Subject name: Interactive Design

Subject code: SEG-14-13

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Learning Outcome

Objectives of this chapter are: -

- Introduction

Chapter 1 Introduction to Special Effects

Introduction

How many interactive products are there in everyday use? Think for a minute about what you use in a typical day: smartphone, tablet, computer, remote control, coffee machine, ATM, ticket machine, printer, iPod, GPS, e-reader, TV, electric toothbrush, radio, games console . . . the list is endless. Now think for a minute about how usable they are. How many are actually easy, effortless, and enjoyable to use? Some, like the iPod, are a joy to use. Others, like a ticket machine, can be very frustrating. Why is there a difference?

Figure 1 - Smartphone

Figure 2 - Tablet

Figure 3 - Computer

Figure 4 - Remote Control

Figure 5 - ATM Machine

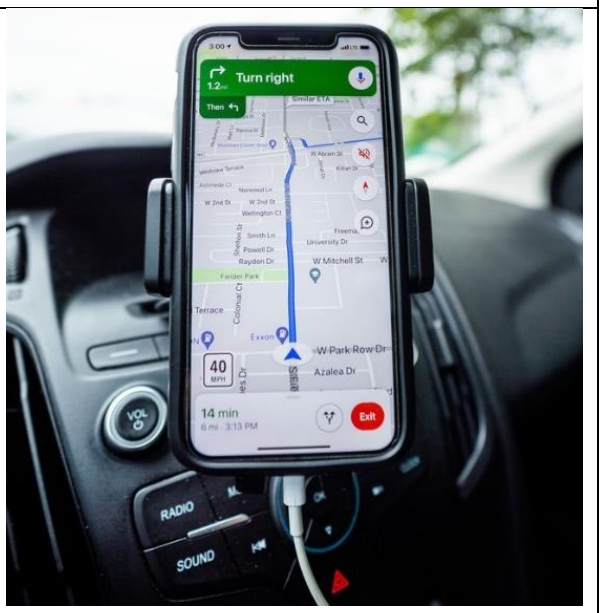

Figure 6 - GPS

Many products that require users to interact with them, such as smartphones and social networking sites, have been designed primarily with the user in mind. They are generally easy and enjoyable to use. Others, such as switching from viewing a rented movie on your smart TV to watching a sports channel, or setting the alarm on a digital clock, have not necessarily been designed with the users in mind, but have been engineered primarily as systems to perform set functions. While they may work effectively, it can be at the expense of how they will be used by real people.

One main aim of interaction design is to reduce the negative aspects (e.g., frustration, annoyance) of the user experience while enhancing the positive ones (e.g., enjoyment, engagement). In essence, it is about developing interactive products that are easy, effective, and pleasurable to use – from the users' perspective. In this chapter we begin by examining what interaction design is. We look at the difference between good and poor design, highlighting how products can differ radically in how usable and enjoyable they are. We then describe what and who is involved in the process of interaction design. The user experience, which is a central concern of interaction design, is then introduced. Finally, we outline how to characterize the user experience in terms of usability goals, user experience goals, and design principles. An assignment is presented at the end of the chapter in which you have the opportunity to put into practice what you have read by evaluating the design of an interactive product.

GOOD AND POOR DESIGN

A central concern of interaction design is to develop interactive products that are usable. By this is generally meant easy to learn, effective to use, and providing an enjoyable user experience. A good place to start thinking about how to design usable interactive products is to compare examples of well- and poorly-designed ones. Through identifying the specific weaknesses and strengths of different interactive products, we can begin to understand what it means for something to be usable or not. Here, we describe two examples of poorly designed products – a voice mail system used in hotels and the ubiquitous remote-control device – and contrast these with two well-designed examples of products that perform the same function.

Voice mail system

Imagine the following scenario. You are staying at a hotel for a week while on a business trip. You discover you have left your cell phone at home so you have to rely on the hotel's facilities. The hotel has a voice mail system for each room. To find out if you have a message, you pick up the handset and listen to the tone. If it goes 'beep, beep, beep' there is a message. To find out how to access the message you have to read a set of instructions next to the phone. You read and follow the first step: -

Figure 7 - Hotel voicemail system

'1. Touch 41.'

The system responds: 'You have reached the Sunny Hotel voice message center. Please enter the room number for which you would like to leave a message.'

You wait to hear how to listen to a recorded message. But there are no further instructions from the phone. You look down at the instruction sheet again and read:

'2. Touch*, your room number, and #.'

You do so and the system replies: 'You have reached the mailbox for room 106. To leave a message, type in your password.' You type in the room number again and the system replies: 'Please enter room number again and then your password.'

'3. Enter password.'

You don't know what your password is. You thought it was the same as your room number, but clearly, it's not. At this point you give up and call reception for help. The

person at the desk explains the correct procedure for recording and listening to messages. This involves typing in, at the appropriate times, the room number and the extension number of the phone (the latter is the password, which is different from the room number). Moreover, it takes six steps to access a message and five steps to leave a message. You go out and buy a new cell phone.

What is problematic with this voice mail system?

- It is infuriating.
- It is confusing.
- It is inefficient, requiring you to carry out a number of steps for basic tasks.
- It is difficult to use.
- It has no means of letting you know at a glance whether any messages have been left or how many there are. You have to pick up the handset to find out and then go through a series of steps to listen to them.
- It is not obvious what to do: the instructions are provided partially by the system and partially by a card beside the phone.

Now consider the following phone answering machine. Figure 1.1 shows two small sketches of an answering machine phone. Incoming messages are represented using physical marbles. The number of marbles that have moved into the pinball-like chute indicates the number of messages. Dropping one of these marbles into a slot in the machine causes the recorded message to play. Dropping the same marble into another slot on the phone dials the caller who left the message.

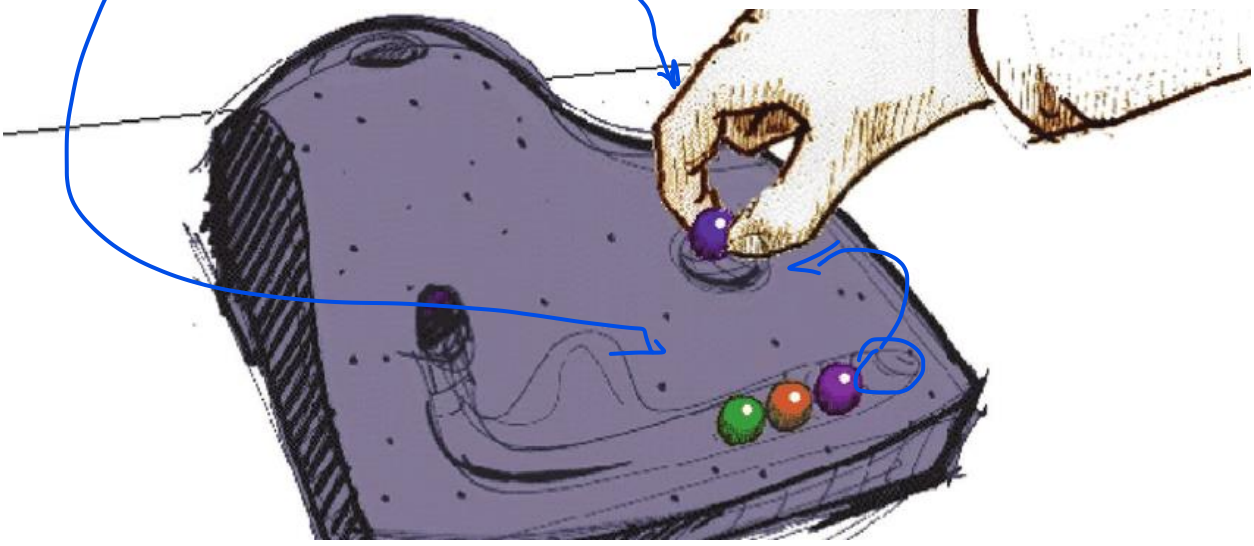

Figure 8 - Marble Answering machine

How does the marble answering machine differ from the voice mail system?

- It uses familiar physical objects that indicate visually at a glance how many messages have been left.
- It is aesthetically pleasing and enjoyable to use.

- It only requires one-step actions to perform core tasks.
- It is a simple but elegant design.
- It offers less functionality and allows anyone to listen to any of the messages.

The marble answering machine is considered a design classic and was designed by Durrell Bishop while he was a student at the Royal College of Art in London (described by Crampton Smith, 1995). One of his goals was to design a messaging system that represented its basic functionality in terms of the behavior of everyday objects. To do this, he capitalized on people's everyday knowledge of how the physical world works. In particular, he made use of the ubiquitous everyday action of picking up a physical object and putting it down in another place. This is an example of an interactive product designed with the users in mind. The focus is on providing them with an enjoyable experience but one that also makes efficient the activity of receiving messages. However, it is important to note that although the marble answering machine is a very elegant and usable design, it would not be practical in a hotel setting. One of the main reasons is that it is not robust enough to be used in public places: for instance, the marbles could easily get lost or be taken as souvenirs. Also, the need to identify the user before allowing the messages to be played is essential in a hotel setting. When considering the design of an interactive product, therefore, it is important to take into account where it is going to be used and who is going to use it. The marble answering machine would be more suited in a home setting – provided there were no children who might be tempted to play with the marbles!

Remote Control Device

Every home entertainment system, be it the TV, cable, smart TV, music system, and so forth, comes with its own remote-control device. Each one is different in terms of how it looks and works. Many have been designed with a dizzying array of small, multicolored, and double-labeled buttons (one on the button and one above or below it) that often seem arbitrarily positioned in relation to one another. Many viewers, especially when sitting in their living room, find it difficult to locate the right ones, even for the simplest of tasks, like pausing or finding the main menu. It can be especially frustrating for those who need to put on their reading glasses each time to read the buttons. The remote-control device appears to have been put together very much as an afterthought.

In contrast, much effort and thought went into the design of the TiVo remote control. The buttons were large, clearly labeled, and logically arranged, making them easy to locate and use in conjunction with the menu interface that appears on the TV monitor. In terms of its physical form, the remote device was designed to fit into the palm of a hand, having a peanut shape. It also has a playful look and feel about it: colorful buttons and cartoon icons were used that are very distinctive, making it easy to identify them in the dark and without having to put reading glasses on.

How was it possible to create such a usable and appealing remote device where so many others have failed? The answer is simple: -

TiVo invested the time and effort to follow a user-centered design process. Specifically, TiVo's director of product design at the time involved potential users in the design process, getting their feedback on everything from the feel of the device in the hand to where best to place the batteries – making them easy to replace but not prone to falling out. He and his design team also resisted the trap of 'button its is' – to which so many other remote controls have fallen victim – where buttons breed like rabbits, one for every new function.

They did this by restricting the number of control buttons embedded in the device to the essential ones. Other functions were then represented as part of the menu options and dialog boxes displayed on the TV screen, which could be selected via the core set of physical control buttons. The result was a highly usable and pleasing device that has received much praise and numerous design awards.

Dilemma

What is the best way to interact with a smart TV?

A challenge facing Smart TV providers is how to enable users to interact with online content such that it can still be as easy and enjoyable to do as it was with previous generations of TV, with a remote-control device. Viewers can now select a whole range of content via their TV screens, but it also involves having to type in passwords and search terms, while scrolling through lots of menus, etc. In many ways it has become more like a computer than a TV. This raises the question of whether the remote control is the best input device to use for someone who is sat on a sofa or chair that is some distance from the TV wide screen. Another possibility is to add a keyboard and touch pad to the remote for menu/icon selection and text input. However, this can be clunky and awkward to use, especially with only one hand. An alternative is to provide an on-screen keyboard and number pad – as Apple TV has done. It has designed a slimline remote device that controls the cursor on the TV screen.

However, to type requires pecking at a grid of alphanumeric letters/numbers that is not the same as the conventional QWERTY keyboard on phones and computers. This style of interaction can be painstakingly slow; it is also easy to overshoot and select the wrong letter or number. Another option is to download an app onto a smartphone and interact with the keypad as if texting. But the app has to be opened each time to act as 'a remote' and is only as good as the person whose smartphone it is.

Figure 9 – (a) Interacting with digital content on a TV screen using Apple TV remote controller (b) The online table of letters and numbers that the user has to select by pressing one button on the remote (c) minuum's keyboard small staggered keyboard

What to Design?

Designing interactive products requires considering who is going to be using them, how they are going to be used, and where they are going to be used. Another key concern is to understand the kind of activities people are doing when interacting with the products. The appropriateness of different kinds of interfaces and arrangements of input and output devices depends on what kinds of activities are to be supported.

For example, if the activity is to enable people to bank online, then an interface that is secure, trustworthy, and easy to navigate is essential. In addition, an interface that allows the user to find out new information about the services offered by the bank without it being intrusive would be useful.

The world is becoming suffused with technologies that support increasingly diverse activities. Just think for a minute what you can currently do using computer-based systems: send messages, gather information, write essays, control power plants, program, draw, plan, calculate, monitor others, play games – to name but a few. Now think about the types of interfaces and interactive devices that are available. They, too, are equally diverse: multitouch displays, speech-based systems, handheld devices, and large interactive displays – to name but a few. There are also many ways of designing how users can interact with a system, e.g., via the use of menus, commands, forms, icons, gestures, etc. Furthermore, ever more innovative everyday artifacts are being created, using novel materials, such as e-textiles and wearables.

Figure 10 - Biking jacket

The interfaces for everyday consumer items, like cameras, microwave ovens, and washing machines, that used to be physical and the realm of product design, are now predominantly digitally based, requiring interaction design (called consumer electronics).

Figure 11 - Camera menu

Figure 12 - Microwave oven menu

The move towards transforming human–human transactions into solely interface-based ones has also introduced a new kind of customer interaction. Self-checkouts at grocery stores, airports, and libraries are becoming the norm where customers themselves have to check in their own goods, luggage, or books. Instead of a friendly face helping them out, interfaces bark orders at them. While more cost- effective, it puts the onus on the users to interact with the system. Accidentally pressing the wrong button can result in a frustrating, and sometimes mortifying, experience, especially for first-time users.

What this all amounts to is a multitude of choices and decisions that interaction designers have to make for an ever-increasing range of products. A key question for

interaction design is: how do you optimize the users' interactions with a system, environment, or product, so that they support and extend the users' activities in effective, useful, and usable ways? One could use intuition and hope for the best.

Alternatively, one can be more principled in deciding which choices to make by basing them on an understanding of the users. This involves: -

- Taking into account what people are good and bad at.
- Considering what might help people with the way they currently do things. Thinking through what might provide quality user experiences.
- Listening to what people want and getting them involved in the design.
- Using tried and tested user-based techniques during the design process.

The aim of this book is to cover these aspects with the goal of teaching you how to carry out interaction design. In particular, it focuses on how to identify users' needs and the context of their activities, and from this understanding move to designing usable, useful, and pleasurable interactive products.

What Is Interaction Design?

By interaction design, we mean designing interactive products to support the way people communicate and interact in their everyday and working lives. Put another way, it is about creating user experiences that enhance and augment the way people work, communicate, and interact.

More generally, Winograd describes it as "designing spaces for human communication and interaction" (1997, p. 160). Thackara views it as "the why as well as the how of our daily interactions using computers" (2001, p. 50) while Saffer emphasizes its artistic aspects: -

> *"The art of facilitating interactions between humans through products and services" (2010, p. 4).*

A number of terms have been used to emphasize different aspects of what is being designed, including user interface design, software design, user-centered design, product design, web design, experience design, and interactive system design. Interaction design is increasingly being accepted as the umbrella term, covering all of these aspects. Indeed, many practitioners and designers, who in the 1990s would have described what they were doing as interface design or interactive system design, now promote what they are doing as interaction design.

The focus of interaction design is very much concerned with practice, i.e., how to design user experiences. It is not wedded to a particular way of doing design, but is more eclectic, promoting the use of a range of methods, techniques, and frameworks. Which is given prominence or is currently in vogue will very much depend on the time and context (Lowgren and Stolterman, 2004; Saffer, 2010).

How does interaction design differ from other approaches to the design of computer-based systems, such as software engineering? A simple analogy to another profession, concerned with creating buildings, may clarify this difference. In his account of interaction design, Winograd (1997) asks how architects and civil engineers differ when faced with the problem of building a house. Architects are concerned with the people and their interactions with each other and with the house being built. For example, is there the right mix of family and private spaces? Are the spaces for cooking and eating in close proximity? Will people live in the space being designed in the way it was intended to be used? In contrast, engineers are interested in issues to do with realizing the project. These include practical concerns like cost, durability, structural aspects, environmental aspects, fire regulations, and construction methods. Just as there is a difference between designing and building a house, so too is there a distinction between designing an interactive product and engineering the software for it.

The Components of Interaction Design

We view interaction design as fundamental to all disciplines, fields, and approaches that are concerned with researching and designing computer-based systems for people. Why are there so many and what do they all do? Furthermore, how do the various disciplines, fields, and design approaches differ from one another?

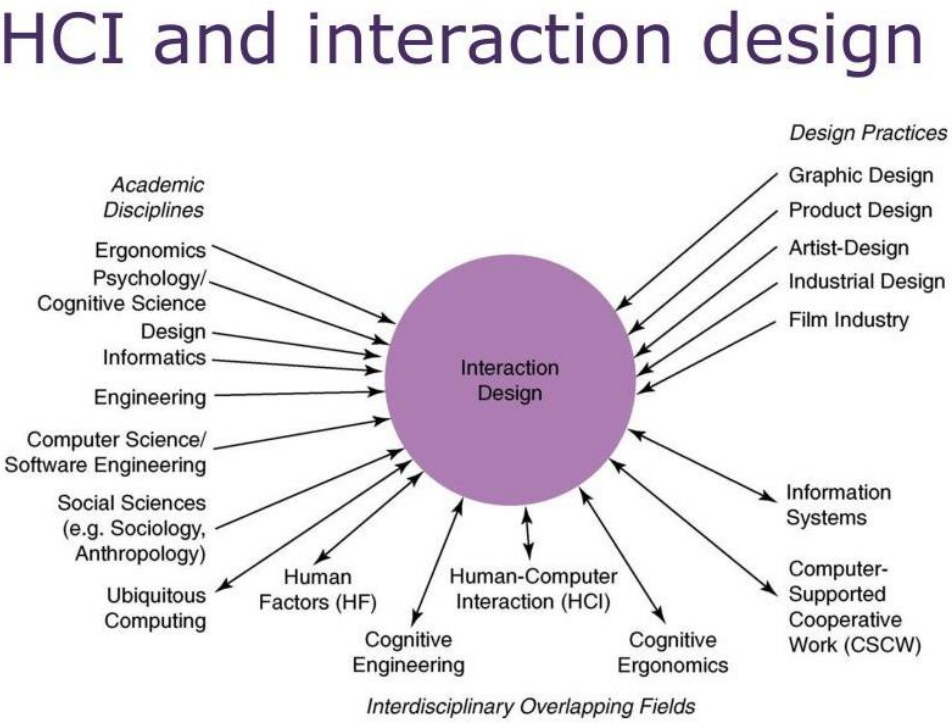

Figure 13 - Relationship among contributing academic disciplines, design practices, and interdisciplinary fields concerned with interaction design (double-headed arrows mean overlapping

We have already described the distinction between interaction design and software engineering. The differences between interaction design and the other approaches referred to in the figure are largely down to which methods, philosophies, and lenses they use to study, analyze, and design computers. Another way they vary is in terms of the scope and problems they address. For example, Information Systems is concerned with the application of computing technology in domains like business, health, and education, whereas Computer-Supported Cooperative Work (CSCW) is concerned with the need also to support multiple people working together using computer systems (Greif, 1988).

Who Is Involved in Interaction Design?

In Figure 13 it can be seen that many people are involved, ranging from social scientists to movie-makers. This is not surprising given that technology has become such a pervasive part of our lives. But it can all seem rather bewildering to the onlooker.

How does the mix of players work together in interactive design?

Designers - Designers need to know many different things about users, technologies, and interactions between them in order to create effective user experiences. At the very least, they need to understand how people act and react to events and how they communicate and interact with each other. To be able to create engaging user experiences, they also need to understand how emotions work, what is meant by aesthetics, desirability, and the role of narrative in human experience.

Developers - Developers also need to understand the business side, the technical side, the manufacturing side, and the marketing side. Clearly, it is difficult for one person to be well versed in all of these diverse areas and also know how to apply the different forms of knowledge to the process of interaction design. Interaction design is mostly carried out by multidisciplinary teams, where the skill sets of engineers, designers, programmers, psychologists, anthropologists, sociologists, artists, toy makers, and others are drawn upon. It is rarely the case, however, that a design team would have all of these professionals working together. Who to include in a team will depend on a number of factors, including a company's design philosophy, its size, purpose, and product line.

One of the benefits of bringing together people with different backgrounds and training is the potential of many more ideas being generated, new methods developed, and more creative and original designs being produced. However, the downside is the costs involved. The more people there are with different backgrounds in a design team, the more difficult it can be to communicate and make progress forward with the designs being generated. Why? People with different backgrounds have different perspectives and ways of seeing and talking about the world. What one person values as important others may not even see (Kim, 1990). Similarly, a computer scientist's understanding of

the term 'representation' is often very different from a graphic designer's or a psychologist.

What this means in practice is that confusion, misunderstanding, and communication breakdowns can surface in a team. The various team members may have different ways of talking about design and may use the same terms to mean quite different things. Other problems can arise when a group of people who have not previously worked as a team is thrown together. For example, Philips found that its multidisciplinary teams that were responsible for developing ideas and products for the future experienced a number of difficulties, namely that project team members did not always have a clear idea of who needed what information, when, and in what form (Lambourne et al, 1997).

Activity

In practice, the makeup of a given design team depends on the kind of interactive product being built. Who do you think should be involved in developing:

1. A public kiosk providing information about the exhibits available in a science museum?
2. An interactive educational website to accompany a TV series?

Comment

Ideally, each team will have a number of different people with different skill sets. For example, the first interactive product would include: -

- Graphic and interaction designers, museum curators, educational advisers, software engineers, software designers, ergonomists.

The second project would include: -

- TV producers, graphic and interaction designers, teachers, video experts, software engineers, software designers.

In addition, as both systems are being developed for use by the general public, representative users, such as school children and parents, should be involved.

In practice, design teams often end up being quite large, especially if they are working on a big project to meet a fixed deadline. For example, it is common to find teams of 15 people or more working on a website project for an extensive period of time, like six months. This means that a number of people from each area of expertise are likely to be working as part of the project team.

Interaction Design Consultants

Interaction design is now widespread in product development. In particular, website consultants, global corporations, and the computing industries have all realized its pivotal role in successful interactive products. The presence or absence of good interaction design can make or break a company. To get noticed in the highly

competitive field of web products requires standing out. Being able to say that your product is easy, effective, and engaging to use is seen as central to this. Marketing departments are also realizing how branding, the number of hits, customer return rate, and customer satisfaction are greatly affected by the usability of a website.

There are many interaction design consultancies now. These include established companies, such as Cooper, Nielsen Norman Group, and IDEO, and more recent ones that specialize in a particular area, such as job board software (e.g., Madgex) or mobile design (e.g., CX partners). IDEO is a large global enterprise, with branches across the world and 30 years of experience in the area. They design products, services, and environments for other companies, pioneering new user experiences (Spreenberg et al, 1995). They have developed thousands of products for numerous clients, each time following their particular brand of interaction design (see Figure 1.5). Some of their most famous designs include the first mouse used by Apple, the Palm V and mMode, the integrated service platform for AT&T cell phones. They were also involved in the design of the TiVo system. More recently, they have focused on designing solutions with climate change at the forefront. Their approach emphasizes design thinking and lies at the intersection of insight and inspiration, informed by business, technology, and culture.

Figure 14 - An innovative product developed by IDEO: wireless cell phones for Telespree. The phones were designed to be inexpensive, playful, and very simple to use, employing voice recognition for driving the interaction and only one button, for turning them on and off

The User Experience

The user experience (UX) is central to interaction design. By this it is meant how a product behaves and is used by people in the real world. Nielsen and Norman (2014)

define it as encompassing "all aspects of the end-user's interaction with the company, its services, and its products."

As stressed by Garrett (2010, p. 10), "every product that is used by someone has a user experience: newspapers, ketchup bottles, reclining armchairs, cardigan sweaters." More specifically, it is about how people feel about a product and their pleasure and satisfaction when using it, looking at it, holding it, and opening or closing it. It includes their overall impression of how good it is to use, right down to the sensual effect small details have on them, such as how smoothly a switch rotates or the sound of a click and the touch of a button when pressing it. An important aspect is the quality of the experience someone has, be it a quick one, such as topping up a cell phone, a leisurely one, such as playing with an interactive toy, or an integrated one, such as visiting a museum (Law et al, 2009).

It is important to point out that one cannot design a user experience, only design for a user experience. In particular, one cannot design a sensual experience, but only create the design features that can evoke it. For example, the outside case of a cell phone can be designed to be smooth, silky, and fit in the palm of a hand; when held, touched, looked at, and interacted with, that can provoke a sensual and satisfying user experience. Conversely, if it is designed to be heavy and awkward to hold, it is much more likely to end up providing a poor user experience, one that is uncomfortable and unpleasant.

Designers sometimes refer to UX as UXD. The addition of the D to UX is meant to encourage design thinking that focuses on the quality of the user experience rather than on the set of design methods to use (Allan wood and Beare, 2014). As Norman (2004) has stressed for many years, "It is not enough that we build products that function, that are understandable and usable, we also need to build joy and excitement, pleasure and fun, and yes, beauty to people's lives."

Activity 2
The iPod phenomenon

Apple's classic (and subsequent) generations of iPods (e.g., Touch, Nano, Shuffle) have been a phenomenal success. How do you think this happened?

Comment

Apple realized early on that successful interaction design involves creating interactive products that have a quality user experience. The sleek appearance of the iPod music player (see Figure 1.6), its simplicity of use, its elegance in style, its distinct family of rainbow colors, a novel interaction style that many people discovered was a sheer pleasure to learn and use, the catchy naming of its product and content (iTunes, iPod), among many other design features, led to it becoming one of the greatest of its kind and a must-have fashion item for teenagers, students, and others alike. While there

were many competing players on the market at the time – some with more powerful functionality, others that were cheaper and easier to use, or with bigger screens and more memory, and so on – the quality of the overall user experience paled in comparison with that provided by the iPod.

Figure 15 - the iPad Nano touch

There are many aspects of the user experience that can be considered and ways of taking them into account when designing interactive products. Of central importance are the usability, the functionality, the aesthetics, the content, the look and feel, and the sensual and emotional appeal. In addition, Carroll (2004) stresses other wide-reaching aspects, including fun, health, social capital (the social resources that develop and are maintained through social networks, shared values, goals, and norms), and cultural identity, e.g., age, ethnicity, race, disability, family status, occupation, education. At a more subjective level, McCarthy and Wright (2004) discuss the importance of people's expectations and the way they make sense of their experiences when using technology.

How realistic is it for interaction designers to take all of these factors (and potentially many others) into account and, moreover, be able to translate and combine them to produce quality user experiences? Put frankly, there is no magic formula to help them. As of yet, there isn't a unifying theory or framework that can be readily applied by interaction designers. However, there are numerous conceptual frameworks, tried and tested design methods, guidelines, and many relevant research findings – these are described throughout the book. Here, we begin by outlining the process and goals of interaction design.

More generally, McCarthy and Wright's (2004) Technology as Experience framework accounts for the user experience largely in terms of how it is felt by the user. They recognize that defining experience is incredibly difficult because it is so nebulous and ever-present to us, just as swimming in water is to a fish. Nevertheless, they have tried to capture the essence of human experience by describing it in both holistic and metaphorical terms. These comprise a balance of sensual, cerebral, and emotional

threads. Their framework draws heavily from the philosophical writings of Dewey and Pragmatism, which focus on the sense-making aspects of human experience. As Dewey (1934) points out: "Emotion is the moving and cementing force. It selects what is congruous and dyes what is selected with its color, thereby giving qualitative unity to materials externally disparate and dissimilar. It thus provides unity in and through the varied parts of experience."

McCarthy and Wright propose four core threads that make up our holistic experiences: sensual, emotional, compositional, and spatio- temporal: -

1. **The sensual thread** - This is concerned with our sensory engagement with a situation and is similar to the visceral level of Norman's model. It can be equated with the level of absorption people have with various technological devices and applications, most notable being computer games, smartphones, and chat rooms, where users can be highly absorbed in their interactions at a sensory level. These can involve thrill, fear, pain, and comfort.
2. **The emotional thread** - Common examples of emotions that spring to mind are sorrow, anger, joy, and happiness. In addition, the framework points out how emotions are intertwined with the situation in which they arise – e.g., a person becomes angry with a computer because it does not work properly. Emotions also involve making judgments of value. For example, when purchasing a new cell phone, people may be drawn to the ones that are most cool-looking but be in an emotional turmoil because they are the most expensive. They can't really afford them but they really would like one of them.
3. **The compositional thread** - This is concerned with the narrative part of an experience, as it unfolds, and the way a person makes sense of it. For example, when shopping online, the options laid out to people can lead them in a coherent way to making a desired purchase or they can lead to frustrating experiences resulting in no purchase being made. When in this situation, people ask themselves questions such as: What is this about? Where am I? What has happened? What is going to happen next? What would happen if? The compositional thread is the internal thinking we do during our experiences.
4. **The spatio-temporal thread** - This refers to the space and time in which our experiences take place and their effect upon those experiences. There are many ways of thinking about space and time and their relationship with one another: for example, we talk of time speeding up, standing still, and slowing down, while we talk of space in terms of public and personal places, and needing one's own space.

The threads are meant as ideas to help designers think and talk more clearly and concretely about the relationship between technology and experience. By describing an experience in terms of its interconnected aspects, the framework can aid thinking about the whole experience of a technology rather than as fragmented aspects, e.g. its

usability, its marketability, or its utility. For example, when buying clothes online, the framework can be used to capture the whole gamut of experiences, including: the fear or joy of needing to buy a new outfit; the time and place where it can be purchased, e.g., online stores or shopping mall; the tensions of how to engage with the vendor,

e.g., the pushy sales assistant or an anonymous website; the value judgment involved in contemplating the cost and how much one is prepared to spend; the internal monologue that goes on where questions are asked such as will it look good on me, what size should I buy, do I have shoes to match, do I need to try it on, how easy will it be to wash, will I need to iron it each time, and how often will I be able to wear it? All of these aspects can be described in terms of the four threads and in so doing highlight which aspects are more important for a given product. For example, if you were to do this exercise when buying a new car versus a domestic energy-saving device, you would find you would get quite different descriptions.

The Process of Interaction Design

The process of interaction design involves four basic activities: -

1. Establishing requirements
2. Designing alternatives
3. Prototyping
4. Evaluating.

These activities are intended to inform one another and to be repeated. For example, measuring the usability of what has been built in terms of whether it is easy to use provides feedback that certain changes must be made or that certain requirements have not yet been met. Eliciting responses from potential users about what they think and feel about what has been designed, in terms of its appeal, touch, engagement, usefulness, and so on, can help explicate the nature of the user experience that the product evokes.

Evaluating what has been built is very much at the heart of interaction design. Its focus is on ensuring that the product is appropriate. It is usually addressed through a user-centered approach to design, which, as the name suggests, seeks to involve users throughout the design process. There are many different ways of achieving this: for example, through observing users, talking to them, interviewing them, modeling their performance, asking them to fill in questionnaires, and even asking them to become co-designers. The findings from the different ways of engaging and eliciting knowledge from users are then interpreted with respect to ongoing design activities.

Equally important as involving users when evaluating an interactive product is understanding what people do. Chapters 3, 4, and 5 explain in detail how people act and interact with one another, with information, and with various technologies, together with describing their abilities, emotions, needs, desires, and what causes them to get annoyed, frustrated, lose patience, and get bored. Such knowledge can greatly help

designers determine which solutions to choose from the many design alternatives available, and how to develop and test these further.

A main reason for having a better understanding of people in the contexts in which they live, work, and learn is that it can help designers understand how to design interactive products that will fit those niches. A collaborative planning tool for a space mission, intended to be used by teams of scientists working in different parts of the world, will have quite different needs from one targeted at customer and sales agents, to be used in a furniture store to draw up kitchen layout plans. Understanding the differences between people can also help designers appreciate that one size does not fit all; what works for one user group may be totally inappropriate for another. For example, children have different expectations than adults about how they want to learn or play. They may find having interactive quizzes and cartoon characters helping them along to be highly motivating, whereas most adults find them annoying. Conversely, adults often like talking-heads discussions about topics, but children find them boring. Just as everyday objects like clothes, food, and games are designed differently for children, teenagers, and adults, so interactive products should be designed for different kinds of user.

Learning more about people and what they do can also reveal incorrect assumptions that designers may have about particular user groups and what they need. For example, it is often assumed that because of deteriorating vision and dexterity, old people want things to be big – be it text or graphical elements appearing on a screen or the physical controls, like dials and switches, used to control devices. This may be true for some old people, but studies have shown that many people in their 70s, 80s, and older are perfectly capable of interacting with standard-size information and even small interfaces, e.g., cell phones, just as well as those in their teens and 20s, even though, initially, some might think they will find it difficult (Siek et al, 2005). It is increasingly the case that as people get older, they do not like to consider themselves as lacking in cognitive and manual skills. Being aware of people's sensitivities is as important as knowing how to design for their capabilities.

Being aware of cultural differences is also an important concern for interaction design, particularly for products intended for a diverse range of user groups from different countries. An example of a cultural difference is the dates and times used in different countries. In the USA, for example, the date is written as month, day, year (e.g. 05/21/15) whereas in other countries it is written in the sequence of day, month, year (e.g. 21/05/15). This can cause problems to designers when deciding on the format of online forms, especially if intended for global use. It is also a concern for products that have time as a function, e.g., operating systems, digital clocks, car dashboards. Which cultural group do they give preference to? How do they alert users to the format that is set as default? This raises the question of how easily an interface designed for one user group can be used and accepted by another (Callahan, 2005). Moreover, why is it that

certain products, like the iPod, are universally accepted by people from all parts of the world, whereas websites are designed differently and reacted to differently by people from different cultures?

As well as there being standard differences in the way cultures communicate and represent information, designers from different cultures (that can be cross- or within-country) will often use different form factors, images, and graphical elements when creating products and dialog features for an interface. This can take the form of contrasting designs, where different colors, types of images, and structuring of information are used to appeal to people in different countries.

Accessibility

Accessibility refers to the degree to which an interactive product is accessible by as many people as possible. A focus is on people with disabilities.

But what does it mean to be disabled? Definitions vary, but the following captures the main points. People are considered to be disabled if: -

- They have a mental or physical impairment.
- The impairment has an adverse effect on their ability to carry out normal day-to-day activities.
- The adverse effect is substantial and long term (meaning it has lasted for 12 months, or is likely to last for more than 12 months or for the rest of their life).

Whether or not a person is considered to be disabled changes over time with age, or as recovery from an accident progresses. In addition, the severity and impact of an impairment can vary over the course of a day or in different environmental conditions.

It is quite common, when people first consider the topic of accessibility and interaction design, to consider it largely in terms of a specific physical disability, such as the inability to walk or being visually impaired. However, it can often be the case that a person will have more than one disability.

There is a wide range of disabilities including: -

- **Color-blindness** - The inability to distinguish between two colors affects approximately 1 in 10 men and 1 in 200 women. This has an impact on the use of color for highlighting or distinguishing interface elements.
- **Dyslexia** - Although usually associated with difficulties in reading and writing, there are many different forms of dyslexia, some of which affect the way in which people comprehend the totality of concepts. A relatively simple interaction design decision that can cause difficulties for people with dyslexia is the contrast between foreground and background text or images.
- **Physical impairments** - These range from conditions such as tremor or shaking, weakness, pain, reduced control of limbs, inability to sit upright, to short or missing limbs.

Quesenbery (2009) comments on how accessibility is often considered as making sure there aren't any barriers to access for assistive technologies but without regard to usability, while usability usually targets everyone who uses a site or product, without considering people who have disabilities. The challenge is to create a good user experience for people with disabilities that is both accessible and usable.

Interaction Design and the User Experience

Part of the process of understanding users is to be clear about the primary objective of developing an interactive product for them. Is it to design an efficient system that will allow them to be highly productive in their work, or is it to design a learning tool that will be challenging and motivating, or is it something else? To help identify the objectives we suggest classifying them in terms of usability and user experience goals. Traditionally, usability goals have been viewed as being concerned with meeting specific usability criteria, e.g., efficiency, whereas, more recently, user experience goals have been concerned with explicating the nature of the user experience, e.g., to be aesthetically pleasing. It is important to note, however, that the distinction between the two types of goal is not clear-cut, since usability is fundamental to the quality of the user experience and, conversely, aspects of the user experience, such as how it feels and looks, are inextricably linked with how usable the product is. We distinguish between them here to help clarify their roles but stress the importance of considering them together when designing for a user experience. Also, historically, HCI was concerned primarily with usability (known as usability engineering) but has since become concerned with understanding, designing for, and evaluating a wider range of user experience aspects.

Usability Goals

Usability refers to 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, at school, and in their everyday lives.

More specifically, usability is broken down into the following goals: -

- Effective to use (effectiveness) - effectiveness is a very general goal and refers to how good a product is at doing what it is supposed to do
- Efficient to use (efficiency) - Efficiency refers to the way a product supports users in carrying out their tasks.
- Safe to use (safety) - Safety involves protecting the user from dangerous conditions and undesirable situations.
- Having good utility (utility) - Utility refers to the extent to which the product provides the right kind of functionality so that users can do what they need or want to do.

- Easy to learn (learnability) - Learnability refers to how easy a system is to learn to use. It is well known that people don't like spending a long time learning how to use a system.
- Easy to remember how to use (memorability) - Memorability refers to how easy a product is to remember how to use, once learned. This is especially important for interactive products that are used infrequently.

Usability goals are typically operationalized as questions. The purpose is to provide the interaction designer with a concrete means of assessing various aspects of an interactive product and the user experience. Through answering the questions, designers can be alerted very early on in the design process to potential design problems and conflicts that they might not have considered. However, simply asking 'is the system easy to learn?' is not going to be very helpful. Asking about the usability of a product in a more detailed way – for example, 'how long will it take a user to figure out how to use the most basic functions for a new smartwatch; how much can they capitalize on from their prior experience; and how long would it take a user to learn the whole set of functions?' – will elicit far more information. Below we give a description of each goal and a question for each one.

Effectiveness - effectiveness is a very general goal and refers to how good a product is at doing what it is supposed to do.

Question: Is the product capable of allowing people to learn, carry out their work efficiently, access the information they need, or buy the goods they want?

Efficiency - Efficiency refers to the way a product supports users in carrying out their tasks. The marble answering machine described at the beginning of this chapter was considered efficient in that it let the user carry out common tasks, e.g., listening to messages, through a minimal number of steps. In contrast, the voice mail system was considered inefficient because it required the user to carry out many steps and learn an arbitrary set of sequences for the same common task. This implies that an efficient way of supporting common tasks is to let the user use single button or key presses. An example of where this kind of efficiency mechanism has been employed effectively is in online shopping. Once users have entered all the necessary personal details in an online form to make a purchase, they can let the website save all their personal details. Then, if they want to make another purchase at that site, they don't have to re-enter all their personal details again. A highly successful mechanism patented by Amazon.com is the one-click option, which requires users only to click a single button when they want to make another purchase.

Question: Once users have learned how to use a product to carry out their tasks, can they sustain a high level of productivity?

Safety - Safety involves protecting the user from dangerous conditions and undesirable situations. In relation to the first ergonomic aspect, it refers to the external conditions

where people work. For example, where there are hazardous conditions – such as X-ray machines or toxic chemicals – operators should be able to interact with and control computer-based systems remotely. The second aspect refers to helping any kind of user in any kind of situation avoid the dangers of carrying out unwanted actions accidentally. It also refers to the perceived fears users might have of the consequences of making errors and how this affects their behavior. To make interactive products safer in this sense involves (i) preventing the user from making serious errors by reducing the risk of wrong keys/buttons being mistakenly activated (an example is not placing the quit or delete-file command right next to the save command on a menu) and (ii) providing users with various means of recovery should they make errors. Safe interactive systems should engender confidence and allow the user the opportunity to explore the interface to try out new operations (see Figure 1.8a). Other safety mechanisms include undo facilities and confirmatory dialog boxes that give users another chance to consider their intentions (a well-known example is the appearance of a dialog box, after issuing the command to delete everything in the trashcan, saying: 'Are you sure you want to remove all the items in the Trash permanently?'

Question: What is the range of errors that are possible using the product and what measures are there to permit users to recover easily from them?

Utility - Utility refers to the extent to which the product provides the right kind of functionality so that users can do what they need or want to do. An example of a product with high utility is an accounting software package that provides a powerful computational tool that accountants can use to work out tax returns. An example of a product with low utility is a software drawing tool that does not allow users to draw freehand but forces them to use a mouse to create their drawings, using only polygon shapes.

Question: Does the product provide an appropriate set of functions that will enable users to carry out all their tasks in the way they want to do them?

Learnability - Learnability refers to how easy a system is to learn to use. It is well known that people don't like spending a long time learning how to use a system. They want to get started straight away and become competent at carrying out tasks without too much effort. This is especially so for interactive products intended for everyday use (e.g., social media, email, GPS) and those used only infrequently (e.g. online tax forms). To a certain extent, people are prepared to spend longer learning more complex systems that provide a wider range of functionality, like web authoring tools. In these situations, pop-up tutorials can help by providing contextualized step-by-step material with hands-on exercises. Akey concern is determining how much time users are prepared to spend learning a product. It seems a waste if a product provides a range of functionality that the majority of users are unable or not prepared to spend time learning how to use.

Question: Is it possible for the user to work out how to use the product by exploring the interface and trying out certain actions? How hard will it be to learn the whole set of functions in this way?

Memorability - Memorability refers to how easy a product is to remember how to use, once learned. This is especially important for interactive products that are used infrequently. If users haven't used an operation for a few months or longer, they should be able to remember or at least rapidly be reminded how to use it. Users shouldn't have to keep relearning how to carry out tasks. Unfortunately, this tends to happen when the operations required to be learned are obscure, illogical, or poorly sequenced. Users need to be helped to remember how to do tasks. There are many ways of designing the interaction to support this. For example, users can be helped to remember the sequence of operations at different stages of a task through meaningful icons, command names, and menu options. Also, structuring options and icons so they are placed in relevant categories of options, e.g., placing all the drawing tools in the same place on the screen, can help the user remember where to look to find a particular tool at a given stage of a task.

Question: What kinds of interface support have been provided to help users remember how to carry out tasks, especially for products and operations they use infrequently?

As well as couching usability goals in terms of specific questions, they are turned into usability criteria. These are specific objectives that enable the usability of a product to be assessed in terms of how it can improve (or not) a user's performance. Examples of commonly used usability criteria are time to complete a task (efficiency), time to learn a task (learnability), and the number of errors made when carrying out a given task over time (memorability). These can provide quantitative indicators of the extent to which productivity has increased, or how work, training, or learning have been improved. They are also useful for measuring the extent to which personal, public, and home-based products support leisure and information-gathering activities. However, they do not address the overall quality of the user experience, which is where user experience goals come into play.

Many of these are subjective qualities and are concerned with how a system feels to a user. They 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. Whereas the terms used to describe usability goals comprise a small distinct set, many more terms are used to describe the multifaceted nature of the user experience. They also overlap with what they are referring to. In so doing, they offer subtly different options for expressing the way an experience varies for the same activity over time, technology, and place. For example, we may describe listening to music in the shower as highly pleasurable, but consider it more apt to describe listening to music in the car as

enjoyable. Similarly, listening to music on a high-end powerful music system may invoke exciting and emotionally fulfilling feelings, while listening to it on an iPod Shuffle may be serendipitously enjoyable, especially not knowing what tune is next. The process of selecting terms that best convey a user's feelings, state of being, emotions, sensations, and so forth when using or interacting with a product at a given time and place can help designers understand the multifaceted and changing nature of the user experience.

Design Principles

Design principles are used by interaction designers to aid their thinking when designing for the user experience. These are generalizable abstractions intended to orient designers towards thinking about different aspects of their designs. A well-known example is feedback: products should be designed to provide adequate feedback to the users to ensure they know what to do next in their tasks.

Another one that has become increasingly important is findability (Morville, 2005). This refers to the degree to which a particular object is easy to discover or locate – be it navigating a website, moving through a building, or finding the delete image option on a digital camera.

Design principles are derived from a mix of theory-based knowledge, experience, and common sense. They tend to be written in a prescriptive manner, suggesting to designers what to provide and what to avoid at the interface – if you like, the dos and don'ts of interaction design. More specifically, they are intended to help designers explain and improve their designs (Thimbleby, 1990). However, they are not intended to specify how to design an actual interface, e.g., telling the designer how to design a particular icon or how to structure a web portal, but act more like triggers to designers, ensuring that they have provided certain features at an interface.

A number of design principles have been promoted. The best known are concerned with how to determine what users should see and do when carrying out their tasks using an interactive product.

Here we briefly describe the most common ones: -

- Visibility - The visibility refers to the system visibility to the user. How visible the function of the system to the user.
- Feedback - Feedback involves sending back information about what action has been done and what has been accomplished, allowing the person to continue with the activity.
- Constraints - The design concept of constraining refers to determining ways of restricting the kinds of user interaction that can take place at a given moment.
- Consistency - This refers to designing interfaces to have similar operations and use similar elements for achieving similar tasks. In particular, a consistent

interface is one that follows rules, such as using the same operation to select all objects.

- Affordance - This is a term used to refer to an attribute of an object that allows people to know how to use it.

Visibility

The visibility refers to the system visibility to the user. How visible the function of the system to the user. The importance of visibility is exemplified by our contrasting examples at the beginning of the chapter. The voice mail system made the presence and number of waiting messages invisible, while the answer machine made both aspects highly visible. The more visible functions are, the more likely it is that users will be able to know what to do next. Norman (1988) describes the controls of a car to emphasize this point. The controls for different operations are clearly visible, e.g., indicators, headlights, horn, hazard warning lights, indicating what can be done. The relationship between the way the controls have been positioned in the car and what they do makes it easy for the driver to find the appropriate control for the task at hand.

In contrast, when functions are out of sight, it makes them more difficult to find and know how to use. For example, devices and environments that have become automated through the use of sensor technology (usually for hygiene and energy-saving reasons) – like faucets, elevators, and lights – can sometimes be more difficult for people to know how to control, especially how to activate or deactivate them. This can result in people getting caught out and frustrated. Highly visible controlling devices, like knobs, buttons, and switches, which are intuitive to use, have been replaced by invisible and ambiguous activating zones where people have to guess where to move their hands, bodies, or feet on, into, or in front of to make them work.

Feedback

Related to the concept of visibility is feedback. This is best illustrated by an analogy to what everyday life would be like without it. Imagine trying to play a guitar, slice bread using a knife, or write using a pen if none of the actions produced any effect for several seconds. There would be an unbearable delay before the music was produced, the bread was cut, or the words appeared on the paper, making it almost impossible for the person to continue with the next strum, cut, or stroke.

Feedback involves sending back information about what action has been done and what has been accomplished, allowing the person to continue with the activity. Various kinds of feedback are available for interaction design – audio, tactile, verbal, visual, and combinations of these. Deciding which combinations are appropriate for different kinds of activities and interactivities is central. Using feedback in the right way can also provide the necessary visibility for user interaction.

Constraints

The design concept of constraining refers to determining ways of restricting the kinds of user interaction that can take place at a given moment. There are various ways this can be achieved. A common design practice in graphical user interfaces is to deactivate certain menu options by shading them gray, thereby restricting the user only to actions permissible at that stage of the activity (see Figure 1.11). One of the advantages of this form of constraining is that it prevents the user from selecting incorrect options and thereby reduces the chance of making a mistake. The use of different kinds of graphical representations can also constrain a person's interpretation of a problem or information space. For example, flow chart diagrams show which objects are related to which, thereby constraining the way the information can be perceived. The physical design of a device can also constrain how it is used; for example, the external slots in a computer have been designed to only allow a cable or card to be inserted in a certain way.

Consistency

This refers to designing interfaces to have similar operations and use similar elements for achieving similar tasks. In particular, a consistent interface is one that follows rules, such as using the same operation to select all objects. For example, a consistent operation is using the same input action to highlight any graphical object at the interface, such as always clicking the left mouse button. Inconsistent interfaces, on the other hand, allow exceptions to a rule. An example is where certain graphical objects (e.g., email messages presented in a table) can be highlighted only by using the right mouse button, while all other operations are highlighted using the left button. Aproblem with this kind of inconsistency is that it is quite arbitrary, making it difficult for users to remember and making the users more prone to mistakes.

One of the benefits of consistent interfaces, therefore, is that they are easier to learn and use. Users have to learn only a single mode of operation that is applicable to all objects. This principle works well for simple interfaces with limited operations, such as a portable radio with a small number of operations mapped onto separate buttons. Here, all the user has to do is learn what each button represents and select accordingly. However, it can be more problematic to apply the concept of consistency to more complex interfaces, especially when many different operations need to be designed for. For example, consider how to design an interface for an application that offers hundreds of operations, e.g., a word-processing application. There is simply not enough space for a thousand buttons, each of which maps onto an individual operation. Even if there were, it would be extremely difficult and time-consuming for the user to search through them all to find the desired operation. A much more effective design solution is to create categories of commands that can be mapped into subsets of operations.

Affordance

This is a term used to refer to an attribute of an object that allows people to know how to use it. For example, a mouse button invites pushing (in so doing activating clicking) by the way it is physically constrained in its plastic shell. At a simple level, to afford means 'to give a clue' (Norman, 1988). When the affordances of a physical object are perceptually obvious, it is easy to know how to interact with it. For example, a door handle affords pulling, a cup handle affords grasping, and a mouse button affords pushing. The term has since been much popularized in interaction design, being used to describe how interfaces should make it obvious as to what can be done at them. For example, graphical elements like buttons, icons, links, and scrollbars are talked about with respect to how to make it appear obvious how they should be used: icons should be designed to afford clicking, scrollbars to afford moving up and down, buttons to afford pushing.

Norman (1999) suggests that there are two kinds of affordance: perceived and real. Physical objects are said to have real affordances, like grasping, that are perceptually obvious and do not have to be learned. In contrast, user interfaces that are screen-based are virtual and do not have these kinds of real affordances. Using this distinction, he argues that it does not make sense to try to design for real affordances at the interface – except when designing physical devices, like control consoles, where affordances like pulling and pressing are helpful in guiding the user to know what to do. Alternatively, screen-based interfaces are better conceptualized as perceived affordances, which are essentially learned conventions.

There are numerous websites and guidebooks that provide more exhaustive sets of design principles that we have just touched upon here, with specific examples for designing for the web, GUIs, and, more generally, interaction design.

Applying Design Principles in Practice

One of the problems of applying more than one of the design principles in interaction design is that trade-offs can arise between them. For example, the more you try to constrain an interface, the less visible information becomes. The same can also happen when trying to apply a single design principle. For example, the more an interface is designed to afford through trying to resemble the way physical objects look, the more it can become cluttered and difficult to use. Consistency can be a problematic design principle; trying to design an interface to be consistent with something can make it inconsistent with something else. Furthermore, sometimes inconsistent interfaces are actually easier to use than consistent interfaces. This is illustrated by Grudin's (1989) use of the analogy of where knives are stored in a house. Knives come in a variety of forms, e.g. butter knives, steak knives, table knives, fish knives. An easy place to put them all and subsequently locate them is in the top drawer by the sink. This makes it easy for everyone to find them and follows a simple consistent rule. But what about the

knives that don't fit or are too sharp to put in the drawer, like carving knives and bread knives? They are placed in a wooden block. And what about the best knives kept only for special occasions? They are placed in the cabinet in another room for safekeeping. And what about other knives like putty knives and paint-scraping knives used in home projects (kept in the garage) and jack-knives (kept in one's pockets or backpack)? Very quickly the consistency rule begins to break down.

Grudin notes how, in extending the number of places where knives are kept, inconsistency is introduced, which in turn increases the time needed to learn where they are all stored. However, the placement of the knives in different places often makes it easier to find them because they are at hand for the context in which they are used and are also next to the other objects used for a specific task, e.g., all the home project tools are stored together in a box in the garage. The same is true when designing interfaces: introducing inconsistency can make it more difficult to learn an interface but in the long run can make it easier to use.