate the user's wants and needs. Do not expect users to search for or gather information or evoke necessary tools. Bring to the user all the information and tools needed for each step of the process.

Autonomy

- The product, the interface, and the task environment all "belong" to the user, but user-autonomy doesn't mean we abandon rules.

  Give users some breathing room. Users learn quickly and gain a fast sense of mastery when they are placed "in charge." Paradoxically, however, people do not feel free in the

absence of all boundaries. User feel most comfortable in an environment that is neither confining nor infinite, an environment explorable, but not hazardous.

- Use status mechanisms to keep users aware and informed.

  No autonomy can exist in the absence of control, and control cannot be exerted in the absence of sufficient information. Status mechanisms are vital to supplying the information necessary for workers to respond appropriately to changing conditions.

- Keep status information up to date and within easy view

  Users should not have to seek out status information. Rather, they should be able to glance at their work environment and be able to gather at least a first approximation of state and workload. Status information can be quite subtle.

Color Blindness

- Any time you use color to convey information in the interface, you should also use clear, secondary clues to convey the information to those who won't be experiencing any color-coding.

  Most people have color displays nowadays, but they are not universal. In addition, approximately 10% of human males, along with a rare sprinkling of females, have some form of color blindness.

Consistency

The following principles, taken together, offer the interaction designer tremendous latitude in the evolution of a product without seriously disrupting those areas of consistency most important to the user.

- Levels of consistency: The importance of maintaining strict consistency varies. The following list is ordered from those interface elements demanding the most faithful consistency effort to those demanding the least. Paradoxically, many people assume that the order of items one through five should be exactly the reverse, leading to applications that look alike, but act completely different in unpredictable ways:

    1. Interpretation of user behavior, e.g., shortcut keys maintain their meanings.
    2. Invisible structures.
    3. Small visible structures.
    4. The overall "look" of a single application or service--splash screens, design elements.
    5. A suite of products.
    6. In-house consistency.
    7. Platform-consistency.

  Invisible structures refers to such invisible objects as Microsoft Word's clever little right border that has all kinds of magical properties, if you ever discover it is there. It may or may not appear in your version of Word. And if it doesn't, you'll never know for sure that it isn't really there, on account of its invisibility. Which is exactly what is wrong with invisible objects and why consistency is so important. Other objects are, strictly speaking, visible, but do not appear to be controls, so users, left to their own devices, might never discover their manipulability. The secret, if you absolutely insist on one, should be crisp and clean, for example, "you can click and drag the edges of current Macintosh windows to size them," not, "You can click and drag various things sometimes, but not other things

other times."

"Small visible structures" refers to icons, size boxes, scroll arrows, etc. The appearance of such objects needs to be strictly controlled if people are not to spend half their time trying to figure out how to scroll or how to print. Location is only just slightly less important than appearance. Where it makes sense to standardize location, do so.

- Inconsistency: It is just as important to be visually inconsistent when things must act differently as it is to be visually consistent when things act the same.

  Avoid uniformity. Make objects consistent with their behavior. Make objects that act differently look different.

- The most important consistency is consistency with user expectations.

  The only way to ascertain user expectations is to do user testing. No amount of study and debate will substitute.

Defaults

- Defaults should be easy to "blow away:" Fields containing defaults should come up selected, so users can replace the default contents with new material quickly and easily.
- Defaults should be "intelligent" and responsive.
- Do not use the word "default" in an application or service. Replace with "Standard," "Use Customary Settings," "Restore Initial Settings," or some other more specific terms describing what will actually happen.

Efficiency of the User

- Look at the user's productivity, not the computers' or products'.

  People cost a lot more money than machines, and while it might appear that increasing machine productivity must result in increasing human productivity, the opposite is often true. In judging the efficiency of a system, look beyond just the efficiency of the machine.

  For example, which of the following takes less time? Heating water in a microwave for one minute and ten seconds or heating it for one minute and eleven seconds?

  From the standpoint of the microwave, one minute and ten seconds is the obviously correct answer. From the standpoint of the user of the microwave, one minute and eleven seconds is faster. Why? Because in the first case, the user must press the one key twice, then visually locate the zero key, move the finger into place over it, and press it once. In the second case, the user just presses the same key–the one key–three times. It typically takes more than one second to acquire the zero keys. Hence, the water is heated faster when it is "cooked" longer.

  Other factors beyond speed make the 111 solution more efficient. Seeking out a different key not only takes time, it requires a fairly high level of cognitive processing. While the processing is underway, the main task the user was involved with–cooking their meal–must be set aside. The longer it is set aside, the longer it will take to reacquire it.

  Additionally, the user who adopts the expedient of using repeating digits for microwave cooking faces fewer decisions. They soon abandon figuring out, for example,

whether bacon should be cooked for two minutes and ten seconds or two minutes and twenty-three seconds. They do a fast estimate and, given the variability of water content and bacon thickness, end up with as likely a successful result with a lot less dickering up front, again increasing human efficiency.

- Keep the user occupied.

  Since, typically, the highest expense in a business is labor cost any time the user must wait for the system to respond before they can proceed, money is being lost.
- Write help messages tightly and make them responsive to the problem: good writing pays off big in comprehension and efficiency.
- Menu and button labels should have the key word(s) first.

Explorable interfaces

- Give users well-marked roads and landmarks, and then let them shift into four-wheel drive.

  Mimic the safety, smoothness, and consistency of the natural landscape. Don’t trap users into a single path through a service, but do offer them a line of least resistance. This lets the new user and the user who just wants to get the job done in the quickest way possible and "no-brainer" way through, while still enabling those who want to explore and play what-if a means to wander farther afield.
- Sometimes, however, you have to provide deep ruts.

  The closer you get to the naive end of the experience curve, the more you have to rein in your users. A single-use application for accomplishing an unknown task requires a far more directive interface than a habitual-use interface for experts.

- Offer users stable perceptual cues for a sense of "home."

  Stable visual elements not only enable people to navigate fast, they act as dependable landmarks, giving people a sense of "home."

- Make Actions reversible

  People explore in ways beyond navigation. Sometimes they want to find out what would happen if they carried out some potentially dangerous action. Sometimes they don't want to find out, but they do anyway by accident.

  By making actions reversible, users can both explore and can "get sloppy" with their work.

- Always allow "Undo."

  The unavoidable result of not supporting undo is that you must then support a bunch of dialogs that say the equivalent of, "Are you really, really sure?" Needless to say, this slows people down.

  In the absence of such dialogs, people slow down even further. A study a few years back showed that people in a hazardous environment make no more mistakes than people in a supportive and more visually obvious environment, but they worked a lot slower and a lot more carefully to avoid making errors.

- Always allow a way out.

  Users should never feel trapped. They should have a clear path out.

Fitt's Law

"Fitts's law (often cited as Fitts' law) is a model of human movement in human computer interaction and ergonomics that predicts that the time required to rapidly moving to a target area is a function of the distance to the target and the size of the target. Fitts's law is used to model the

act of *pointing*, either by physically touching an object with a hand or finger, or virtually, by pointing to an object on a computer or a device monitor using a pointing device. Paul Fitts proposed it in 1954" ("Fitts's Law," 2011)

> "While at first glance, this law might seem patently obvious; it is one of the most ignored principles in design. Fitt's law indicates that the most quickly accessed targets on any computer display are the four corners of the screen, because of their pinning action, and yet they seem to be avoided at all costs by designers.
>
> Use large objects for important functions (Big buttons are faster).
>
> Use the pinning actions of the sides, bottom, top, and corners of your display: A single-row toolbar with tool icons that "bleed" into the edges of the display will be many times faster than a double row of icons with a carefully-applied one-pixel non-clickable edge along the side of the display" Tognazzini (2003).

Human Interface Objects

Human-interface objects are not necessarily the same as objects found in object-oriented systems. Our objects include folders, documents, and the trashcan. They appear within the user's environment and may or may not map directly to an object-oriented object. In fact, many early GUIs were built entirely in non-object-oriented environments.

- Human-interface objects can be seen, heard, touched, or otherwise perceived.
- Human interface objects that can be seen are quite familiar in graphic user interfaces. Objects that play to another sense such as hearing or touch are less familiar. Good work has been done in developing auditory icons (Gaver).

- Human-interface objects have a standard way of interacting.
- Human-interface objects have standard resulting behaviors.
- Human-interface objects should be understandable, self-consistent, and stable

Latency Reduction

- Wherever possible, use multi-threading to push latency into the background.

Latency can often be hidden from users through multi-tasking techniques, letting them continue with their work while transmission and computation take place in the background.

- Reduce the users' experience of latency.
    - Acknowledge all button clicks by visual or aural feedback within 50 milliseconds.
    - Display an hourglass for any action that will take from 1/2 to 2 seconds.
    - Animate the hourglass so users know the system hasn't died.
    - Display a message indicating the potential length of the wait for any action that will take longer than 2 seconds.
    - Communicate the actual length through an animated progress indicator.
    - Offer engaging text messages to keep users informed and entertained while they are waiting for long processes, such as server saves, to be completed.
    - Make the client system beep and give a large visual indication upon return from lengthy (>10 seconds) processes, so that users know when to return to using the system.
    - Trap multiple clicks of the same button or object. Because the Internet is slow, people tend to press the same button repeatedly, causing things to be even slower.
- Make it faster

Eliminate any element of the application that is not helping.

Learnability

Ideally, products would have no learning curve: users would walk up to them for the very first time and achieve instant mastery. In practice, all applications and services, no matter how simple, will display a learning curve.

- Limit the Trade-Offs.

  Usability and learnability are not mutually exclusive. First, decide which is the most important, then attack both with vigor. Ease of learning automatically coming at the expense of ease of use is a myth.

Use of Metaphors

- Choose metaphors well, metaphors that will enable users to instantly grasp the finest details of the conceptual model.

  Good metaphors are stories, creating visible pictures in the mind.

- Bring metaphors alive by appealing to people's perceptions–sight, sound, touch, and kinesthesia–as well as triggering their memories.

  Metaphors usually evoke the familiar, but often add a new twist. For example, Windows has an object called a briefcase. Like a real-world briefcase, its purpose is to help make electronic documents more portable. It does so, however, not by acting as a transport mechanism, but as a synchronizer: Documents in the desktop briefcase and the briefcase held on portable media are updated automatically when the portable media is inserted in the machine

Protect Users' Work

- Ensure that users never lose their work as a result of error on their part, the vagaries of Internet transmission, or any other reason other than the completely unavoidable, such as sudden loss of power to the client computer.

Readability

- Text that must be read should have high contrast. Favor black text on white or pale yellow backgrounds. Avoid gray backgrounds for dark text.
- Use font sizes that are large enough to be readable on standard monitors. Favor particularly large characters for the actual data you intend to display, as opposed to labels and instructions. For example, the label, "Last Name," can afford to be somewhat small. Habitual users will learn that that two-word gray blob says "Last Name." Even new users, based on the context of the form on which it appears, will have a pretty good guess that it says "Last Name." The actual last name entered/displayed, however, must be clearly readable. This becomes even more important for numbers. Human languages are highly redundant, enabling people to "heal" garbled messages. Numbers, however, unless they follow a very strict protocol, have no redundancy, so people need the ability to examine and comprehend every single character.
- Pay particular attention to the needs of older people. Presbyopia, the condition of hardened, less flexible lenses, coupled with reduced light transmission into the eye, affects most people over age 45. Do not trust your young eyes to make size and contrast decisions

Track State

- Because many of our browser-based products exist in a stateless environment, we have the responsibility to track state as needed.

  We may need to know:

  - Whether this is the first time the user has been in the system
  - Where the user is
  - Where the user is going
  - Where the user has been during this session
  - Where the user was when they left off in the last session

  and myriad other details.

  In addition to simply knowing where they've been, we can also make good use of what they've done.

- State information should be held in a cookie on the client machine during a session with a transaction service, and then stored on the server when they log off.

  Users should be able to log off at work, go home, and take up exactly where they left off.

Visible Navigation

- Avoid invisible navigation.

  Most users cannot and will not build elaborate mental maps and will become lost or tired if expected to do so.

  The World Wide Web, for all its pretty screens and fancy buttons, is, in effect, an invisible navigation space. True, you can always see the specific page you are on, but you cannot see anything of the vast space between pages. Once users reach our applications,

we must take care to reduce navigation to a minimum and make that navigation that is left clear and natural. Present the illusion that users are always in the same place, with the work brought to them. This not only eliminates the need for maps and other navigational aids, it offers users a greater sense of mastery and autonomy.

As with the inherent statelessness of the web (see Track State, above), our job is not to accept blindly what the architects have given us, but to add the layers of capability and protection that users want and need. That the web's navigation is inherently invisible is a challenge, not inevitability.

2.5 Relationship between interaction design and industrial design

In the research paper "Interaction Design: Industrial design in information age," author Ann (2011) says that, as we enter the Information Age, products are no longer only electrical and mechanical, but also include computing and networked capabilities. Designing products highly interactive in nature becomes much more complex than before, going beyond the traditional realm of Industrial Design. Moreover, the fundamental definition of "a product" is being challenged and requires a fundamental shift in thinking as well as new work methods. How people interact with products, systems or environments and its social and cultural impact is what Interaction Design is concerned about.

"As products' nature evolves, so does the role of the products' creators. The industrial designer's role in product development has been designing the form factor and ergonomics of objects. A design project usually starts with a design brief of mechanisms and electronics required of the product design. And the industrial designer generates different physical form

factors and styles suitable for the user and target market.

Much of this is changing with emerging types of hybrid-networked products. First, with software as an integral part of the products' user experience, industrial designers can no longer design the hardware independent of the software experience. A button pushed on the hardware can trigger a screen display and without close integration between hardware and software design, the user's experience will be a frustrating one. Secondly, skills required of designers today are beyond form making. The challenge that many corporations are facing is not what technology can do, but what technology should do. Designers' creativity can be expanded to more strategic roles in redefining what these new product typologies should be and envision how people should experience them" (Ann 2011).

2.6 Interaction design and form language

"In many discussions about design, products are primarily approached in terms of either functionality or aesthetics. They fulfill functions - ranging from practical functions to functions in the realm of product language - and they have specific aesthetic qualities which give them meaning, beauty, and style. These two approaches fail to take into account a third, essential dimension of products: their mediating role in human practices and experiences. Products help to shape human actions and perceptions, and organize specific relations between users and their environment" (Verbeek 2008).

"Designers extended the dominant part-whole determinism of functionalism to the relationship between the form of products and the functions they were meant to serve. This is evident in Louis Sullivan's (1896) aesthetic formula "form follows function." "Following,"

meant logically derivable from a correct understanding of the functions that an artifact had to satisfy. In a climate of technological determinism, this formula served designers well. If designers could argue that the form of their design was unique to the function the product was meant to serve, their proposals were more readily acceptable. Amazingly, the connection between form and function became the ground for an (industry-sponsored and industrial production supporting) functionalist aesthetics" (Krippendorff 2008).

"The introduction of calm technologies and ubiquitous computing (Weiser, 1991) brought forth a growing number of interactive digital products. They even created new categories of digital products including digital audio players, car navigation devices and mobile phones. At the same time, they transformed traditional everyday items, such as chairs, tables and kitchen appliances, into smart, interactive products through embedded microcontrollers, sensors and new electronic displays. These new kinds of everyday products and environments shape our lives and have become major topics of design.

One of the most important roles of designers in this situation is to infuse more emotional value into such technological products, being that emotional value in such products can help people be happier and more creative when using them (Norman, 2005). This supports aesthetic user experience beyond goal-oriented qualities such as effectiveness and efficiency.

It is rare to see users consider digital products similar to how they see conventional products. This may be because of the nature of new digital technologies. The ease of duplicability and the rapid improvements in performance make it difficult for them to contribute extra emotional value that traditional products might have. This may explain why digital watches rapidly decrease in value while analogue watches retain value for long periods of time. This underlines the necessity for designers to explore new approaches that add intrinsic emotional

value to digital objects" (Nam & Kim 2011).

Ross and Wensveen (2010) suggested a design approach called "Designing for Aesthetic Interaction through Aesthetic Interaction," referring to the use of aesthetic experience as a design mechanism.

2.7 Development of guidelines:

From the literature review and research of interaction design principles, the following objectives were developed for the application of interaction design principles in the industrial design process. These objectives are developed to achieve and deliver better communication and experience of a product, system or a service to the user.

2.7.1 Objectives

Industrial design is concerned with the following:

1) To design and develop products, systems or services to support people to achieve ease in use, better productivity, better communication and the best possible interaction.
2) To implement principles from the interaction design field in industrial design processes to enhance experiences and appreciation of developed products or systems.
3) To analyze the design process from multiple disciplines of design, involving many inputs from wide-reaching disciplines of design.

4) To provide the user that creative platform to develop, learn and understand because user creating his or her story about the product or service always follows product interaction.

2.7.2 Developed guidelines

Following are the identified guidelines for task-oriented interface-based design processes where the user is the main point of concentration. From the research and philosophies of interaction design, referred guidelines namely: consistency, user intuition and guidance already exist, and are formally referred for this study. Application of these guidelines to an industrial design process will be goal of this research.

1. Iconic and graphics simplicity
2. Aesthetic sensitivity
3. User intuition
4. Definite choices
5. Consistency
6. Closure to user environment
7. Guidance
8. Easy learning curve
9. Easy to remember: How to use?
10. Match usability goals.

3. APPLICATIONS

3.1 Introduction

"According to Herta A. Murphy and Herbert W. Hildebrandt in their book *Effective Business Communications,* good communication should be complete, concise, clear, concrete, correct, considerate, and courteous. More specifically, this means that communication should: answer basic questions like who, what, when, where; be relevant and not overly wordy; focus on the receiver and his or her interests; use specific facts and figures and active verbs; use a conversational tone for readability; include examples and visual aids when needed; be tactful and good natured; and be accurate and nondiscriminatory"("Communication Systems*,* " 2011).

In this era of globalization, communication and information or data exchange are the most crucial factors for every business. Every individual and organization demands effective ways of communication and means through which they can find, exchange, and upgrade information. Various industries and businesses are dependent on factors such as availability of material, manufacturing, sales, new market trends, and market requirements. The aim of this project is to provide a platform with which a business-oriented user can keep business updated with the all the factors surrounding their business. "Business mate" is a proposed product designed using guidelines developed from the above study. The developed interactive application will allow businessmen to search, communicate, exchange and upgrade information.

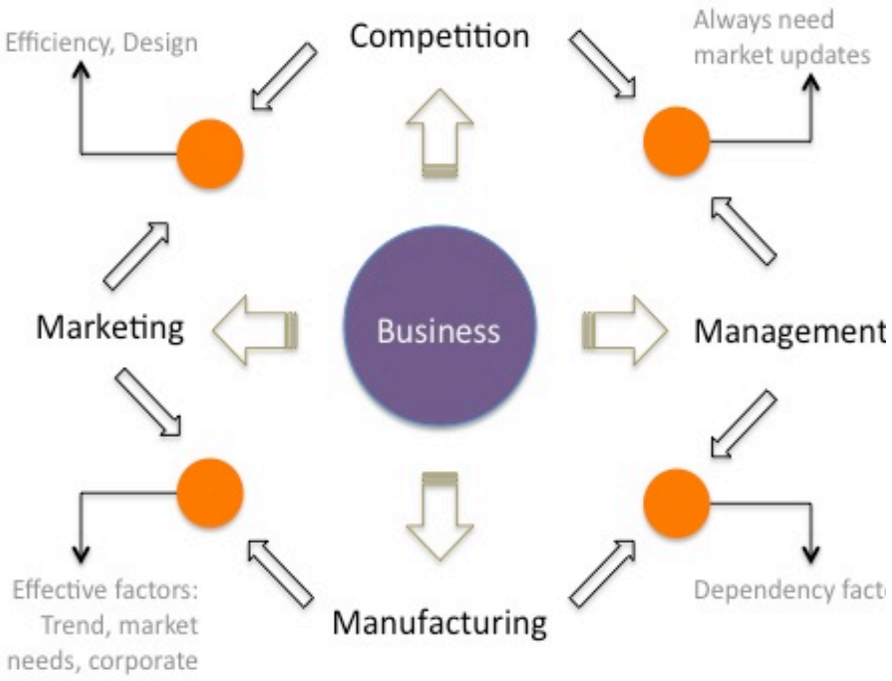


Figure 3: Factors affecting business communication.

3.2. Design project

This design projects focuses on development of an interface-based product called "Business mate" where the interaction design guidelines developed from the above research are applied in the industrial design process of this product.

3.2.1 Project brief

Design Brief:

To develop a communication device which allows business-oriented users, to communicate with other users and access information and data using Internet.

3.2.2 Research and understanding of project:

Business:

A business is a legally recognized organization designed to provide goods and/or services to consumers. As business becomes more reliant on technology, high quality business communications are becoming essential for businesses and organizations.

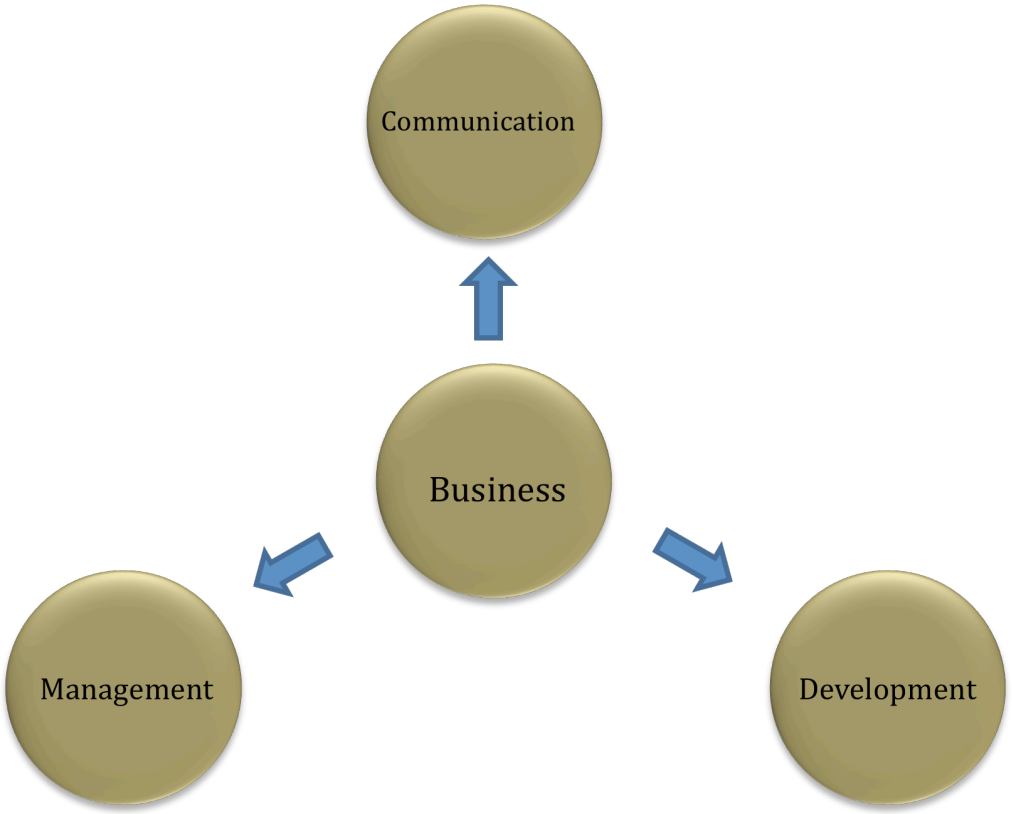


Figure 4: Important factors surrounding business.

Business Communication:

Communication is used to promote a product, service, or organization; relay information within the business; or deal with legal and similar issues. It is also a means of reliance in a supply chain, for example between the consumer and manufacturer. Business Communication is

known simply as "Communications." It encompasses a variety of topics, including marketing, branding, customer relations, consumer behavior, advertising, public relations, corporate communication, community engagement, research and measurement, reputation management, interpersonal communication, employee engagement, online communication, and event management. It is closely related to the fields of professional communication and technical communication.

Figure 5: Representation of business communication.

Methods of Business Communication:

There are several methods of business communication, including:

- Web-based communication - for better and improved communication, anytime anywhere.
- E-mails - which provide an instantaneous medium of written communication worldwide.
- Reports - important in documenting the activities of any department.
- Presentations - very popular method of communication in all types of organizations, usually involving audiovisual material, like copies of reports, or material prepared in Microsoft PowerPoint or Adobe Flash.

- Telephoned meetings - which allow for long distance speech.
- Forum boards - which allow people to instantly, post information at a centralized location.
- Meetings - face-to-face communication.

3.2.3 Understanding the environment:

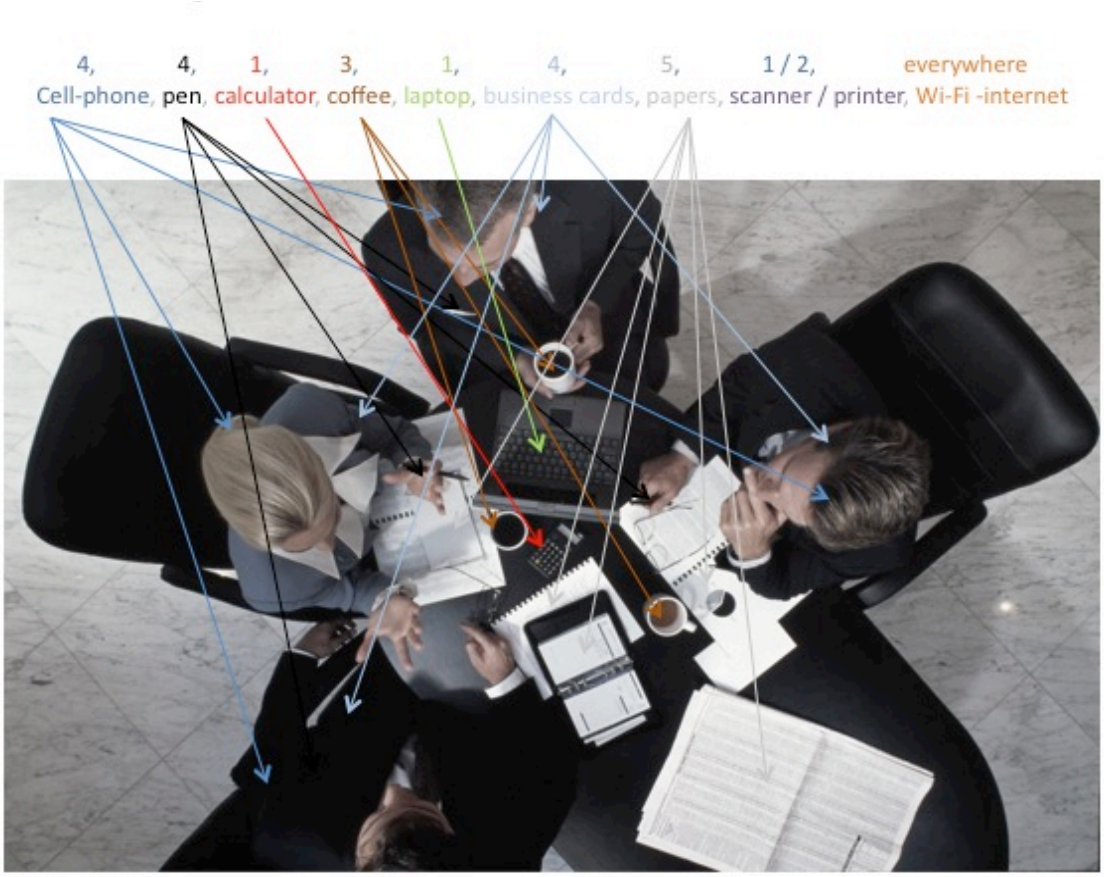


Figure 6: Physical factors surrounding business.

The above figure illustrates a general business environment where, interaction between the users and the physical products is documented. Different colors of arrows show different products and their respective quantities. It can be concluded from the

above figure, that, use of paper and physical documenting media is essential in the business environment. Also paper or small writing products like notebooks, notepads, scribble pads are always used in business environment irrespective of use of digital devices.

Essential Design Factors:

- Provide a digital device with which the user can access, search and communicate. This also includes web browsing, personal data access and sharing.
- Provide scanning device, where user can scan his or her own work and can transfer in to digital media.
- Provide writing material with easy access to paper, writing pad, cards, etc. Camera with audiovisual conferencing.
- Business cards scanner.
- Product should be
    - Compact
    - Easy to understand and
    - Aesthetically pleasing

Interaction Design Guidelines to be introduced in the Design Process:

1. Iconic and graphic simplicity
2. Aesthetic sensitivity
3. Consistency
4. User intuition

5. Definite choices
6. Easy learning curve
7. Match usability goals

Essential Design Factors for Interface:

1. Communication with other users and business-oriented business groups.
2. Business World Updates and Advertisements.
3. Companies, Products, Owner, etc. search.
4. Quick information about desired companies.
5. Internet Access.
6. Personal Database.

Desired Design Factors for Interface:

1. Personal and Business profile Creator.
2. Web Portal for required databases.
3. Development of Product Environment for single and multiple users.
4. Communication methods such as E-mail, telephone service, conferencing, one-to-one and one-to-multiple users communication.

3.2.4 Concept development:

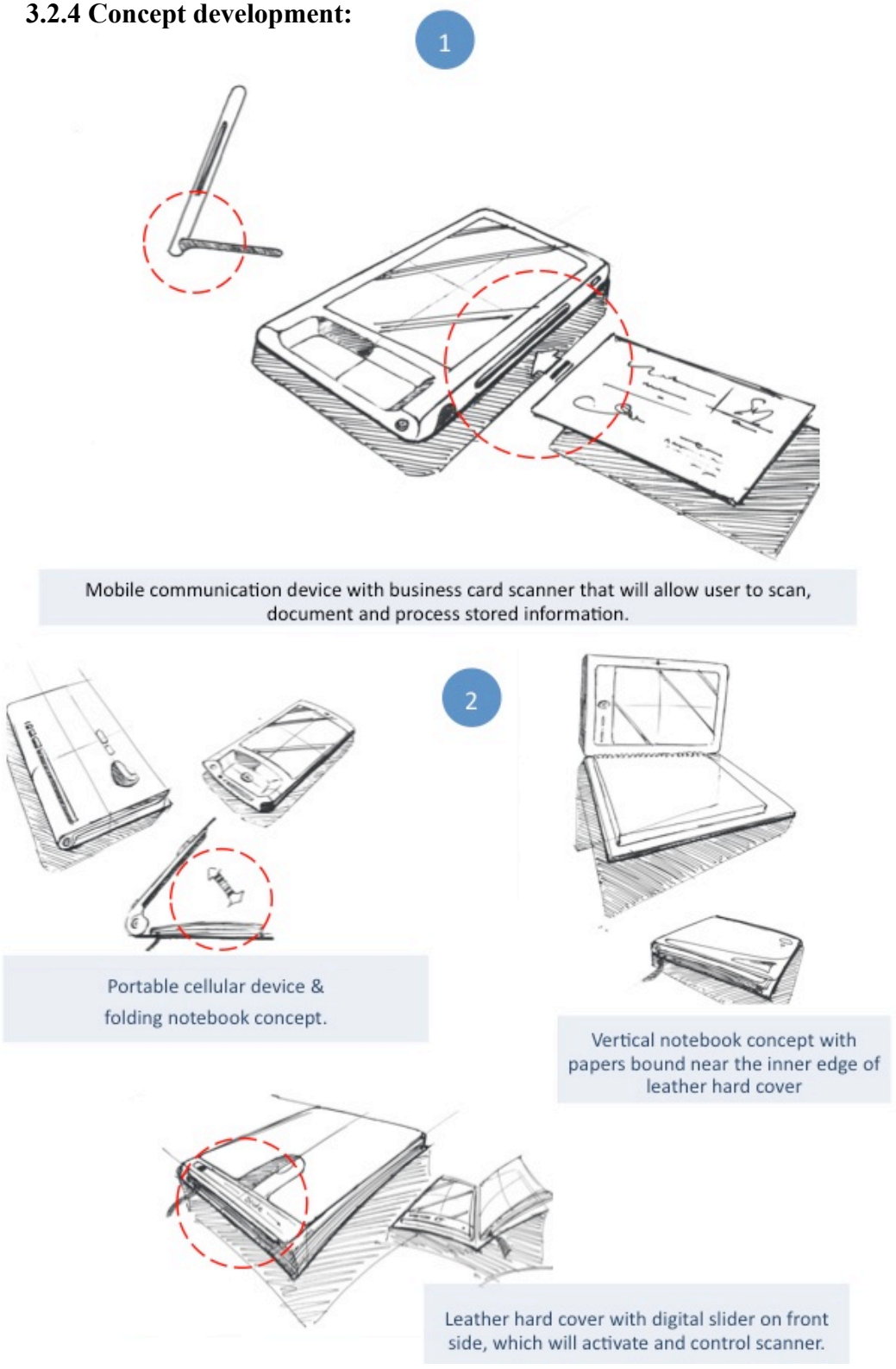
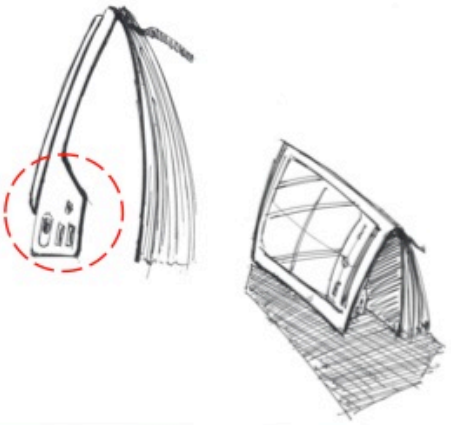
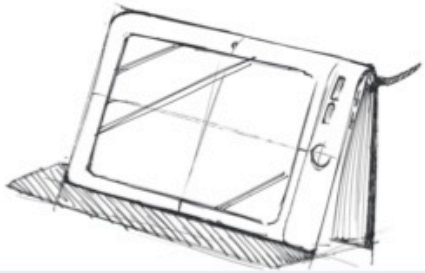


Figure 7: Concept development.

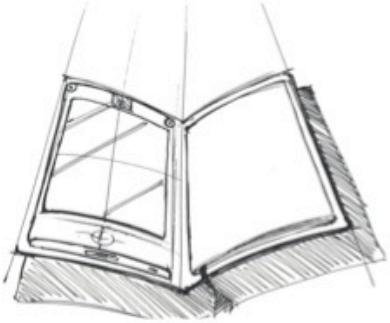


Concept with portable printer and a scanner.

3



The digital device can also be turn horizontally and used as a screen for video-conferencing.



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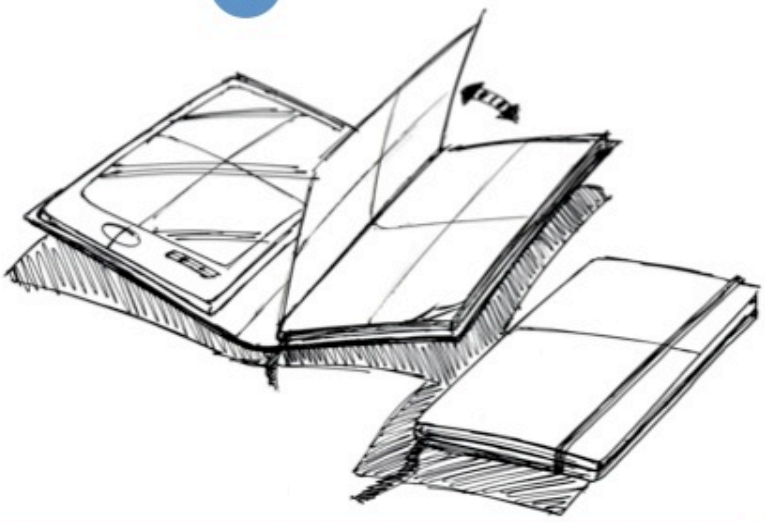

Finalized concept, where the device will be enclosed in a leather covering. It is provided with a vertical or a horizontal notepad. The light sensitive digital screen can be used as a scanner to scan documents or writings on the notepad. Also these scanned documents can be transferred to other devices or web using internet.

Figure 8: Concept development.

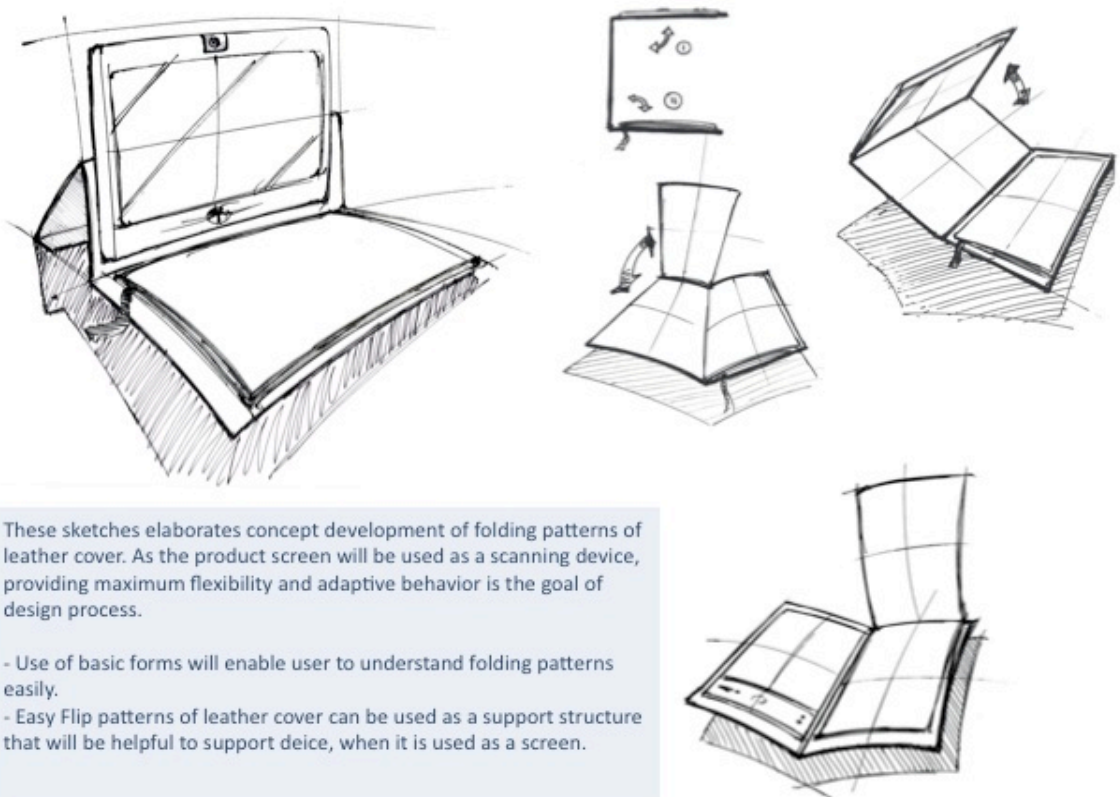

Figure 9: Concept development.

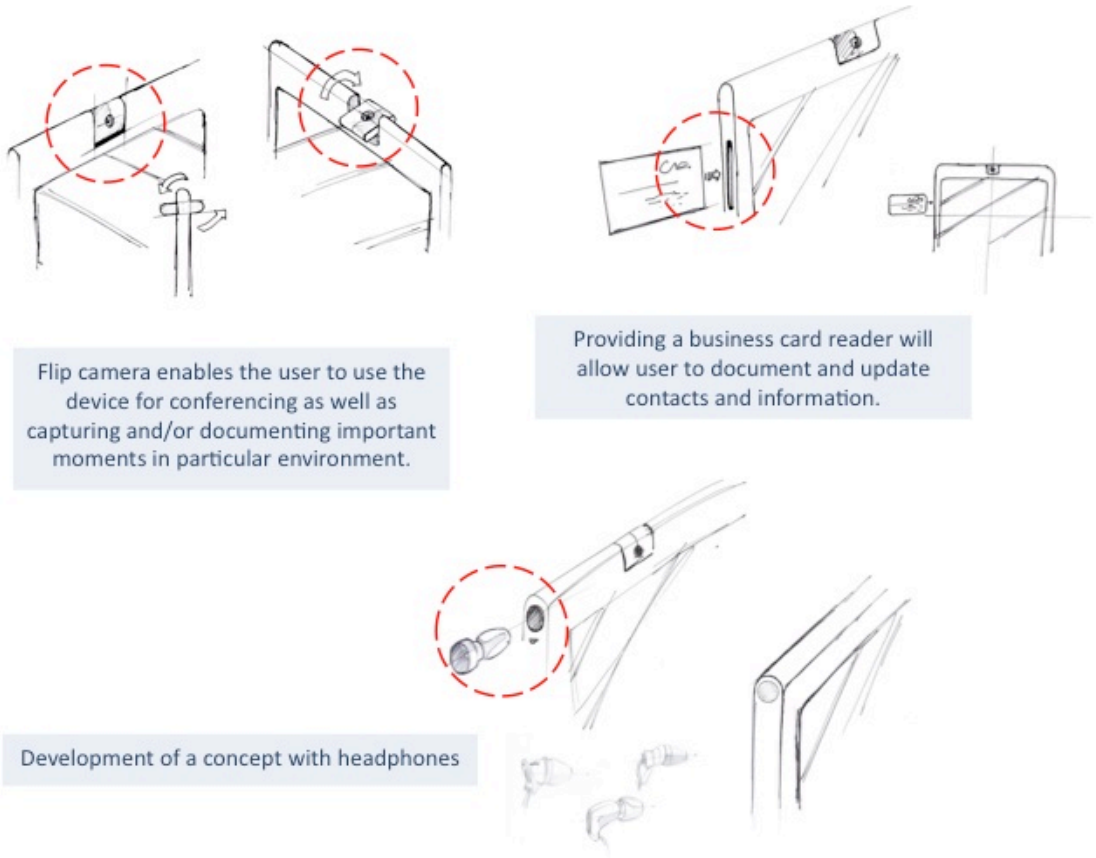

Figure 10: Concept development and details.

3.2.5 Logos and signs development:

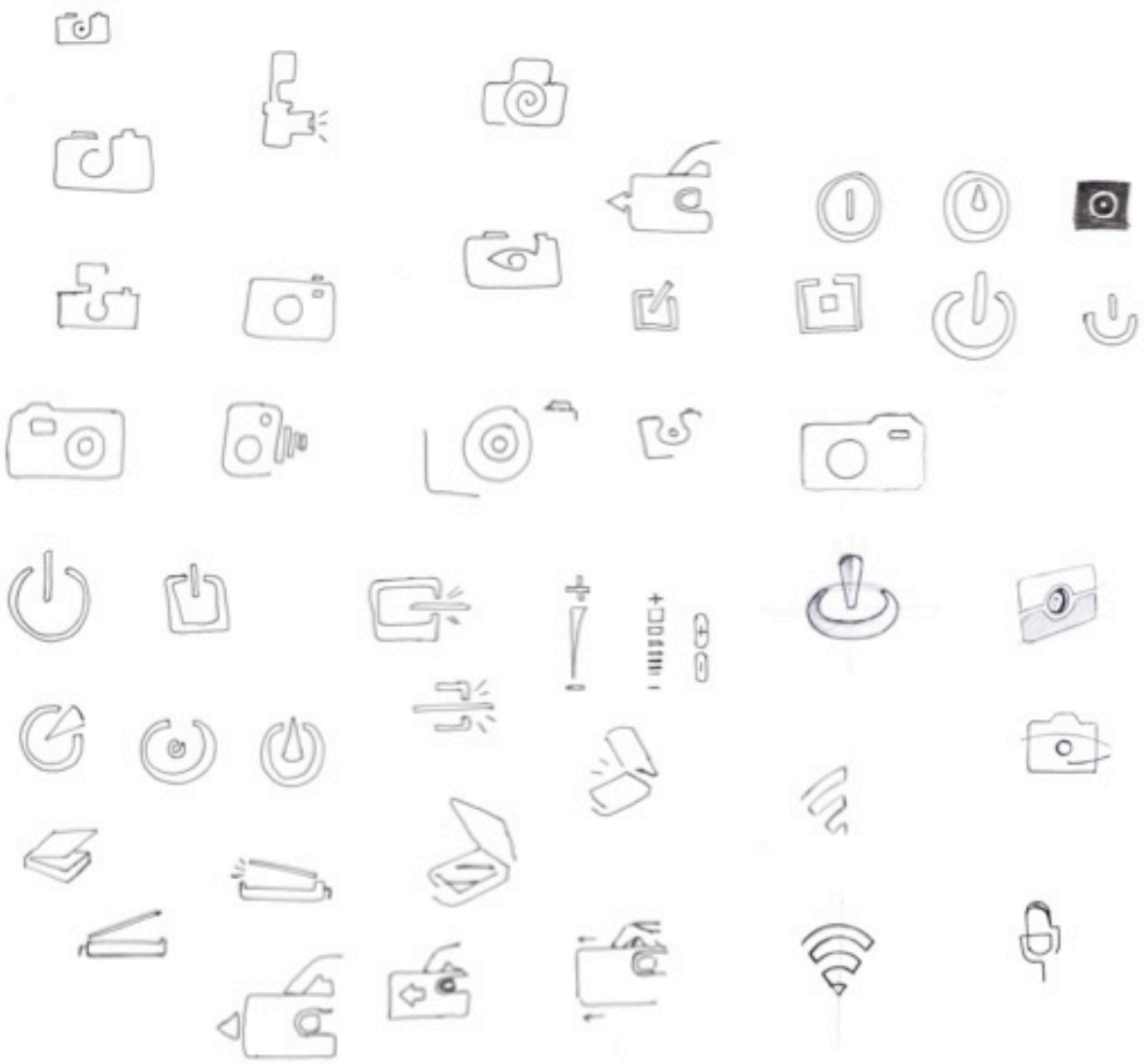

Figure 11: Logos and Signs concept development.

3.2.6 Final logos and signs:

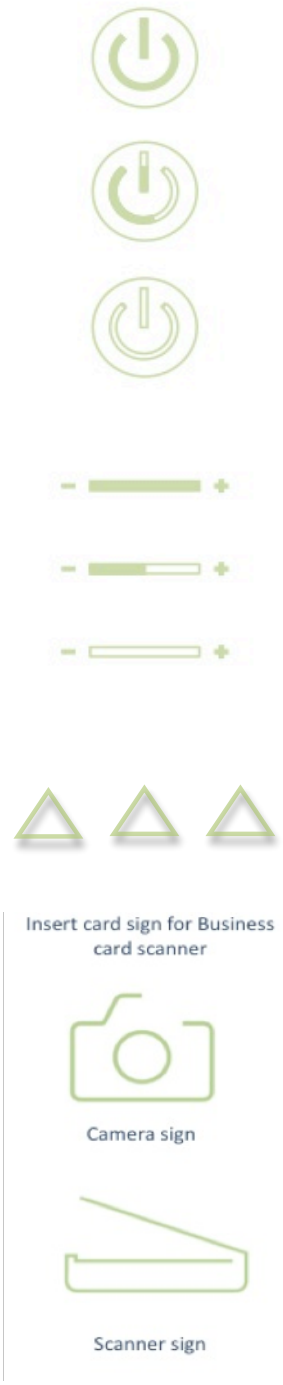

Figure 12: Final logos and signs proposed for the product.

3.2.7 Final product images:

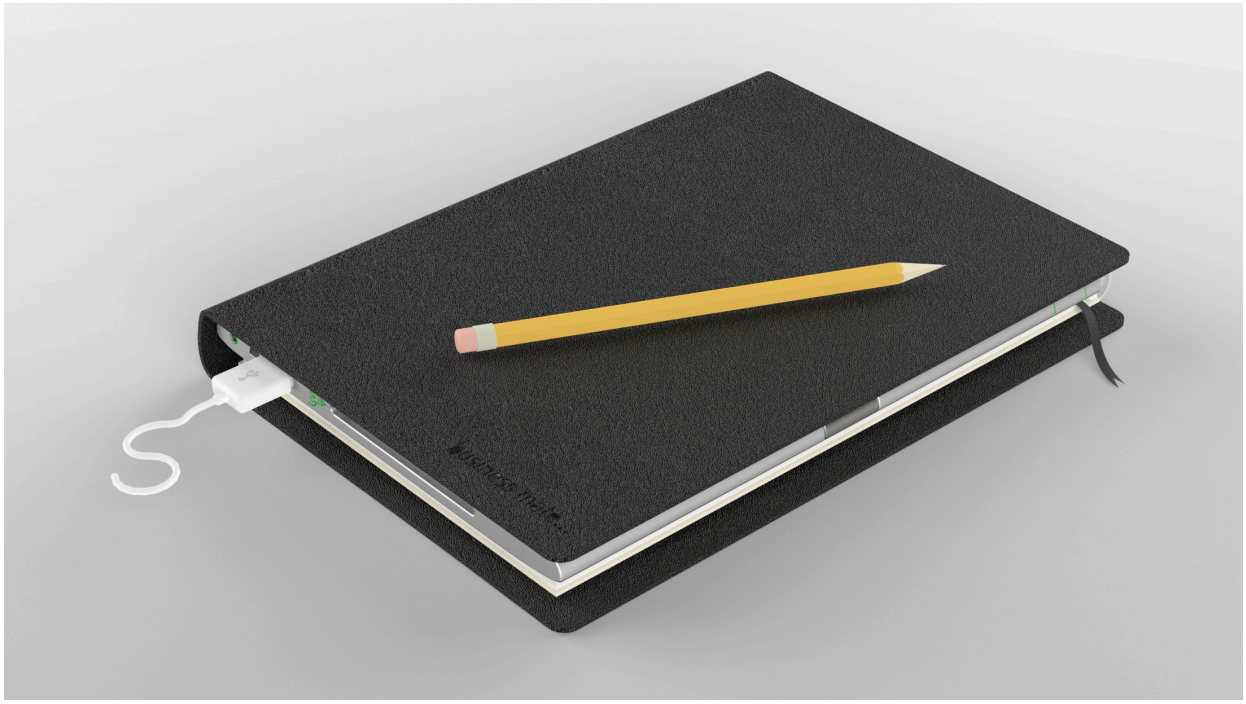

Figure 13: Closed business mate.

Figure 14: Opened business mate.

3.2.8 Final product features:

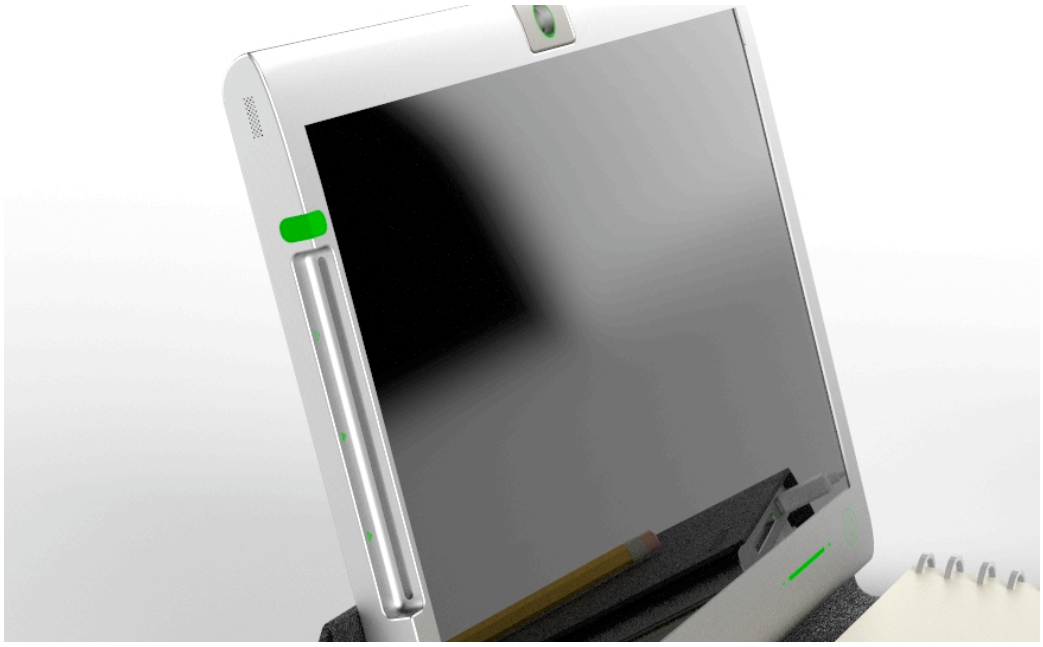

Figure15: Business card scanner slot with feedback light.

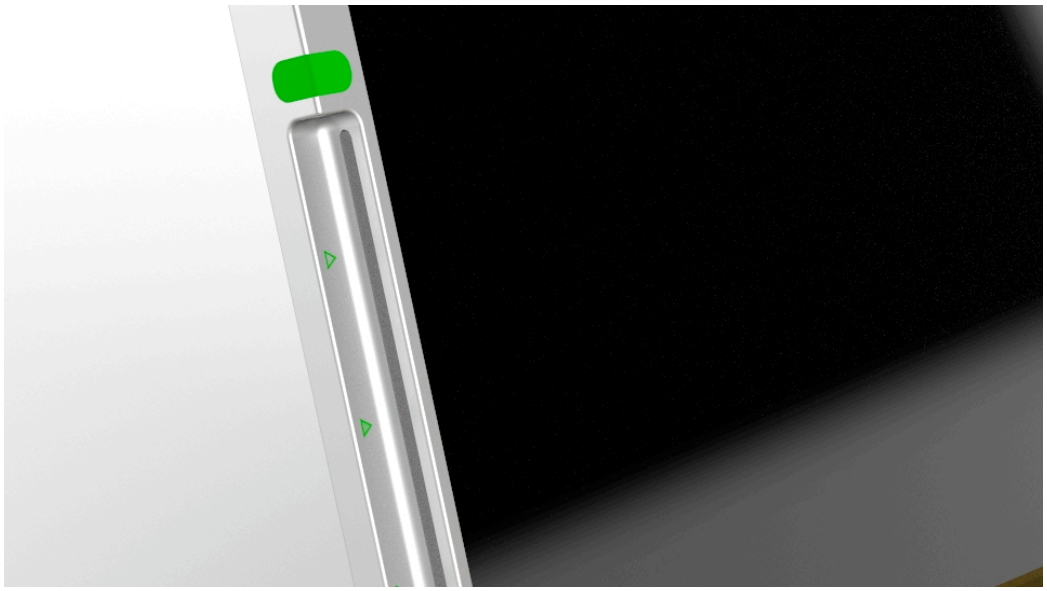

Figure16: Business card scanner detail.

Figure17: Camera control, physical volume button and speaker detail.

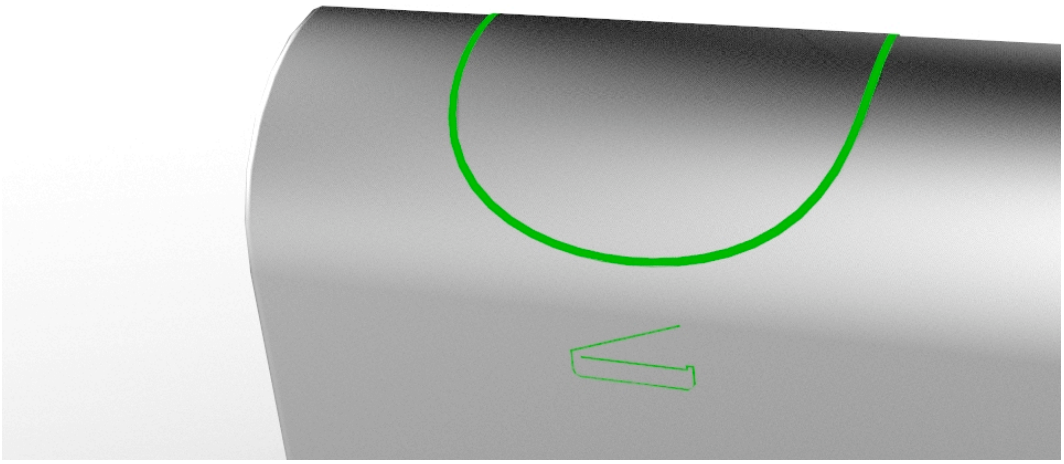

Figure18: Scanner switch detail.

Figure19: flipped camera detail.

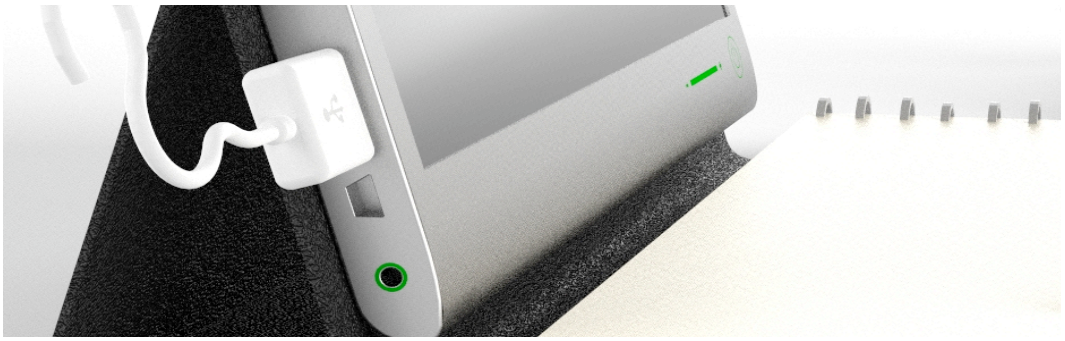

Figure20: USB/AC charging and auxiliary jack detail.

3.3 Design process matrix:

Design Process		Guidelines						
		Iconic & graphic simplicity	Aesthetic sensitivity	Consistency	User intuition	Definite choices	Easy learning curve	Match usability goals
Signs & Symbols	Physical buttons	X	X	X	X		X	
	Dual function buttons	X		X		X		X
	Aesthetic symbols		X		X		X	
Form	Form architecture			X		X	X	
	Form & it's function		X		X			X
Features	Camera	X	X		X	X	X	
	Scanner	X	X		X	X	X	
	Writing pad		X			X		
	Card scanner	X			X		X	X

Table 1: Design process matrix

3.4 Interface design:

3.4.1 Hierarchy tree

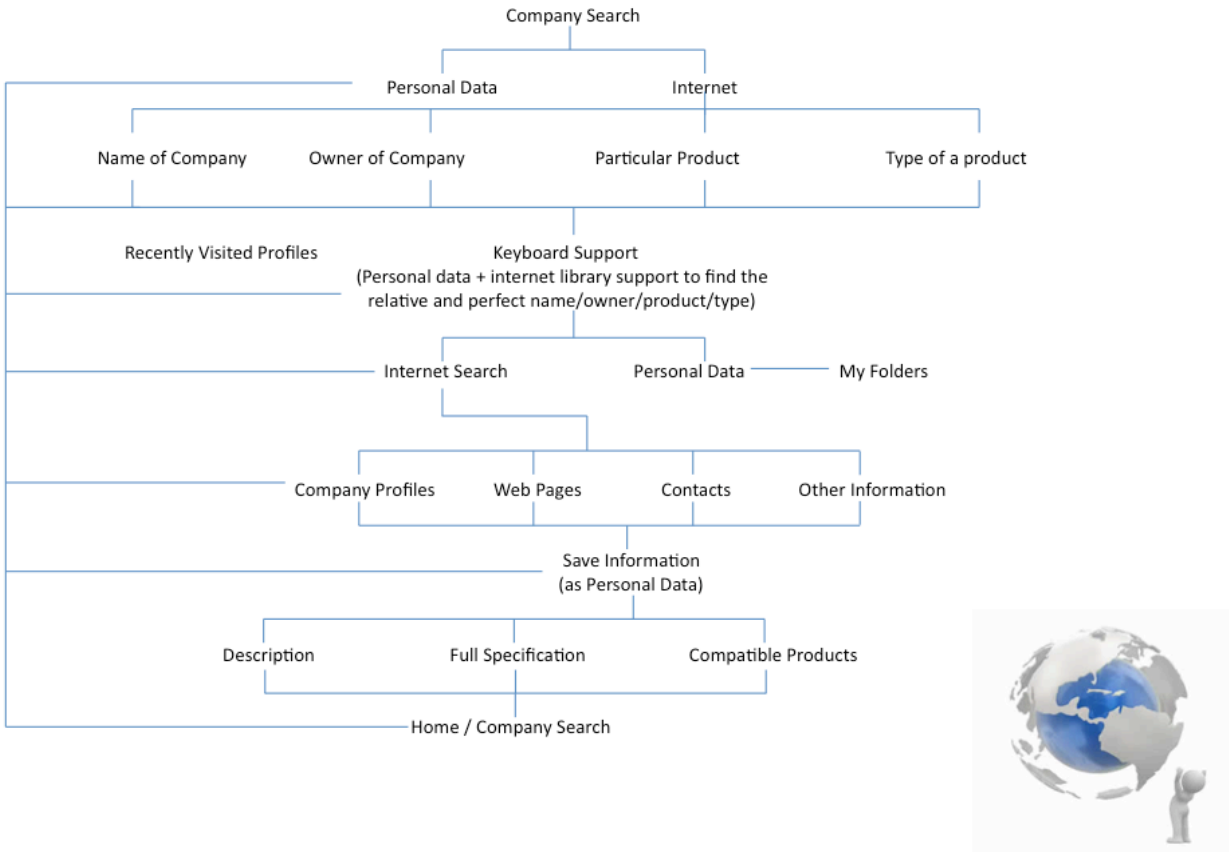

Figure 21: Hierarchy tree.

The hierarchy tree above gives activity information of the particular product 'Business mate.'

3.4.2 Applied design principles

Guideline 1: Iconic and graphic simplicity

Graphic icons, symbols, or activity buttons used in interfaces should always give a reference of an activity or familiar information. Following are the symbols developed for the application that will allow navigating users to interact with device in the easiest possible way. Following is the list of icons that were developed for the business mate application.

: Search Icon

Figure 22: Search icon

: Home Icon

Figure 23: Home icon

: Internet Icon

Figure 24: Internet icon

: Folder Icon

Figure 25: Folder icon

: Personalized Folder Icon

Figure 26: Personalized folder icon

: Save Information Icon

Figure 27: Save icon

: Update/Download Icon

Figure 28: Update/download icon

Guideline 2: Aesthetic sensitivity

Aesthetic sensitivity is defined as an individual's perception of the beauty of objects in his or her immediate environment. As the definition illustrates the affect is generally considered to be positive because aesthetics is by definition concerned with beauty. However, it is also possible that the affective response to an object is negative, namely when the object is not found to be aesthetically pleasing or familiar.

Figure 29: Screen shot 1, aesthetic sensitivity.

If the user does not perceive an object or a key on the screen as self-explanatory or recognizable, the resulting affective reaction might be neutral or negative. Following this idea, the guideline aims to assess aesthetic responses that are either positive or negative responses to everyday objects. The objective of the aesthetic sensitivity guideline is thus to measure to what extent individuals are sensitive towards the "look and interactivity" of an object**.**

Guideline 3: User intuition

"Intuition is one's first impression, of apparent understanding that comes in response to a situation" (Russel 2006). For application of interaction design principles in an industrial design process, intuition is often what guides initial work of development of users' understanding of a product, system or an interface. This usually helps in building a hierarchy tree and activity architecture of a product or an interface.

Figure 30: Screen shot 2, user intuition.

Figure 30 above illustrates the application of this guideline, user intuition. The first impression of this product gives a specific choice where a user can access and personalize his or her upcoming activities, like searching or accessing information using the particular product "Business mate". Product activity follows users' intuition when a design process is successful.

Guideline 4: Definite choice

Make sure that choices are presented in the user's language and are clearly understood Ensure that the number of options available at any branch is shown clearly, avoid creating empty levels in the hierarchy and allow easy backtracking when a branch of choices is not successful.

Figure 31: Screen shot 3, definite choice.

Figure 31 above illustrates definite choices provided to the user where a user is given the freedom of using a search option or a reference library. Business mate will remember the specific searches made by the user and will keep them in search history, which can be used, reused, or referred to accordingly. Providing definite choices of previous searches, additional searches and / or a home option gives the user particular levels of hierarchy.

Guideline 5: Consistency

The design and activity architecture of the product application should be consistent. The user should not become confused while using the product or product interface because of the introduction of new patterns, colors, symbols or activity directions. Patterns of visible and invisible structures should be kept in order.

Figure 32: Screen shot 4, consistency

In the above design, the layout and appearance of the application is consistent and can be easily related with any keyboard and search toolbar of virtually any application. Also, the availability of shortcut keys, like cut, copy, paste, select all, and so on, gives the user confidence and a familiar environment with which to work.

Guideline 6: Closure to user environment

Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions (Shneiderman 1998).

Figure 33: Screen shot 5, closure to user environment

The above figure illustrates how sequences of actions are organized into groups and how they lead the user to perform specific tasks. Also, a variety of search options provided with consistency of search activities give the user satisfaction and rapid feedback.

Guideline 7: Guidance

Guidance is one of the most important elements of interface design. User and product or user and interface-based systems interact on the basis of exchange of information and then by processing received information. As individuals, users can perform at different levels of complexities in accordance with the provided information; guiding users for performing a task and providing information prior to their action as a choice can make the overall process easy and fast.

Figure 34: Screen shot 6, guidance

The above figure illustrates how an interface can guide users by providing information from memory or recently used or found items.

Guideline 8: Easy learning curve

Ideally, products and interfaces should have no learning curve: users should be able to achieve instant mastery when used the very first time. In practice, all applications and services, no matter how simple, will display a learning curve. The provision of appropriate graphics and appropriate use of metaphors can simplify the learning curve, and always keeping users informed about what is happening with appropriate feedback.

Figure 35: Screen shot 7, Easy learning curve

Figure 36: Screen shot 8, Easy learning curve

Figure 37: Screen shot 9, Easy learning curve

Guideline 9: Easy to remember: How to use?

Human memory is better accessed through images and icons than by alphanumeric strings (Bagnara & Smith, 2006). The interdependency of images and graphics is easy to understand and memorize. Using metaphors to help users in remembering the activity hierarchy makes it easy to remember how to use a product.

Figure 38: Screen shot 10, Easy to remember: How to use?

Guideline 10: Match usability goals

Usability is generally regarded as ensuring that interactive products are easy to learn, effective to use, and enjoyable from users' point of view. It involves optimizing the interactions people have with interactive products. It is well accepted that understanding the users and a thorough analysis of their goals and tasks is a prerequisite for usability. Introduction of usability goals to a design process enhances the user experience of that particular product or interface.

Figure 39: "Business mate" product image

Usability goals for particular product "Business mate" are resourceful, easy to use, satisfying, helpful, fast, and reliable.

3.5 Summary

Communication is the most important factor for every business-oriented user. Intelligent interaction is a tool for effective communication and it can bring success to a business. A developed communication device is a step towards smart research and its effective application. Communication devices for business-oriented user must identify, analyze and simplify required processes for personalized use. Application of the previously developed guidelines in the design process of particular product “Business mate” made the product exclusive. It fulfilled essential and desired design factors required in the design process corresponding with the design brief.

4. CONCLUSION

4.1 Designer and user

Interaction design is concerned with designing interactive products to support people in their everyday and working lives. Interaction design is multidisciplinary field, involving much input from wide-reaching disciplines and fields. This research is a step where a set of guidelines were developed for industrial designers to understand, refine, and apply interaction design principles while developing interface-based products, systems, or services. These developed guidelines will help industrial designers to refine their design process and achieve better communication between users and a product, system, or service.

Industrial designers develop products, systems and services for people. User satisfaction is the goal for every designer. Application of the guidelines developed in this thesis will elevate users' perception and understanding of products, interface systems or services and will provide a better experience.

4.2 Educating industrial designers

Interaction design is now big business: many companies want it. An industrial designer with background and knowledge of interaction design, its principles, and fundamentals will increase his or her area of expertise and can optimize the interaction between users and interactive products. This requires taking into account a number of interdependent factors, including context of use, type of task, and kind of user. Through guidelines such as those developed in this thesis, an industrial designer can develop interactive products to match usability goals like ease of use and learning.

4.3 Further studies should involve

Future studies should involve:

- Finding relation between product semantics and interaction design principles.
- Developing guidelines for conceptualization of products, systems or services.
- Research on interactive display systems.

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