ANALYSIS OF GRAPHICAL USER INTERFACE DESIGN IN THE CONTEXT OF HUMAN-COMPUTER INTERACTION (WITH A CASE STUDY ON OVEN CONTROL PANEL)

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ABSTRACT

In this era that the popularity of digital products has risen, computer and its tools affect every part of our lives. New technologies provide extraordinary powers to those people who master them. Digital products and their graphical user interfaces are still new technologies that are being rapidly disseminated. Human performance in the use of digital product will remain a rapidly expanding research and development topic in the coming decades. For this reason, the importance of interaction between digital product and user should be considered.

The term "Graphical user interface" is the layer where the digital product communicated with human and human communicated with digital product. A well-designed product can fail with an unsuccessful interface. Conversely, a product has not good design values can become successful with its well-designed interface. To get best interaction between digital product and user, the graphical interface design itself has some rudimentary design values like user-friendliness, usability, easy to learn, etc.

At an individual level, user interfaces change many people's lives. For instance, doctors can make diagnoses that are more accurate, children can learn more effectively and technicians can manipulate their job more safely. Some changes, however, are disruptive; too often, users must cope with frustration, fear, and failure when they encounter excessive complexity, incomprehensible terminology, or chaotic layouts. Designers are exploring how best to organize information graphically. They are developing query languages and visually attractive facilities. Techniques such as direct-manipulation, telepresence, and virtual realities may change the ways that we interact with and think about digital products. Consequently, the goal of making the user's quality of life better is important to keep in mind.

In this research, from the point of an industrial designer's view, the subject matter 'Graphical user interface design', and its all interaction rules with user are evaluated. In terms of design language, which has the ability of understand the user behavior, it puts the subject matter on the agenda to explore recipe of a successful product.

ÖZ

Dijital ürünlerin popülaritesinin arttığı çağımızda, bilgisayar ve araçları hayatımızın her parçasını etkilemektedir. Yeni teknolojiler, bu ürünleri ve araçlarını kullananlara alışılmamış bir güç sağlamaktadır. Dijital ürünler ve onların grafiksel arayüzleri, hala hızla yayılan yeni teknolojilerdir. Yakın gelecekte, dijital ürünlerin kullanımı içinde insan performansı, hızla genişleyen bir araştırma-geliştirme konusu olarak kalacaktır. Bu nedenle dijital ürün ve kullanıcı arasındaki iletişim tasarımının önemi göz önünde tutulmalıdır.

Grafiksel arayüz terimi dijital ürünün insanla, insanın dijital ürünle iletişim kurduğu ara tabaka anlamına gelir. İyi tasarlanmış bir ürün başarısız bir arayüzle başarısız olabilir. Tam tersine, iyi tasarım değerlerine sahip olmayan bir ürün ise iyi tasarlanmış bir arayüzle başarılı olabilir. Kullanıcı ve dijital ürün arasında en iyi etkileşimi elde etmek için grafiksel arayüzün kendisi kullanıcıyla iyi ilişkiler kurma, kullanılabilir olma, kolay öğrenilme gibi bazı temel tasarım değerlerine sahip olmalıdır.

Kullanıcı seviyesinde arayüzler bir çok insanın hayatını değiştirebilir. Örneğin doktorlar daha kesin ölçümler yapabilir, çocuklar daha kolay öğrenebilir, teknisyenler işlerini daha güvenle yapabilirler. Bazı değişikler ise bu örnekleri yadsır. Sıklıkla, kullanıcı aşırı kompleks, detaylı terminolojiye sahip karmakarışık taslaklarla karşı karşıya gelince hüsran, korku ve başarısızlıkla başa çıkmak zorundadır. Tasarımcılar bilgiyi en iyi şekilde organize etmenin yollarının aramaktadırlar. Yeni iletişim dilleri, görsel ve çekici olanaklar geliştirmektedirler. Direkt kullanım, görüntülü iletişim ve görsel gerçeklik dijital ürünlerle ilişki kurmamızı değiştirebilir. Sonuç olarak, kullanıcının yaşam kalitesini iyi tutma hedefi akılda tutulmalıdır.

Bu araştırmada, endüstriyel tasarımcının bakış açısından, asıl konu olan grafiksel arayüzün tasarımı ve onun kullanıcıyla etkileşim yöntemleri değerlendirilmiştir. Kullanıcı davranışını iyi tanımlayan bir tasarım diliyle bu çalışma, konunun öznesi olan başarılı bir ürün reçetesini araştırmayı gündeme getirmeyi amaçlar.

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CHAPTER 1

INTRODUCTION

1.1. Definition of the problem

Design includes the study of how people read and understand parts and wholes of products. Today, with 'ubiquitous computing', more and more products contain digital components whose technology is more difficult for the general user to understand. Currently digital products like an oven with an LCD control panel, personal digital assistants (PDAs), and cellular phones is designed by teams within which there are individuals from a variety of disciplines, but very few of whom are trained in defining the overall user experience. For this reason, such devices have scattered functionality and many features, which do not fit together because of their complex and in comprehensible graphical user interface. Instead of designing the device around functionality relevant to the consumer, these devices become simple platforms for features that fail to form into a cohesive unit. Without a clear direction, the usability of such technology appliances will surely suffer, as users become increasingly exhausted with scattered features and interaction models.

New technology seems to lead the industrial designer into new fields, and it is therefore essential to ask what role the industrial designer will and should play in the era of ubiquitous computing. How can the industrial designer contribute to giving digital products meaning and make people feel less alienated? It discusses the importance of the graphical user interface in design in the point of interaction, and in here, the future role of the industrial designer.

It should be the role of the industrial designer to define a product as a unified set of features and functions by creating a conceptual model of what the product is and how one should interact with it. Consequently, industrial design involves designing both for form and function, graphical user interface design is a natural extension of the industrial designer's domain.

1.2. Aims of the study

In the era that surrounded by ubiquitous computed products, product is the result of the integration of computer systems and industrial systems. So, the importance of how product interacts with user by its graphical user interface becomes more considerable. Digital product has been founded by team includes the experts coming from different disciplines such as, graphic design, computer and mechanical engineering, etc. It is possible to fail in the end product because of the integration problems of different approaching styles of distinct disciplines. Consequently, to get successfully designed digital product, it should be taken into account the leading of the industrial designer in the whole design process because of its inter-disciplinary characteristic.

The main purpose of this research is to guide the industrial designer reaching the well-designed digital product by giving some fundamentals about graphical user interface. Moreover, the information mentioned in this research lights the way for designing the digital product and its all components to industrial designer who undertakes the activitist role in the whole design process.

1.3. Method of the study

The study is comprised of five chapters. In the first introductory chapter, the aims and means of the study are defined. In the second chapter, elements of human graphical user interface interaction are evaluated in three sections. Human, interface, interaction are the basic parts of the product system and the user. In the boundaries of the research, elements are examined. The third chapter consists of the literatural analysis of the concepts, methods, phases, and design considerations about the design process. The fourth chapter is about designing graphical user interface of an oven. The necessary information about parts of oven is explained. The last chapter comprises the conclusion of the thesis to find an answer to the question of 'how the graphical user interface design of product is taken a step further to supply well founded user product interaction by criticizing and showing the basic of graphical user interface design according to universal design principles. This research is constructed by documentation review and observation.

CHAPTER 2

ELEMENTS OF HUMAN-GRAPHICAL USER INTERFACE INTERACTION

"Unlike machines, human minds can create ideas. We need ideas to guide us to progress, as well as tools to implement them… Computers do not have 'brains' anymore than stereos contain musical instruments… Machines only manipulate numbers; people connect them to meaning." (Penzias 1989)

Human-Computer Interaction is the relation of user and computer system. The whole progress becomes by interaction of the system with interface and the interface with user.

Firstly, to define the parts of interaction that are human and system, this chapter comprises the relation of human (user) with graphical user interface in the context of human- computer interaction. This interaction process is shown in Figure 2.1 in the point of use and context.

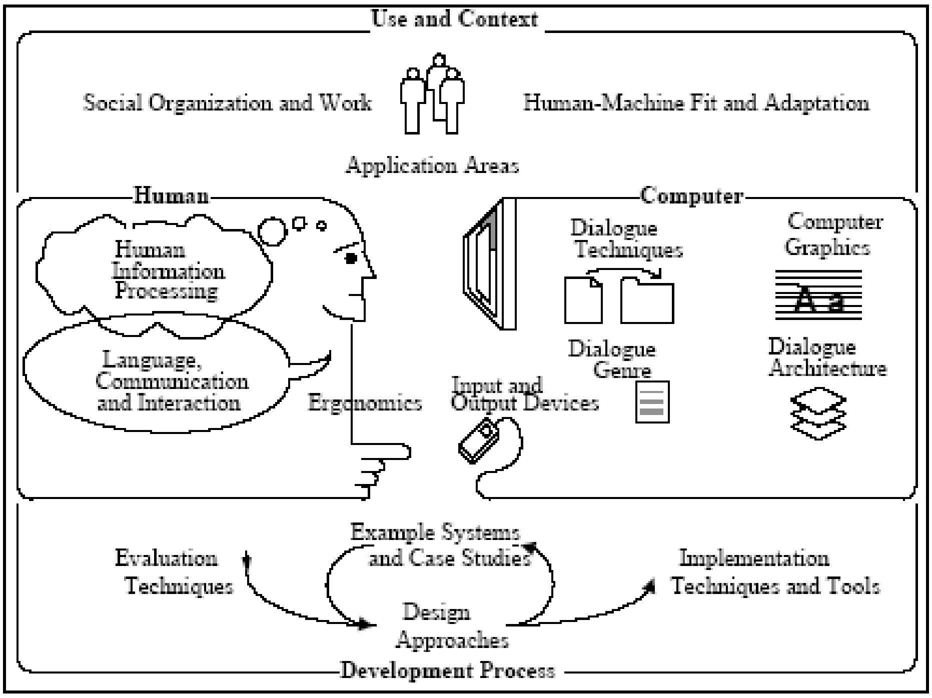


Figure 2.1. Map of Human-Computer Relation. (Source: Hewett 1992)

2.1. Overview on Human Graphical User Interface Interaction

A rough definition of human computer interaction, according to ACM SIGCHI (ACM (Association for Computing Machinery) Special Interest Group on Computer-Human Interaction Curriculum Development Group), is: "Human-computer interaction is a discipline concerned with the design, evaluation, and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.". WEB_1 (2003)

Human interface interaction in the large is an interdisciplinary area. It is emerging as a specialty concern within several disciplines, each with different emphases: computer science (application design and engineering of human interfaces), psychology (the application of theories of cognitive processes and the empirical analysis of user behavior), sociology and anthropology (interactions between technology, work, and organization), and industrial design (interactive digital products).

Design of graphical user interfaces is described as visual design. This should be seen as an integration of graphical components. Visual design disciplines are communication-oriented graphic design, industrial design, and architecture. Other visual disciplines like painting, sculpture, or photography have much in common but are less communication-oriented. In user interface design, the interaction with the human is the primary concern. This is also the main difference to print media. Although new electronic media differs greatly from print media in resolution, interaction possibilities, and animation, the knowledge gained from the print industry is applicable. As mentioned above visual design disciplines are communication-oriented, therefore the interaction between the human and the machine is the most important aspect.

Firstly, there is a need to define a meaningful digital product and its relation with its user for analyzing products for being human centered and usable. Digital products have already entered the market, and it is interesting to investigate the new design methods and styles that have been used for their design. In addition, these could be an application platform for discussing how the development will and should affect the role and profession of the industrial designer, what could be expected of digital products to come in the near future.

Since the concern is how to design things, To design for everyday life involves much more than supporting people to accomplish certain tasks more effectively, and therefore, design for usability and practical functionality is not sufficient. However, in this area, it is appropriate to search what the role of industrial designer is.

To find the keys of the successful product, firstly, the parts of the foundation of designing human-graphical user interface of product interaction should be examined. In this chapter, elements of subject are evaluated in terms of design approach and human behavior.

2.2 Graphical user interface

The term "User Interface" refers to the methods and devices that are used to accommodate interaction between machines and the human beings, users, who use them. User interfaces can take on many forms, but always accomplish two fundamental tasks: communicating information from the product to the user, and communicating information from the user to the product. The term "Graphical User Interface" is a graphical user interface to a computer. The term came into existence because the first interactive user interfaces to computers were not graphical; they were text-and-keyboard oriented and usually consisted of commands.

According to the online Oxford English Dictionary, an interface is:

> 1. A surface lying between two portions of matter or space, and forming their common boundary. 2. transf. and fig. a. A means or place of interaction between two systems, organizations, etc.; a meeting-point or common ground between two parties, systems, or disciplines; also, interaction, liaison, dialogue. b. (An) apparatus designed to connect two scientific instruments, devices, etc., so that they can be operated jointly. WEB_2 (2004)

Literally, 'computer-mediated' means to facilitate communication between human beings or between a human being and an artifact. The user interface embodies both physical and communicative aspects of input and output, or interactive activity. The user interface includes both physical objects and computer systems. This last term seems appropriate for an era in which computers themselves disappear, leaving only 'smart' ritual objects and displays, such as 'smart home appliances', 'smart mobile phones' and 'smart fridges' (Marcus, 2002).

2.2.1. Evolution of Graphical User Interface

Generally, the evolution of graphical user interface is defined with hardware technology, but according to Nielsen (1993), the backbone of most histories of computers is the simplistic model of 'generations' of computers. Nevertheless, as shown in Table 2.1, several other interesting dimensions of computing have followed a set of generations roughly parallel with hardware developments; as the scope of user interfaces has broadened. This table specifically deals with recent and coming changes in user interfaces and it defines and suggests the next generation of user interfaces.

Generation	Hardware technology	Operating mode	Programming languages	Terminal technology	User types	Advertising image	User interface paradigm
-1945 Pre-history	Mechanical, electro-mechanical (Babbage, Zuse Z3)	Calculations	Plugboard, jumpers, cable	Lights	Inventors	-	-
1945-1955 Pioneer	Vacuum tubes, huge machines, short mean time between failures	One User at a time at machine	Machine language	Punch Cards, typewriter, TTY	Experts, pioneers	Calculator	Programming, batch processing
1955-1965 Historical	Transistors	Batch System	Assembler	Line-oriented terminals	Technocrats, professional computerists	Information processor	Command languages
1965-1980 Traditional	Integrated circuits (IC)	Time-sharing	High-level languages	Full-screen terminals, alpha-numeric characters only	Normal Users with special knowledges	Enhance Productivity	Full-screen hierarchical menus and form fill-in
1980-Now	VLSI, Wafer-scaled integrations	Network, single user and embedded systems	Problem oriented languages	Graphical Displays, Desktops, Laptops, embedded systems, cellulars, ...	Everybody	Computer for everybody (without knowledge)	WIMP (Windows, Icons, Menus, Pointing Device)

Table 2.1. Summary of the generations of computers and user interfaces.(Source: Nielsen 1993)

Most current user interfaces are similar and belong to one of two common types: Either the traditional alphanumeric full-screen terminals with a keyboard and function keys, or the more modern workstations with windows, icons, menus, and a pointing device. In fact, most new user interfaces released after 1983 have been remarkably similar. In contrast, the next generation of user interfaces may move beyond the standard window operations to involve elements like virtual realities, head-mounted displays, sound and speech, pen and gesture recognition, animation and multimedia, limited artificial intelligence, and highly portable computers with cellular or other wireless communication capabilities (Nielsen, 1993).

By the development of hardware technology, computer dialogue styles have been transformed over the last twenty-five years by the introduction of first minicomputers and then, microprocessors. The introduction of the first minicomputer, that is the DEC PDP8, though primarily viewed as a breakthrough in dedicated real-time computing, also represented a landmark in human-computer interaction.

Since the early 1970's the microprocessor has become a ubiquitous part of most electronic systems. The widespread availability of microcomputers based upon microprocessor technology has accelerated the trends first begun by minicomputers, by putting significant raw computing power in the hands of inexperienced users for the first time (see figure 2.2).

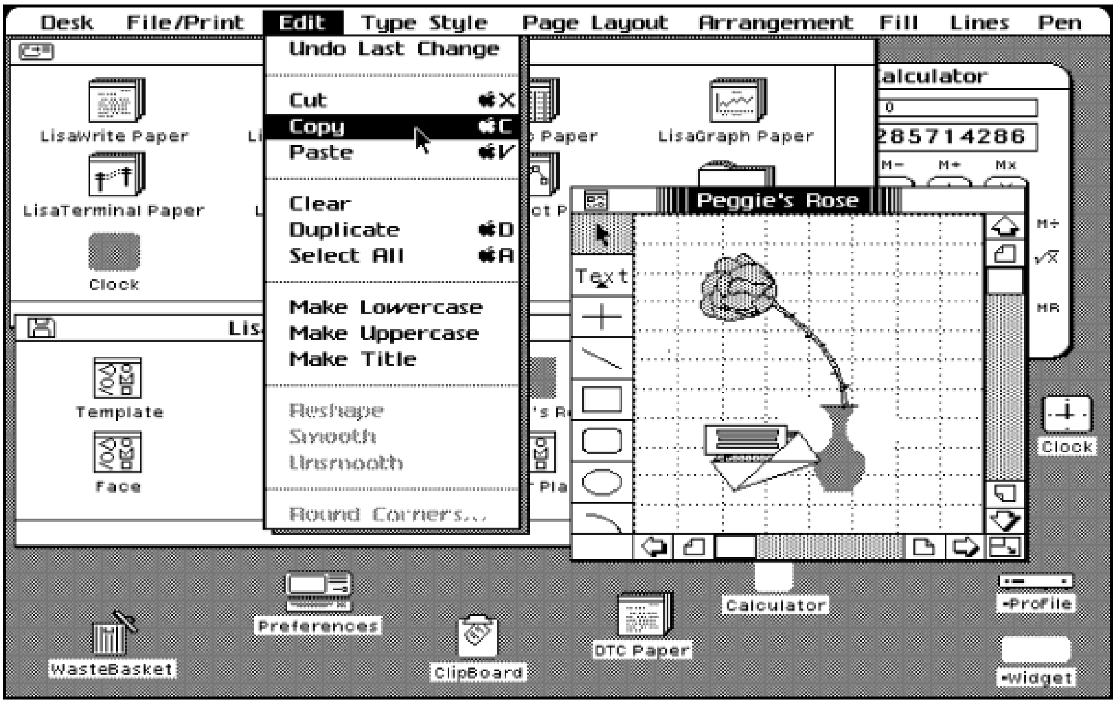


Figure 2.2. Macintosh Desktop.

(Source: http://www.computerhistory.org/timeline/index.page)

Figure 2.3. Desktop with applications in Mac OS 10.1.

(Source: http://devworld.apple.com/techpubs/mac/pdf/HIGuidelines.pdf)

These examples (See figure 2.2, and 2.3) illustrate the close interrelationship between the capabilities of the technology and the style of the user interface. Because the WIMP (variously an acronym for windows, icons, mouse, pull-down menus, or windows, icons, menus, pointers) style of user interaction was fully explored, and evaluated in the early 1970s at the Xerox Palo Alto Research Center using dedicated minicomputer workstations. In spite of their apparent visual appeal and friendliness, however, the software complexity of such graphics-oriented interfaces is high, and thus it was not until 16- and 32-bit microprocessors were introduced that sufficient processing power was available to enable such systems to become practicable at low cost. (Downton, pp. 31-33)

Although the concept of a human-computer dialogue conjures up images of the user sitting in front of a terminal interacting with a keyboard and video display, the expression admits a much wider range of interpretations than this. Many products now contain embedded microcontrollers with which dialogues of a sort are conducted. A minimal example of such a system is the familiar digital watch shown in Figure 2.4.

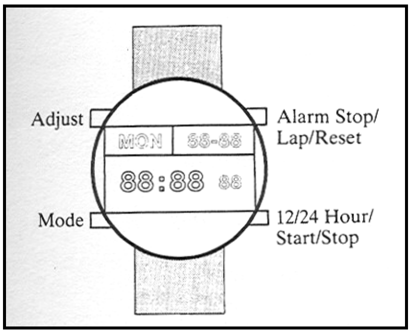


Figure 2.4. The digital watch. (Source: Downton, 1993)

Typically, this incorporates, in addition to clock, day and date functions, a stopwatch with lap timer, a presettable countdown timer, and one or more alarms. It may seem natural and obvious with hindsight that all these functions could be readily controlled and initialized with only four pushbuttons, but in the absence of a known solution the problem would be much more taxing. Furthermore, given only the specification of the required functionality, and the availability of a single four-bit input, it is clear that many possible solutions could be generated, varying widely in simplicity, consistency, flexibility and ease of use. Other examples of domestic equipment containing a microcontroller are now commonplace: PDA's, microwave and conventional ovens, and automatic washing machines and internet products. Some examples of products are shown in Figure 2.5 and 2.6

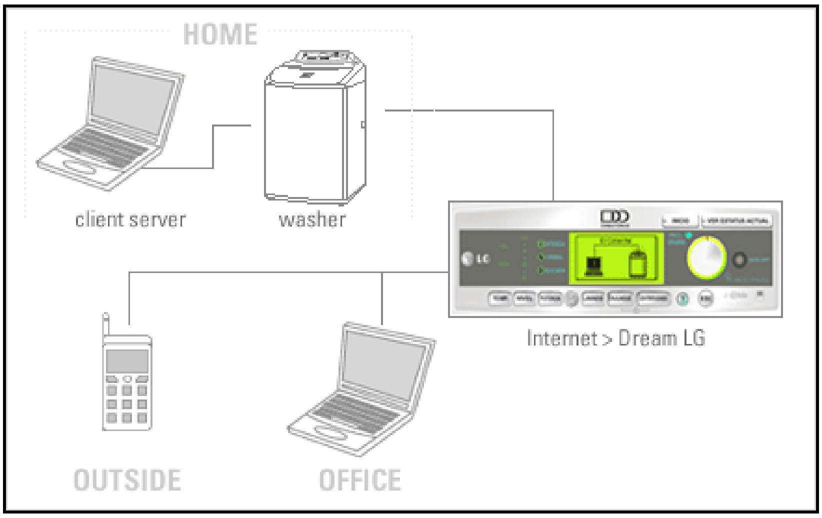


Figure 2.5. LG internet product system. (Source: http://www.lge.com/products/homenetwork/internetproduct/washingmachine/summary.jsp)

Figure 2.6. Bosch Nexxt Premium Washer Control Panel.

(Source: http://www.bosch.com/products/fulllaundry/logicxx)

Such dialogues, typically augmented by feedback from a display panel generally categorized as simple forms of menu selection, and they are readily formalized using state transition diagram techniques. In the office, business, and industrial environment, examples of embedded systems abound. Photocopiers, telephones, machine tools, and industrial process controllers are all controlled using dialogues of greater or lesser sophistication. Word processors, video games and personal computers running databases, spreadsheets, graphics and communication packages represent the conventional concept of computers and provide a more versatile and flexible potential for human computer interaction. The availability of video displays, and graphic input devices opens up opportunities for much richer, more powerful, and more extensive dialogues using menus, form-filling, command languages, and/or direct manipulation to specify commands.

Nowadays, according to Mark Weiser's paper (Weiser, 1991), his vision of 'ubiquitous computing' has become a practical reality. Digital interactions with a wide variety of products have been evolved (See Figure 2.7). The hardware provides_a range of scales and physical embodiments that are opening up_new arenas of use. In the coming 20 years, this shift in hardware technology could support the development of new interaction designs and systems. It could be shifted from the machine-centered architecture of today's world (even the Internet world), to a human-centered computing space and individual machines, applications, and computer representations become invisible as Weiser foresaw.

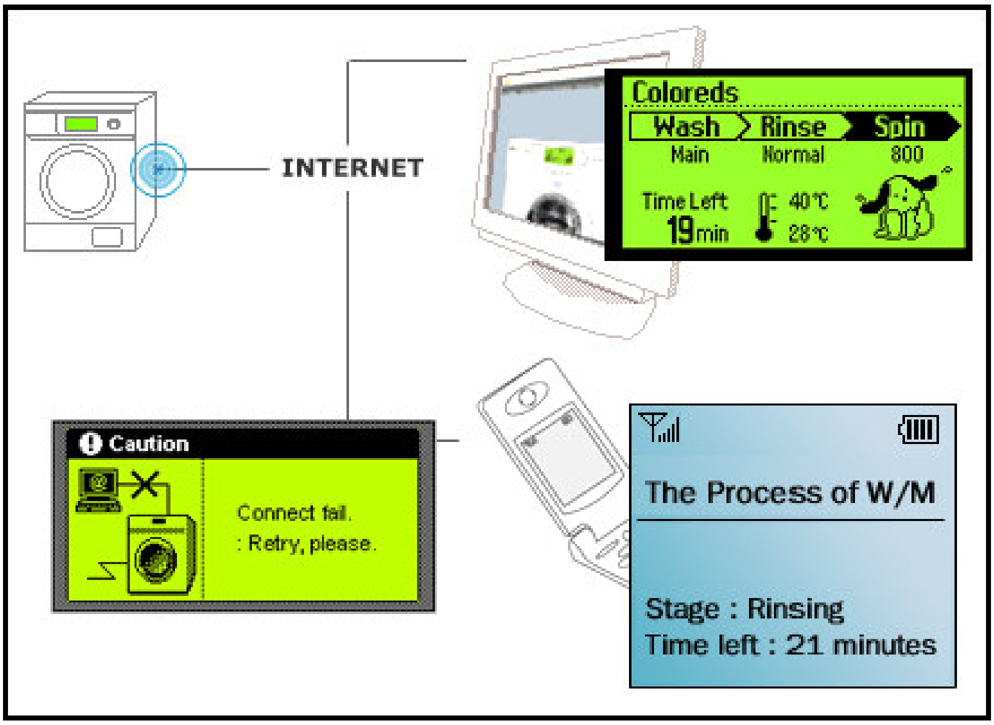


Figure 2.7. The Internet-Mobile Phone Monitoring function of LG Washing Machine. (Source:http://www.lge.com/products/homenetwork/internetproduct/ washingmachine/ monitoring.jsp)

Comparison between the current user interface generation of command-based interfaces and the potential next generation of interfaces across twelve dimensions are shown in Table 2.2.

Table 2.2 (cont.): The comparison of interface generations. (Source: Nielsen 1993)

	Current Interface Generation	**Next-Generation Interfaces**
User focus	Controlling computer	Controlling task domain
Computer's role	Obeying orders literally	Interpreting user actions and doing what it consents appropriate
Interface control	By user (i.e. interface is explicitly made visible)	By computer (since user does not worry about the interface as such)
Syntax	Object-Action composites	None (no composites since single user token constitutes an interaction unit)

Object visibility	Essential for the use of direct manipulation	Some objects may be implicit and hidden
Interaction stream	Single device at a time	Parallel streams from multiple devices
Bandwidth	Low (keyboard) to fairly low (mouse)	High to very high (virtual realities)
Tracking feedback	Possible on lexical level	Needs deep knowledge of object semantics
Turn-taking	Yes; user and computer wait for each other	No; user and computer both keep going
Interface locus	Workstation screen, mouse, and keyboard	Embedded in user's environment, including entire room and building
User programming	Imperative and poorly structured macro languages	Programming-by-demonstration and non-imperative, graphical languages
Software packaging	Monolithic applications	Plug-and-play modules

2.3. Interpretations on Human-Graphical User Interaction

2.3.1. Human Cognitive Skills

Cognition involves the cognitive processes such as thinking, remembering, learning, decision making, problem solving, planning. To save the acquired information the human memory is used. It consists of the sensory memories, the short-term memory, and the long-term memory. The short-term memory keeps information only a short time. It is used as a working memory. It has only a limited capacity and saves whole portion. The long-term memory stores information for a longer period depending on the amount of invocations.

The three main activities are storage, deletion, and retrieval. Deletion is mainly caused by decay. It is not fully clear if we actually ever forget anything or it just gets harder to access the information. From the first saving, the 100 percent of the recallable information falls down to about 10 percent after one month, if the information was not accessed in the meantime. A phenomenon of the human memory is, that it is easier to recognize something than fully recall. The power of the human long-term memory is its remarkable flexibility. The same information can be combined in many different ways.

Generally, we can think of the long-term memory as a network of linked concepts. For example, if we think of a particular concept (like data visualization) we can easily bring other related concepts into our mind (like computer graphics, data analysis, visualization, etc.).

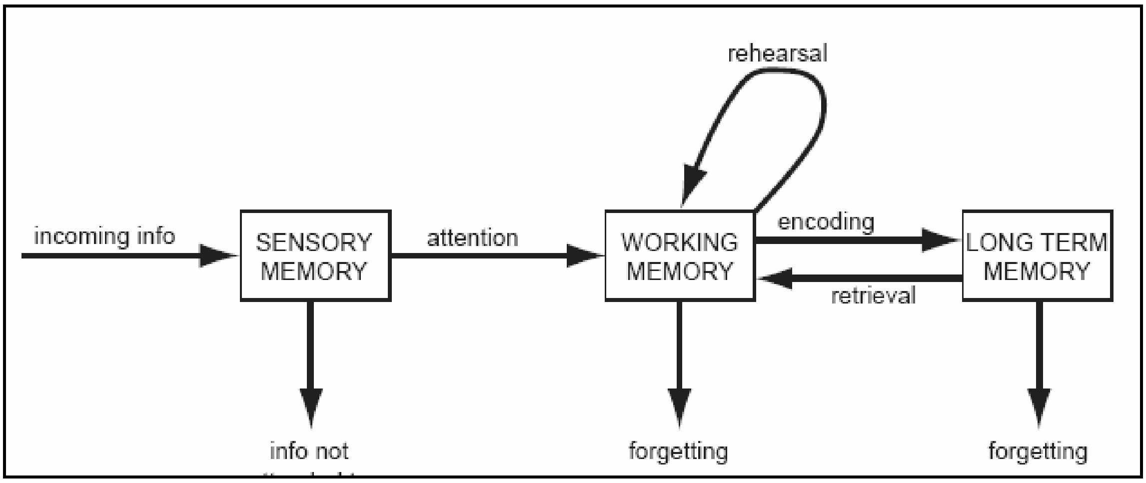


Figure 2.8. Connections between the three memories. (Source: Hinum 2004)

2.3.1.1. Human Senses

Vision is, for the normally sighted person, the most powerful sense. The human visual system is designed to produce organized perception in terms of motion, size, shape, distance, relative position, and texture. The visual system attempts to interpret all stimulation reaching the eyes as if it were reflected from a real scene in three dimensions even stimulation is on a flat, two-dimensional surface.

Luminance is the light reflected from the surface of an object and measured in candelas per square meter. As the luminance of an object becomes greater, the eye's visual acuity or ability to discern small detail also increases. The pupil diameter decreases and therefore increases the depth of focus in the same way as in a standard camera lens when the aperture is adjusted.

Contrast, as the term suggests, describes the relationship between light emitted from an object and light emitted from the background surrounding the object. Contrast is defined as the difference between the luminance of the object and its background divided by the luminance of the background.

Brightness is a subjective response to light. There is no real means of measuring absolute levels of brightness as there is of measuring luminance and contrast, but in general, a high luminance from an object implies a high brightness. It is possible to experience odd effects around areas of high- to-low brightness boundaries. For example, in the Hermann grid shown in Figure 2.9, most people 'see' white dots at the intersections of the black lines and black dots at the intersections of the white lines but the dots 'disappear' at an intersection when that intersection is viewed directly. This type of effect is quite frequently observed, and designers should be wary of creating it on a display screen.

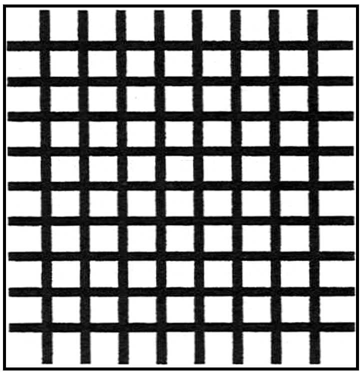


Figure 2.9. The Hermann grid (Source: Downton 1993)

Visual angle is defined as the angle subtended by an object at the eye. **Visual acuity** defines the minimum visual angle that can be resolved. For example, in the diagram shown in Figure 2.10 an object, which is L meters high and D meters from an observer, produces an angle 4J minutes of arc at the eye as approximated below: Because these angles are fairly small they are usually measured in minutes or seconds of an arc. For Human Computer Interaction purposes, the designer of a visual display should note that in good viewing conditions, a minimal perceptible visual angle of about 15 min of arc should be maintained and in poor viewing conditions, this should be increased to 21 min. These correspond to a 4.3-mm object and a 6.l-mm object respectively viewed from I m.

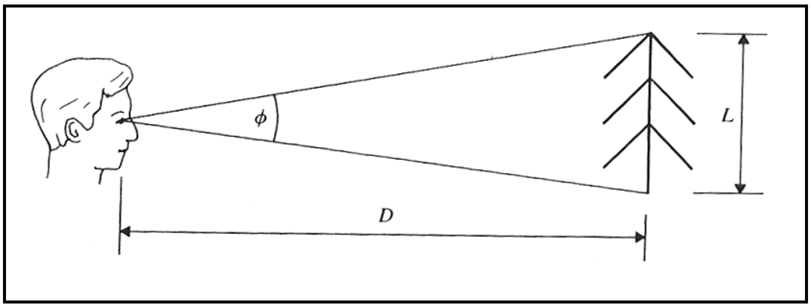


Figure 2.10. Visual acuity. (Source: Downton 1993)

Hearing is the most important sense after vision in any computer interaction. Most people can detect sound in the frequency range 20 Hz up to 20 000 Hz but both the upper and lower frequency limits tends to deteriorate with age and health. Hearing is more sensitive within the range 1000-4000 Hz, which in musical terms corresponds approximately to the top two octaves of the piano keyboard.

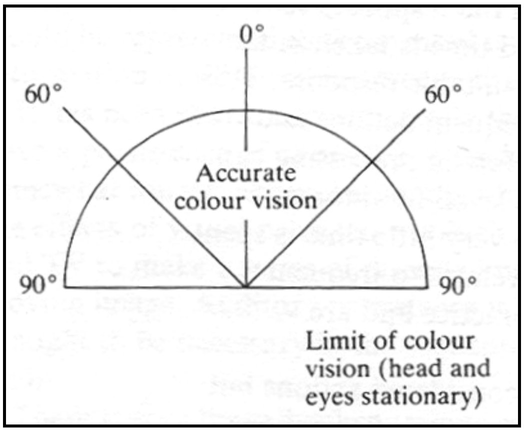


Figure 2.11. Field of view for accurate color vision. (Source: Downton 1993)

As well as frequency variation, sound can also have loudness variation. Defining the threshold of hearing as 0 dB, then a whisper registers as 20 dB and normal conversation registers between 50 dB and 70 dB. Ear damage is likely to occur if the sound exceeds 140 dB. The ear is insensitive to frequency changes below about 20 dB (that is, below a whisper). The sensitivity to both frequency and loudness varies from person to person and indeed, for the same person from time to time, depending upon what level of sound they have been exposed to in the very recent past.

Although sound is the second most important medium for conveying information to the user from a computer system, it can also be a cause of great distraction and annoyance. Because sound is, such an invasive medium, it should be used sparingly and with a great deal of caution in the design of human-computer systems.

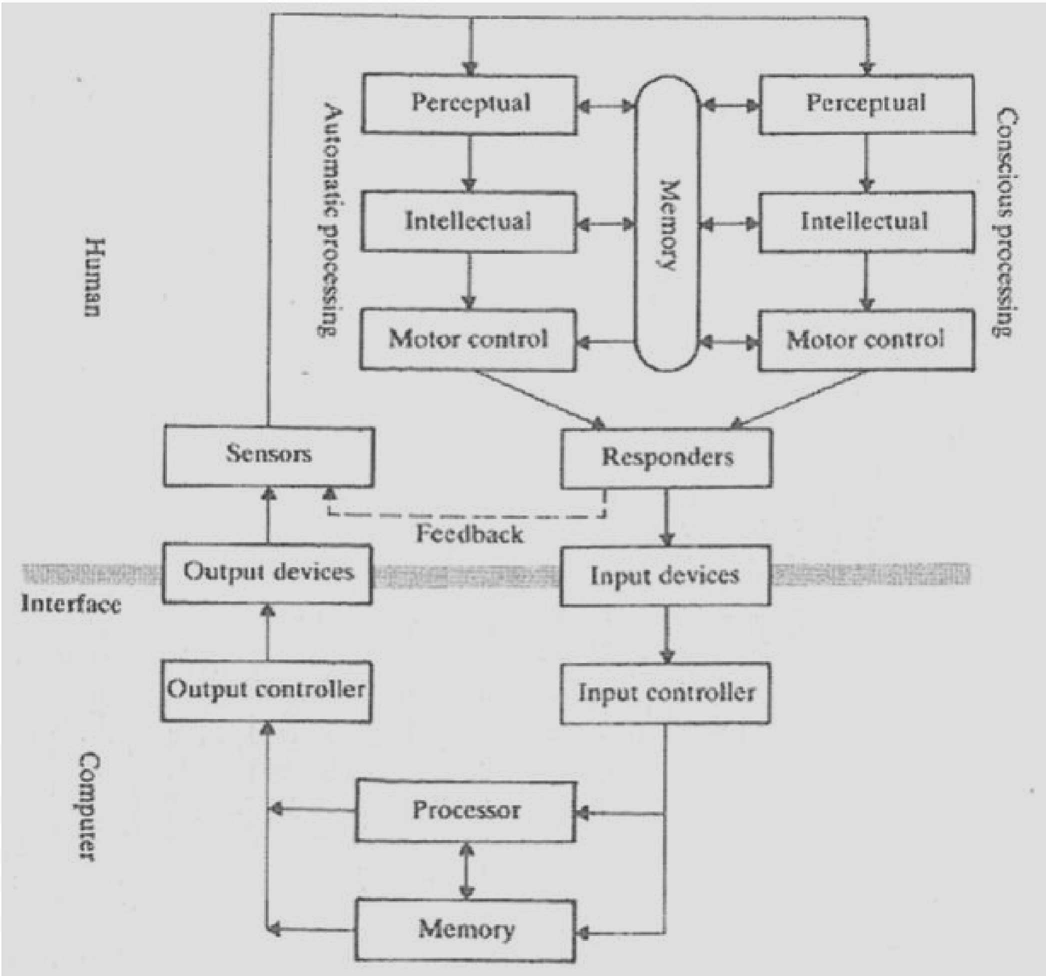


Figure 2.12. The process model of the human-computer interaction.

(Source: Downton 1993)

For computer interaction purposes, the sense of touch ranks third after vision and hearing. However, for the blind it has a higher importance and is therefore useful in aids for the disabled. It is also useful in areas of high auditory or visual noise where an additional channel is needed to attract the user's attention. For example, there are paging systems that vibrate to attract the wearer's attention. Although touch is not used a great deal consciously in human-computer interaction, tactile feedback conveys important subconscious information. Touch is also closely associated with ergonomic design aspects of a system. It is not common for computer operators to complain that they do not like the 'feel' of a particular keyboard. These complaints can be associated with the position and shape of the keys but are also directed at keyboards that require too much or too little pressure to operate the keys.

As shown in Figure 2.12, on the right of the diagram is a simple model of a conventional computer system and on the left is a model of the human user. This model has many similarities with models of conventional computers in terms of processors, memories, and interaction between them by paths similar to busses. In reality, the brain is a massively parallel network of neurons. However, despite its limitations the model provides useful insights into human processing.

As can be seen in Figure 2.12, the three subsystems of the human processing system are split into two parts: conscious and automatic processing. *Conscious processing* occurs where all the responses to incoming stimuli on the senses are considered and time is taken in the intellectual part of the processing to decide on a suitable response. This form of processing is associated with new or infrequent actions and therefore produces slow, considered responses. Human processing can also take place at the automatic or subconscious level. In automatic processing all responses are of a reflex nature, as very little time is spent on intellectual processing. *Automatic processing* relates to frequent actions that have become automatic through practice and are therefore relatively fast responses.

All actions begin as consciously processed or considered actions but with practice and experience, they become automatic or reflex actions with occasional conscious observation.

2.3.1.2. Gestalt Theories

Gestalt theory allows communicators to predict how viewers will respond to design elements. Based on theories of perception, the gestalt principles were developed in the nineteenth century by psychologists who believed that whole images are often perceived as more than the sum of their parts. Knowing and using gestalt theory in industrial design can help ensure that our visual messages will be understood and that our designs will be dynamic. WEB_7 (2004)

Proximity is a grouping principle of perceptual organization. It states that, all else being equal, humans tend to perceive elements to be associated when they are close together. Things that are close together are perceived as a group (See Figure 2.13). This is the most powerful principle and the most useful for designers. It can be used for placing descriptions or grouping objects on the screen. (Hinum, 2004, p. 21)

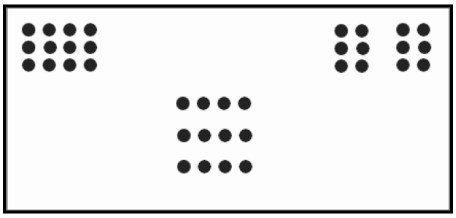


Figure 2.13. Proximity principle.
(Source: http://www.byz.org/~david/neuro/optical_illusions.pdf)

Similarity is another grouping principle, which states that those elements that share qualities (of color, size, or shape, for example) will be perceived as part of the same form (See Figure 2.14). This principle can be used to draw a viewer's attention. For instance, in the figure below, the top-middle circles seems different because of its color, In the middle image, columns appear because we associate similar colors together even though the squares are evenly spaced. In the bottom image, rows appear because we associate similar shapes together.

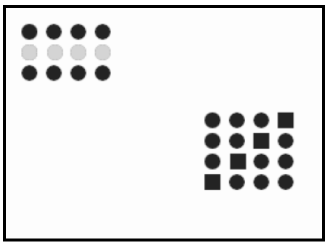


Figure 2.14. Similarity principle.
(Source: http://www.byz.org/~david/neuro/optical_illusions.pdf)

Continuity states that human brain prefers to perceive smooth, continuous contours rather than abrupt changes in direction. Elements that continue a pattern tend to be grouped together. This principle is shown in Figure 2.15.

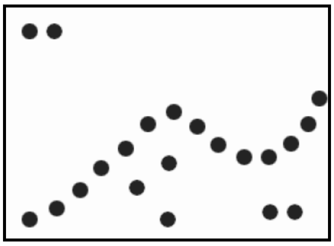


Figure 2.15. Continuity principle.

(Source: http://www.byz.org/~david/neuro/optical_illusions.pdf)

Closure states that human brain tends to enclose spaces by completing contours and ignoring gaps in figures. It follows from good continuity and allows us to group elements together or to interpret forms as complete though parts may be missing. Both the square and the "A" in pear are not drawn, but we complete the contours to create closed-in elements, completing each image even though parts are missing (see figure 2.16).

Figure 2.16. Closure principle.

(Source: http://www.byz.org/~david/neuro/optical_illusions.pdf)

Figure/ground organization principle states that human brain tends to perceive some visual elements as the figure, with a definite shape and border, while other elements appear as the ground, further away and behind the main focus of the figure. At any moment, one will be able to see either the black vase (in the center area) as "figure" or the white profiles on each side (in which case the black is seen as "ground"). Not only does perception involve organization and grouping, it also involves distinguishing an object from its surroundings. Two different foreground colors let the viewer perceive different things from the same illustration. It is noticed that once an object is perceived, the area around that object becomes the background, WEB_7 (2004).

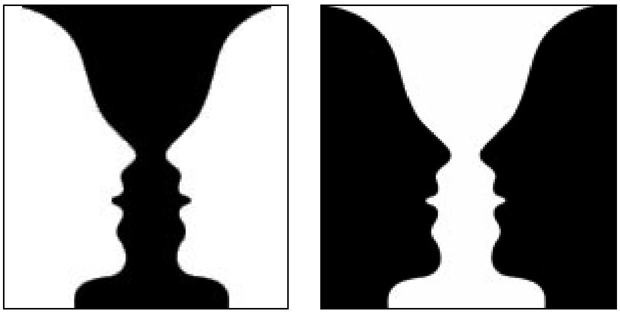


Figure 2.17. Figure/ground principle, “Rubin's Vase”. (Source: Chang at al. 2001)

Surroundedness, in other word subjective contours, is another principle that organizes figure and ground. The elements of an image seen as surrounded will be perceived as the figure, and the elements that are doing the surrounding will be perceived as the ground. For instance, human brain tends to perceive a white triangle floating in front of the black circles in the figure in left. There is a similar phenomenon with a white circle floating above converging lines. Again, the way the lines are cut out makes humans think a circle is there.

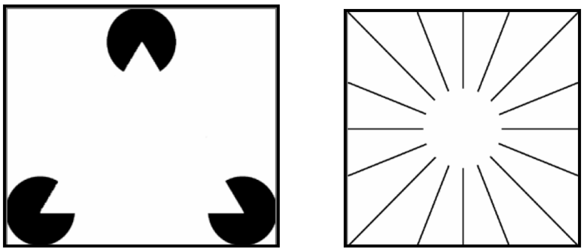


Figure 2.18. Subjective contours principle.
(Source: http://www.byz.org/~david/neuro/optical_illusions.pdf)

Symmetry principle states that human brain tends to perceive shapes as figures based on their combined symmetrical forms, rather than their individual asymmetric parts. The left pattern in figure below consists out of two parallel contours. The two patterns on the right deliver a much stronger sense of a holistic figure because they are composed in respect to the Gestalt law symmetry. (Hinum, 2004, p.24)

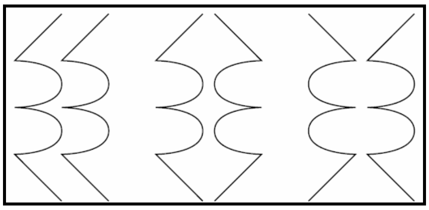


Figure 2.19. Subjective contours principle. (Source: Hinum 2004 p.24)

Pragnanz, in other word the principle of good form, states that human perceives an image as well as the stimulus conditions allow. Preferred perceptual organization should be the simplest, most regular interpretation of the elements in the image because individuals organize their visual experience in as simple, symmetrical, and complete manners as possible. The IBM logo consists of little white bars to form three individual letters is a good example for explaining this principle. (Chang, Dooley and Tuovinen, 2001, p.2)

2.3.1.3. Effective Color Usage

For that, 97 percent of the populations who are not color-blind, differences in color are processed more or less automatically and in parallel with characteristics of shape and motion. Some of the published guidance on color usage presumes the validity of the common belief that "warm" colors such as red and orange have an arousing effect on humans, whereas "cool" colors such as green and blue are calming. This color-induced state arousal is often supposed to influence such things as mood and productivity. Most people have color preferences and preconceived notions about their significance (many of them, which are culturally dependent).

Table 2.3. Psychological Effects of Color.

(Source: http://cfg.cit.cornell.edu/cfg/design/concepts.html#global)

color	effects of distance	effects of temperature	psychological effects
blue	distance	cold	calming
green	distance	very cold to neutral	very calming
red	vicinity	warm	goading, scaring
orange	very close	very warm	very animating
yellow	vicinity	very warm	animating
brown	very close	neutral	animating
violet	very close	cold	aggressive, scaring, frustrating

Here it needs to explain some about computer color sytems.There are two main color system.

RGB stands for red, green and blue and is an additive colour system. In this additive system coloured light sources are superimposed to create all colours. If all three light sources are overlaid white light is produced.

This system is widely used in televisions and computer monitors. In a computer system every channel (light source) is stored with one byte (8 bits). That means that 256 different values for one channel are possible leading to 16.7 million different colours.

CMYK stands for cyan, magenta, yellow and key (black) and is a subtractive colour system. Subtractive means that each pigment that is painted, absorbs light and therefore another colour is reflected. When pigments of all three primary colours(CMY) are painted theoretically black should appear. Because the colours do not have ideal reflectance properties a pure black can not be produced. Therefore, a fourth channel, the K in CMYK, with pure black pigments is used. The CMYK colour system is usually used for printers and has a smaller colour space than the RGB system. This means that some colours in the RGB colour space are not in the CMYK colour space and the designer has to consider this limitation.

Color theories comprise the three perceptual attributes of color: hue, lightness, and saturation. There are three simple rules for making effective color choices:

1. Exaggerating lightness differences between foreground and background colors and avoiding using colors of similar lightness adjacent to one another, even if they differ in saturation or hue is the first rule of the qualified perception.

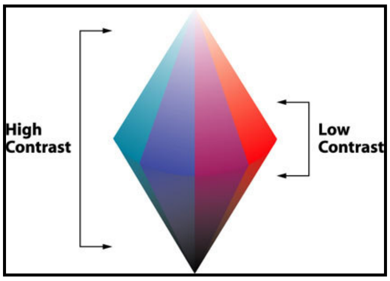


Figure 2.20. High and Low contrast.
(Source: http://www.lighthouse.org/print_leg.htm)

The lightness perceived should not be the same as the lightness perceived by people with color deficits. Lighten the light colors and darken the dark colors in your design increases the visual accessibility.

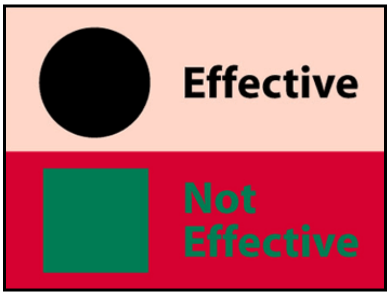


Figure 2.21. Effective color usage.
(Source: http://www.lighthouse.org/print_leg.htm)

2. Designers should choose dark colors with hues from the bottom half of the hue circle against light colors from the top half of the circle. It is not appropriate to use contrasting light colors from the bottom half against dark colors from the top half.

Figure 2.22. Color wheel.

(Source: http://www.lighthouse.org/print_leg.htm)

3. In color preferences, it should not be chosen that contrasting hues from adjacent parts of the hue circle, especially if the colors do not contrast sharply in lightness.

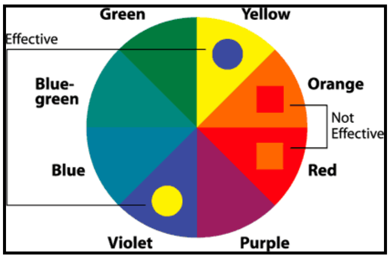


Figure 2.23 Color wheel.

(Source: http://www.lighthouse.org/print_leg.htm)

Color defects associated with partial sight and congenital deficiencies make it difficult to discriminate between colors of similar hue.

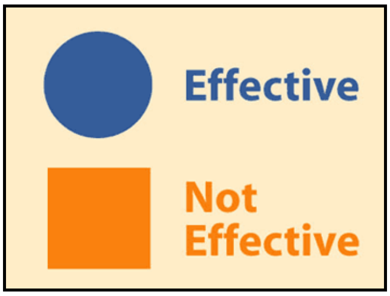


Figure 2.24. Similar hue usage.

(Source: http://www.lighthouse.org/print_leg.htm)

Hue, lightness, and saturation are the three perceptual attributes of color. However, these features should be envisioned as a solid. Hue varies around the solid; lightness varies from top to bottom and saturation is the distance from the center.

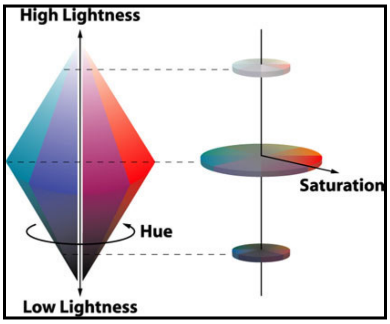


Figure 2.25. Solid color chart.

(Source: http://www.lighthouse.org/print_leg.htm)

Hue is the perceptual attribute associated with elementary color names. Hue enables us to identify basic colors, such as blue, green, yellow, red, and purple. People with normal color vision report that hues follow a natural sequence based on their similarity to one another.

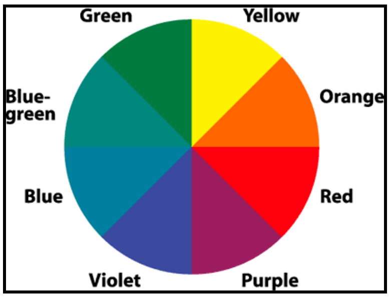


Figure 2.26. Main and Interval colors.

(Source: http://www.lighthouse.org/print_leg.htm)

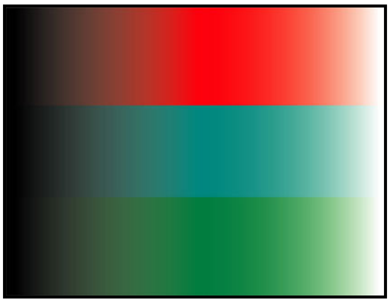


Figure 2.27. Lightness and darkness.
(Source: http://www.lighthouse.org/print_leg.htm)

Lightness corresponds to how much light appears to be reflected from a surface in relation to nearby surfaces. Lightness, like hue, is a perceptual attribute that should not be computed from physical measurements alone. It is the most important attribute in making contrast more effective. With color deficits, the ability to discriminate colors because of lightness is reduced.

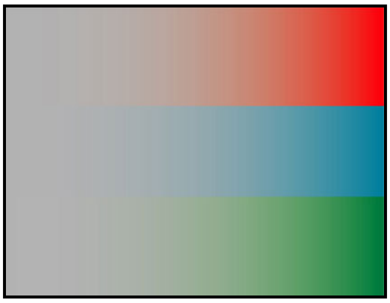


Figure 2.28. Saturation.
(Source: http://www.lighthouse.org/print_leg.htm)

Saturation is the degree of color intensity associated with a color's perceptual difference from a white, black, or gray of equal lightness. Slate blue is an example of a desaturated color because it is similar to gray. A deep blue, even if it has the same lightness as slate blue, has greater saturation. Congenital and acquired color deficits typically make it difficult to discriminate between colors because of saturation.

Congenital and acquired color deficits typically make it difficult to discriminate between colors based on saturation.

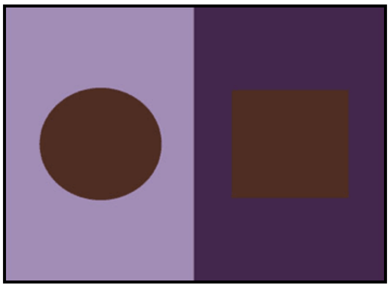


Figure 2.29. Color deficits.
(Source: http://www.lighthouse.org/print_leg.htm)

To a person with color-deficient partial sight, the left-hand panel might appear as the right-hand panel appears to a person with normal color vision. With color deficits, the ability to discriminate colors (within all three attributes hue, lightness, and saturation) is reduced. To compensate for these deficits by making colors differ more dramatically in all three attributes improves design solutions WEB_8 (2004).

2.3.1.4. Diversity of Human Cognitive Skills

The remarkable diversity of human abilities, backgrounds, motivations, personalities, and work styles challenges designers. Understanding the physical, intellectual, and personality differences among users is vital.

Physical abilities and physical workplaces are related to the basic data about human dimensions comes from research in anthropometry. The great diversity in these static measures reminds us that there can be no image of an "average" user, and that compromises must be made or multiple versions of a system must be constructed. The choice of control panel design parameters evolved to meet the physical abilities of users in terms of distance between keys, size of keys, and required pressure. The physical design of workplaces is often discussed under the term ergonomics. Anthropometry, sociology, industrial psychology may offer useful insights in this area.

A vital foundation for interactive-systems designers is an understanding of the **cognitive and perceptual abilities** of the users. The human ability to interpret sensory input rapidly and to initiate complex actions makes modern computer systems possible. In milliseconds, users recognize slight changes on their displays and begin to issue a stream of commands. The journal Ergonomics Abstracts offers this classification of human cognitive processes; Short-term memory, Long-term memory and learning, Problem solving, Decision making, Attention and set (scope of concern), Search and scanning, Time perception. In any application, background experience and knowledge in the task domain and the interface domain play key roles in learning and performance. Tasks or computer-skill inventories can be helpful in predicting performance.

Personality differences are also important factor for user centered design systems. Some people dislike computers or are made anxious by them; others are attracted to or are eager to use computers. A clear understanding of personality and cognitive styles can be helpful in designing systems for a specific community of users. Many hundreds of psychological scales have been developed, including risk taking versus risk avoidance; internal versus external locus of control, reflective versus impulsive behavior; convergent versus divergent thinking; high versus low anxiety; tolerance for stress; tolerance for ambiguity, motivation, or compulsiveness; field dependence versus independence; assertive versus passive personality; and left-versus right-brain orientation. As designers explore computer applications for home, education, art, music, and entertainment, they will benefit from paying greater attention to personality types.

Cultural and international diversity should be considered in the perspective of designing universal products. Another perspective on individual differences has to do with cultural, ethnic, racial, or linguistic background. It seems obvious that users who were raised learning to read Japanese or Chinese will scan a screen differently from users who were raised learning to read English or French. Little is known about computer users from different cultures, but designers are regularly called on to make designs for other languages and cultures. The growth of a worldwide-computerized market means that designers must prepare for internationalization. User-interface design concerns for: internationalization includes the following:

1. Characters, numerals, special characters, and diacriticals
2. Left-to-right versus right-to-left versus vertical input and reading
3. Date and time formats
4. Numeric and currency formats
5. Weights and measures
6. Names and titles (Mr, Ms, Mme, M, Dr)
7. Social-security, national identification and passport numbers
8. Capitalization and punctuation

9. Sorting sequences

10. Icons, buttons, colors

11. Pluralization, grammar, spelling

12. Etiquette, policies, tone, formality, metaphors

To promote effective designs, companies should run usability studies with users from each country and culture, and language community.

Users with disabilities should be keeping in mind in creation process. Designers can benefit by planning early to accommodate users who have disabilities, since substantial improvements can be made at low or no cost. The term “computer curb cuts” brings up the image of sidewalk cutouts to permit wheelchair access that is cheaper to build than standard curbs if they are planned rather than added later. Similarly, moving the on-off switch to the front of a computer adds a minimal change to the cost of manufacturing and helps mobility-impaired users, as well as other users.

Elderly users are also parts of the subject. There can be many pleasures and satisfactions to seniority, but there are also negative physical, cognitive, and social consequences of aging. Understanding the human factors of aging can lead us to computer designs that will facilitate access by the elderly. Other benefits include increased access of the society to the elderly for their experience, increased participation of the elderly in society through communication networks, and improved chances for productive employment of the elderly (Shneiderman, 1987).

Jakob Nielsen found out that the top three usability differences due to individual differences between users. The three main dimensions along which users experience are shown in Figure 2.30 (Nielsen, 1989);

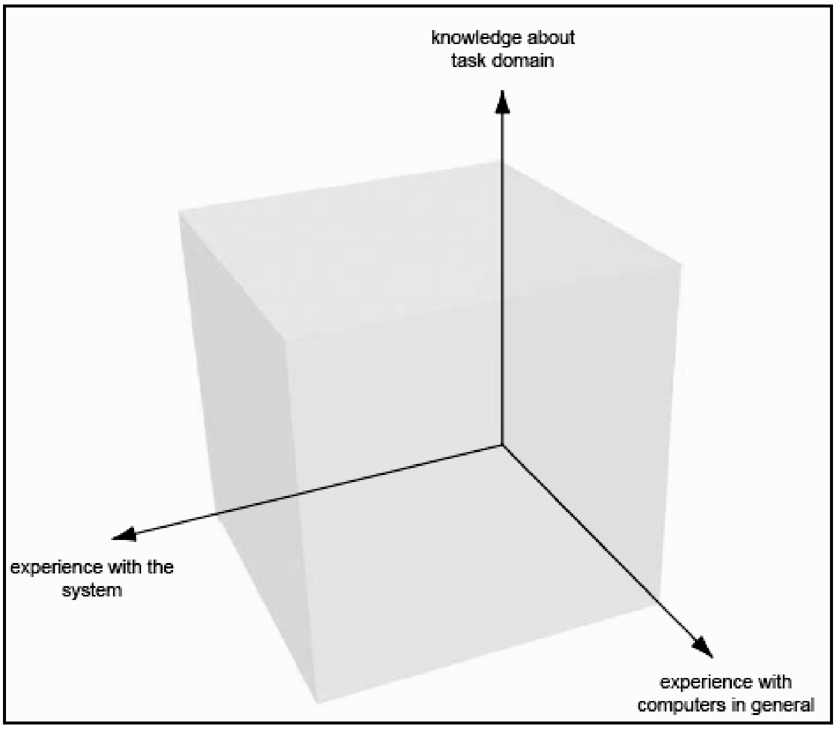


Figure 2.30. User cube for specifying user differences. (Source: Nielsen, 1989)

Experience with the system: The users can be either novices, experts, or somewhere in between. This attribute is also considered in the learnability of the system.

Experience with computers in general: This axis is influenced by the time the user spent working with computers and what he or she is able to do with computers. In addition, experience with similar applications can be taken into account. For example, a utility for novice users has to have a more descriptive user interface than the same utility for administrators.

Experience with the task domain: is how good the knowledge of the task domain addressed by the system. If the user is experienced with the task domain, the interface can use specialized terminology, abbreviations, and a high density of information. In the other case that the user has little knowledge about the task domain, the interface should explain each option, function, and the terminology should not be abbreviated and dense. Especially the user interface for novices should be very explanatory so that the user knows what goes on. The designer can assume that the expert does not need so much additional information about what each function does.

2.3.2. Interaction Styles

Interaction involves at least two participants: the user and the system. Both are complex, and they are very different from each other in the way that they communicate and view the domain and the task. The interface must therefore effectively translate between them to allow the interaction to be successful. The usage models of interaction help us to understand exactly what is going on in the interaction and identify the likely root of difficulties.

The purpose of an interactive system is to aid a user in accomplishing goals from some application domain. A domain defines an area of expertise and knowledge in some real-world activity. A domain consists of concepts that highlight its important aspects. Tasks are operations to manipulate the concepts of a domain. A goal is the desired output from a performed task. An intention is a specific action required to meet the goal (Dix and Finlay, 1993).

Task analysis involves the identification of the problem space for the user of an interactive system in terms of the domain, goals, intentions, and tasks. We can use our knowledge of tasks and goals to assess the interactive system that is designed to support them. The concepts used in the design of the system and the description of the user are separate called the System and the User. The System's language is called as the core language and the User's language is the task language. The core language describes computational attributes of the domain relevant to the System state, whereas the task language describes psychological attributes of the domain relevant to the User state.

Donald Norman in "The Psychology of Everyday Things" offers a compelling model (See Figure 2.31) of how software comes to be conceived by the user.

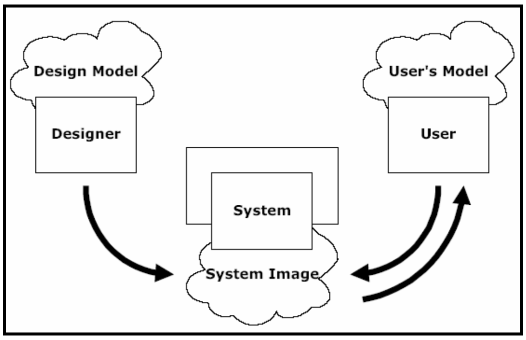


Figure 2.31. Norman's Conceptual Models. (Source: Norman, 1988)

The execution-evaluation cycle is the Norman's model of interaction (Norman, 1988). It is the most influential in Human-Computer Interaction. When the plan, or part of the plan, has been executed, the user observes the interface to evaluate the result of the executed plan, and to determine further actions. The interactive cycle can be divided into two major phases: execution and evaluation. These can be subdivided into further stages, seven in all. The stages in Norman's model of interaction are as follows (Dix and Finlay, 1993):

1. establishing the goal
2. forming the intention
3. specifying the action sequence
4. executing the action
5. perceiving the system state
6. interpreting the system state
7. evaluating the system state with respect to the goals and intentions

Each stage is an activity of the user. Firstly, the user forms a goal. This is the user's notion of what needs to be done and is framed in terms of the domain, in the task language. It is liable to be imprecise and therefore needs to be translated into the more specific intention, and the actual actions that will reach the goal, before the user can execute it. The user perceives the new state of the system, after execution of the action sequence, and interprets it in terms of his expectations. If the system state reflects the user's goal then the computer task has done what he wanted and the interaction has been successful; otherwise the user must formulate a new goal and repeat the cycle.

Norman uses this model of interaction to demonstrate why some interfaces cause problems to their users. He describes these in terms of the gulfs of execution and the gulfs of evaluation. The user and the system do not use the same terms to describe the domain and goals.

The term, “The gulf of execution” is the difference between the user's formulation of the actions to reach the goal, and the actions allowed by the system. If the actions allowed by the system correspond to those intended by the user, the interaction will be effective. The interface should therefore aim to reduce this gulf.

The term, "The gulf of evaluation" is the distance between the physical presentation of the system state and the expectation of the user. If the user can readily evaluate the presentation in terms of his goal, the gulf of evaluation is small.

The interaction framework attempts a more realistic description of interaction by including the system explicitly, and breaks it into four main components, as shown in Figure 2.32. The nodes represent the four major components in an interactive system-the System, the User, the Input and the Output. Each component has its own language. In addition to the User's task language and the System's core language, there are languages for both the Input and Output components to represent those separate, though possibly overlapping, components. Input and Output together form the Interface.

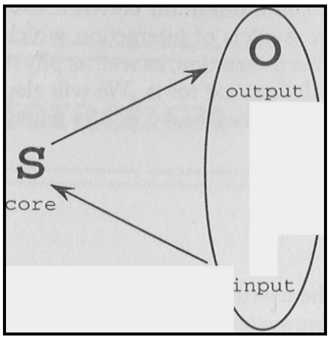


Figure 2.32. The general interaction framework. (Source: Dix and Finlay 1993)

Interaction could be seen as a dialogue between the computer system and the user. The choice of interface style can have a profound effect on the nature of this dialogue. There are a number of common interface styles including:

The command line interface was the first interactive dialogue style to be commonly used and, in spite of the availability of menu-driven interfaces, it is still widely used. Command language user interfaces use artificial languages, much like programming languages. They are concise and unambiguous, but they are often difficult for a novice to learn and remember. However, since they usually permit a user to combine constructs in new and complex ways, they can be more powerful for advanced users. For them, command languages provide a strong feeling that they are in charge and that they are taking the initiative rather than responding to the computer. Command language users must learn the syntax, but they can often express complex possibilities rapidly, without having to read distracting prompts. However, error rates are typically high, training is necessary, and retention may be poor. Error messages and on-line assistance are difficult to provide because of the diversity of possibilities and the complexity of relating tasks to computer concepts and syntax. Command languages and lengthier query or programming languages are the domain of the expert frequent users (power users), who often derive satisfaction from mastering a complex set of concepts and syntax. Command language interfaces are also the style most amenable to programming, that is, writing programs or scripts of user input commands.

Menu-based user interface explicitly presents the options available to a user at each point in a dialogue. Users read a list of items, select the one most appropriate to their task, type, or point to indicate their selection, verify that the selection is correct, initiate the action, and observe the effect. If the terminology and meaning of the items are understandable and distinct, users can accomplish their tasks with little learning or memorization and few keystrokes. The menu requires only that the user be able to recognize the desired entry from a list rather than recall it, placing a smaller load on long-term memory. The greatest benefit may be that there is a clear structure to decision making, since only a few choices are presented at a time. This interaction style is appropriate for novice and intermittent users. It can also be appealing to frequent users if the display and selection mechanisms are very rapid. A principal disadvantage is that they can be annoying for experienced users who already know the choices they want to make and do not need to see them listed. Well-designed menu systems, however, can provide bypasses for expert users. Menus are also difficult to apply to ‘‘shallow’’ languages, which have large numbers of choices at a few points, because the option display becomes too big. For designers, menu selection systems require careful task analysis to ensure that all functions are supported conveniently and that terminology is chosen carefully and used consistently. Software tools to support menu selection help in ensuring consistent screen design, validating completeness, and supporting maintenance.

Natural language is the most attractive means of communicating with computers, at least at first glance. Natural language understanding, both of speech and written input, is the subject of much interest and research. The ambiguity of natural language makes it very difficult for a machine to understand. Language is ambiguous at a number of levels. Firstly, the syntax, or structure, of a phrase may not be clear. When the sentence the man hit the boy with the stick is given, we cannot be sure, whether the stick is the instrument with which the boy was hit, or whether it is the boy's possession (See Figure 2.33).

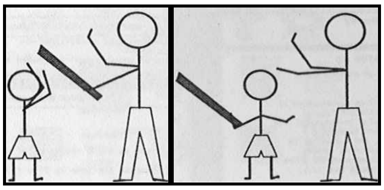


Figure 2.33. A man with a stick or a boy with a stick.
(Source: Dix and Finlay 1993)

Even if a sentence's structure is clear, ambiguity can befind in the meaning of the words used. For example, the word 'pitch' may refer to a sport's field, a throw, a waterproofing substance or even, colloquially, a territory. We often rely on the context and our general knowledge to sort out these ambiguities. This information is difficult to provide to the machine. To complete matters further, the use of pronouns and relative terms adds further ambiguity. The user must learn which phrases the computer understands and may become frustrated if too much is expected. However, it is also not clear how useful a general natural language interface would be. Language is by nature vague and imprecise: this gives it its flexibility and allows creativity in expression.

The principal benefit of *natural language* user interfaces is, of course, that the user already knows the language. The hope that computers will respond properly to arbitrary natural language sentences or phrases has engaged many researchers and system developers, but with limited success thus far. Natural language interaction usually provides little context for issuing the next command, frequently requires ‘‘clarification dialog,’’ and may be slower and more cumbersome than the alternatives. Therefore, given the state of the art, such an interface must be restricted to some subset of natural language, and the subset must be chosen carefully both in vocabulary and range of syntactic constructs. Such systems often behave poorly when the user veers even slightly away from the subset. Since they begin by presenting the illusion that the computer really can ‘‘speak English,’’ the systems can trap or frustrate novice users. For this reason, the techniques of human factors engineering can help. A human factors study of the task and the terms and constructs people normally use to describe it can be used to restrict the subset of natural language in an appropriate way, based on empirical observation. Human factors study can also identify tasks for which natural language input is good or bad. Although future research in natural language offers the hope of human-computer communication that is so natural it is ‘‘just like talking to a person,’’ such conversation may not always be the most effective way of commanding a machine. It is often more verbose and less precise than computer languages. In settings such as surgery, air traffic control, and emergency vehicle dispatching, people have evolved terse, highly formatted languages, similar to computer languages, for communicating with other people. For a frequent user, the effort of learning such an artificial language is outweighed by its conciseness and precision, and it is often preferable to natural language.

Question and answer dialogue system user interface is the place there is a simple mechanism for providing input to an application in a specific domain. The user is asked a series of questions (mainly with yes/no responses, multiple choice, or codes) and so is led through the interaction step by step. These interfaces are easy to learn and use. As such, they are appropriate for restricted domains, particularly information systems, and for novice or casual users.

Query languages on the other hand are used to construct queries to retrieve information from a database. They use natural language style phrases, but in fact require specific syntax, as well as knowledge of the database structure. Queries usually require the user to specify an attribute or attributes for which to search the database, as well as the attributes of interest to be displayed. The effective use of query languages therefore requires some experience.

Form-filling interfaces are used primarily for data entry but can also be useful in data retrieval applications. The user is presented with a display resembling a paper form, with slots to fill in. Often the form display is based upon an actual form with which the user is familiar, which makes the interface easier to use. The user works through the form filling in appropriate values. The data are then entered into the application in the correct place. Most form-filling interfaces allow easy movement around the form and allow some fields to be left blank. They also require correction facilities as users may change their minds or make a mistake about the value that belongs in each field. The dialogue style is useful primarily for data entry applications and, as it is easy to learn and use, for novice users. However, assuming a design that allows flexible entry, form filling is also appropriate for expert users. Seeing the full set of related fields on the screen at one time in, a familiar format is often very helpful. Form fill-in interaction does require that users understand the field labels, know the permissible values, be familiar with typing and editing fields, and be capable of responding to error messages. These demands imply that users must have some training or experience.

The WIMP environment system interface supports the presentations of windows are called windowing systems. Figure 2.34. gives an impression of what a typical windowing system looks like. WIMP stands for windows, icons, menus and pointers, and is the default interface style for the majority of interactive computer systems in use today, especially in the PC and desktop workstation arena.

Windows can usually contain text or graphics, and can be moved or resized. More than one window can be on a screen at once, allowing separate tasks to be visible at the same time. Users can direct their attention to the different windows as they switch from one thread of work to another. If one window overlaps the other, then the back window is partially obscured, and then refreshed when exposed again. Usually, windows have various things associated with them that increase their usefulness. Bars are one such attachment, allowing the user to move the contents of the window up and down, or from side to side. This makes the window behave as if it were a real window onto a much larger world, where new information is brought into view by manipulating the scrollbars. There is usually a title bar attached to the top of a window, identifying it to the user, and there may be special boxes in the corners of the window to aid resizing, closing, or making as large as possible. Each of these can be seen in Figure 2.34.

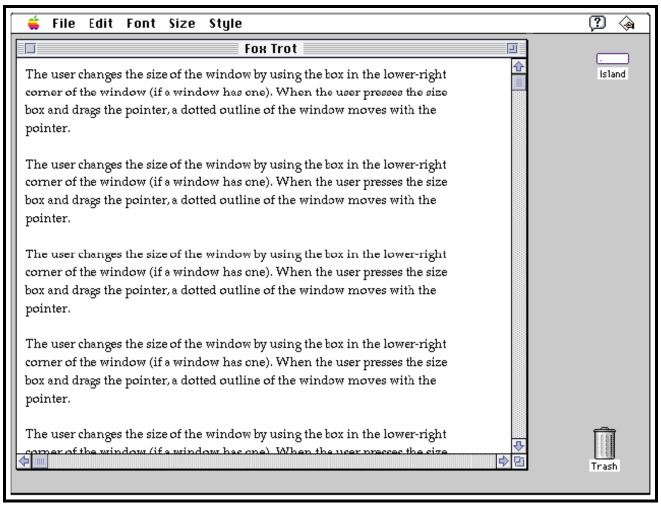


Figure 2.34. An appearance of window system

(Source: http://www.designboom.com/portrait/kare.html)

Icon is a small picture used to represent a closed window. By allowing icons, many windows can be available on the screen at the same time, ready to be expanded to their full size by clicking on the icon. Figure 2.35 shows a few examples of some icons used in a typical windowing system.

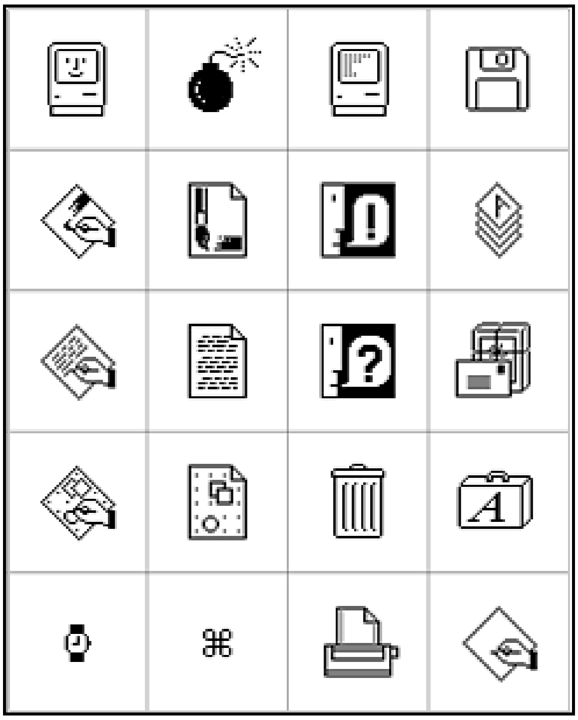


Figure 2.35. Macintosh icons designed by Susan Kare
(Source: http://www.designboom.com/portrait/kare.html)

Icons is also used to represent other aspects of the system, such as a wastebasket for throwing unwanted files into, or various disks and programs that are accessible to the user. Icons can take many forms; they can be realistic representations of the objects that they represent, or they can be highly stylized. They can even be arbitrary symbols.

Pointer is an important component of the WIMP interface, since the interaction style required by WIMP relies very much on pointing and selecting things such as icons. The user is presented with a cursor on the screen that is controlled by the input device. A variety of pointer cursors is shown in Figure 2.36.

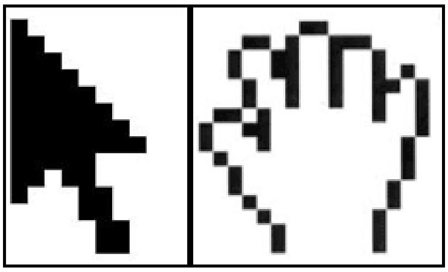


Figure 2.36. A variety of pointer cursors.
(Source: http://www.designboom.com/portrait/kare.html)

The last main feature of window system is the menus, an interaction technique that is common across many non-windowing systems as well. A menu presents a choice of operations or services that can be performed by the system at a given time. Menus provide information cues in the form of an ordered list of operations that can be scanned. This implies that the names used for the commands in the menu should be meaningful and informative. The pointing device is used to indicate the desired option. As the pointer moves to the position of a menu item, the item is usually highlighted to indicate that it is the potential candidate for selection. Selection usually requires some additional user action, such as pressing a button on the mouse that controls the pointer cursor on the screen or pressing some special key on the keyboard. The main menu should be always visible to the user and sub-menus should be pulled down or across from it upon request.

The major problems with menus in general are what to include in the menus and how to group the items. Including too many items makes menus too long or creates too many of them, whereas grouping causes problems in that items all relating to the same topic need to come under the same heading, but many items could be grouped under more than one heading. These groupings should be consistent across applications so that the user can transfer learning to new applications. Menu items should be ordered in the menu according to importance and frequency of use, and opposite functionalities, such as save and delete, should be kept apart to prevent accidental selection of the wrong function, with potentially disastrous consequences.

In a graphical or direct manipulation style of user interface, a set of objects is presented on a screen, and the user has a repertoire of manipulations that can be performed on any of them. This means that the user has no command language to remember beyond the standard set of manipulations, few cognitive changes of mode, and a reminder of the available objects and their states shown continuously on the display. Examples of this approach include painting programs, spreadsheets, manufacturing or process control systems that show a schematic diagram of the plant, air traffic control systems, some educational and flight simulations, video games, and the Xerox Star desktop and its descendants (Macintosh, Windows, and various X Window file managers). By pointing at objects and actions, users can rapidly carry out tasks, immediately observe the results, and, if necessary, reverse the action. Keyboard entry of commands or menu choices is replaced by cursor motion devices, such as a light pen, joystick, touch screen, trackball, or mouse, to select from a visible set of objects and actions. Direct manipulation is appealing to novices, is easy to remember for intermittent users, encourages exploration, and, with careful design, can be rapid for power users. The key difficulty in designing such interfaces is to find suitable manipulable graphical representations or visual metaphors for the objects of the problem domain, such as the desktop and filing cabinet.

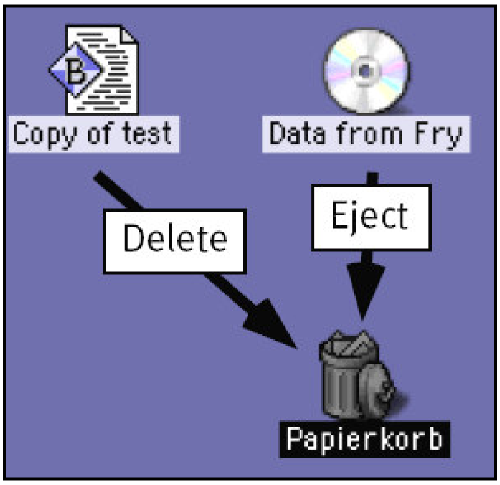


Figure 2.37. The trashcan metaphor of Macintosh desktop.
(Source: http://devworld.apple.com/techpubs/mac/pdf/HIGuidelines.pdf)

A principal drawback of direct manipulation is that it is often difficult to create scripts or parameterized programs in such an inherently dynamic and ephemeral language. In a well-designed direct manipulation interface, the user's input actions should be as close as possible to the user's thoughts that motivated those actions; the gap between the user's intentions and the actions necessary to input them into the computer should be reduced. Direct manipulation interfaces have enjoyed great success, particularly with new users, largely because they draw on analogies to existing human skills (pointing, grabbing, moving objects in space), rather than trained behaviors.

Virtual reality environments carry the user's illusion of manipulating real objects and the benefit of natural interaction still further. By coupling the motion of the user's head to changes in the images presented on a head-mounted display, the illusion of being surrounded by a world of computer-generated images, or a virtual environment, is created. Hand-mounted sensors allow the user to interact with these images as if they were real objects located in space surrounding him or her. *Augmented reality* interfaces blend the virtual world with a view of the real world through a half-silvered mirror or a TV camera, allowing virtual images to be superimposed on real objects and annotations or other computer data to be attached to real objects. The state of the art in virtual reality requires expensive and cumbersome equipment and provides very low resolution display, so such interfaces are currently used mainly where a feeling of ''presence'' in the virtual world is of paramount importance, such as training of fire fighters or treatment of phobias. As the technology improves, they will likely find wider use. Virtual reality interfaces, like direct manipulation interfaces, gain their strength by exploiting the user's pre-existing abilities and expectations. Navigating through a conventional computer system requires a set of learned, unnatural commands, such as keywords to be typed in, or function keys to be pressed. Navigating through a virtual reality system exploits the user's existing, natural ''navigational commands,'' such as positioning his or her head and eyes, turning his or her body, or walking toward something of interest. The result is a more natural user interface, because interacting with it is more like interacting with the rest of the world.

CHAPTER 3

FUNDAMENTALS ON DESIGN PROCESS OF GRAPHICAL USER INTERFACE

The term 'Industrial Design' describes the creation of products and systems that satisfy human needs and improve people's lives. In understanding the needs of the end user, the industrial designer represents a communication link between the consumer and all others participating in the product development process. In this framework an industrial designer is seen to be an expert who is able to interpret human users and implement their psychological, physical and cultural characteristics in the design of a product and integrate them with all necessary technical and production requirements. This responsibility requires highly developed research and visualisation skills, as well as an intimate knowledge of a vast range of manufacturing processes.

Industrial designers typically follow a formal process in developing products for manufacture. This generally starts with product research required to identify needs and wants of the intended users. According to Shneiderman (1987), human and machines differ from each other. The table 3.1 shows the distinction of human and machine.

Table 3.1. Relative Capabilities of humans and machines. (Source: Shneiderman 1987)

Humans better at:	**Machines better at:**
Sense low level stimuli Detect stimuli in noise Recognize constant patterns in varying situations Sense unusual and unexpected events Remember principles and strategies Retrieve pertinent details a priori Draw on experience and adapt decisions	Sense stimuli outside human range Count or measure physical quantities Store quantities of coded information accurately Monitor specified (and infrequent) events Make rapid and consistent responses to input signals Recall quantities of detailed information accurately

Humans better at:	Machines better at:
Select alternatives Reason inductively; generalize from observations Act in emergency or novel situations Apply principles Make subjective evaluations Concentrate on important tasks when overload occurs Adapt physical response	Process quantitative data Reason deductively; infer from principles Perform repetitive preprogrammed actions reliably Exert high forces Perform simultaneous activities Maintain operation under heavy load Maintain performance over extended periods of time

3.1. Design Considerations

The Eight Golden Rules of Interface Design (Dix and Finlay, 1993) presents underlying principles of design that are applicable in most interactive systems. These principles of interface design should be validated and refined in design process.

Strive for Consistency: It is very important to make sure that the interface is consistent. All fonts should be match, terminology should be similar throughout, and layout is to be consistent. Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent color, layout, capitalization, fonts, and so on should be employed throughout.

Enable Frequent Users to Use Shortcuts: When users begin to use the software more, they want to be able to reduce the amount of time it takes to interact with the program. Usage of shortcuts helps cut time from the frequent user's day. As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Frequent knowledgeable users appreciate abbreviations, special keys, hidden commands, and macro facilities. Short response times and fast display rates are other attractions for frequent users.

Offer Informative Feedback: Since every interaction the user has with the computer should have a response, make them informative but not distractive. For every user action, there should be system feedback. For frequent and minor actions, the response can be modest, whereas for infrequent and major actions, the response should be more substantial.

Design Dialogs to Yield Closure: During sequences of actions, it is important to allow the user to yield. This allows the user more control of what the program is doing.

Offer Error Prevention and Simple Error Handling: As often as possible when designing the project, avoid opportunities for the user to cause a critical error. For example, when a user inputs a number when a letter is needed, do not allow the number to be entered. This will avoid an error.

Permit Easy Reversal of Actions: All actions that can be reversible should be. This allows the user to make something undo that might have been a mistake or was not appealing to them.

Support Internal Locus of Control: Users want to feel in control of the software. If the user does not feel in control, they will feel anxiety and dissatisfaction

Reduce Short-Term Memory Load: It should be realized that human short-term memory is not perfect. This limitation should be recognized when designing. Too much information is bad information

Additionally, when organizing the display design, using these rules (Shneiderman, 1987, p.80) provides the experience that is more effective.

- Consistency of data-entry transactions; delimiters, abbreviations, etc
- Minimal input actions by user
- Minimal memory load on user
- Compatibility of data entry with data display
- Flexibility for user control of data entry

3.2. Concepts of Graphical User Interface Design

To achieve the successful interaction of user and product, there are some principles that should be in consider (Shneiderman, 1987). These principles of interface design underlined and derived heuristically from experience should be applied. WEB_10 (2004)

3.2.1. Learnability vs. Usability

The goal of the user interface should be foremost in the design process. For example, a visitor information system located on a kiosk will be designed; the primary goal for the interface designers should be ease of operation for the first-time user.

In contrast, consider a data entry system used daily by an office of heads-down operators. Here the primary goal should be that the operators could input as much information as possible as efficiently as possible. Once the users have learned how to use the interface, anything intended to make first-time use easier will only get in the way.

3.2.2. Metaphors and Idioms

Apple's & Window's "desktop" is such a metaphor where operations of mathematics, processing of flows of data are translated into icons that are called "documents" and which are stored in "folders". The metaphor, however, is important, because it explains how things work. However, the designer must be careful that the implementation of the metaphor provides a lucid and inviting translation of functions and benefits, rather than becoming itself a level of obfuscation of and adversity in using the application.

Most visual elements of the graphical user interface are better thought of as idioms. A scroll bar, for example, is not a metaphor for anything in the physical world. It is an entirely new construct, yet it performs an obvious function, its operation is easily mastered, and users easily remember how it works. It is the visual aspect of the scroll bar that allows easy-learn. Users operate it with visual clues rather than remembering the keys for line up, line down, page up, page down, etc.

The use of metaphor can be helpful when it fits well into a situation. The use of icons as metaphors for functions is a good example. It can be a gamble if someone will understand the connection between an icon and the function.

Figure 3.1. Microsoft Word 5.0 toolbar.

(Source: http://cfg.cit.cornell.edu/cfg/design/concepts.html#global)

In the Microsoft Word 5.0 toolbar (see figure 3.1), some icons area readily identifiable, some are not. The unidentifiable icons, however, can be utterly perplexing, and rather than helping, they can create confusion and frustration. Moreover, with so many pictographs crammed into such a small space.

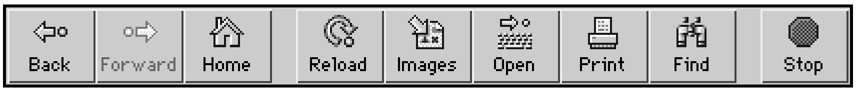


Figure 3.2. The Netscape toolbar.
(Source: http://cfg.cit.cornell.edu/cfg/design/concepts.html#global)

The Netscape toolbar (see figure3.2), by contrast, can be considered much more graceful and useful. The buttons are a bit larger, which makes them generally more readable. Their added size also allows the inclusion of text labels indicating the command to which the icon corresponds. Once the meaning of each icon has become learned the icon can serve as a visual mnemonic, but until then the text label clearly and unambiguously relays the function the button will initiate.

The Netscape toolbar admittedly consumes more valuable window real estate than the Microsoft Word toolbar does. There are keystroke shortcuts for every button, however, and users who have mastered them can easily hide the toolbar from view. Users who prefer to use the toolbar are probably willing to sacrifice that small bit of real estate in order to have a toolbar that is presentable and easy to use.

One major pitfall into which metaphors can lead us is the "Global Metaphor", which is a metaphor that is intended to encompass an entire application. The "desktop" concept is an example of a global metaphor.

The global metaphor becomes a quagmire when reality begins to diverge from the metaphor. Consider carefully the desktop metaphor. It can be seen how it deviates from reality immediately. The trashcan is a wonderful metaphor for the deletion function, but trashcans are generally not situated on the top of a desk.

The use of the trashcan to eject a disk is a perfect example of contorting the metaphor to accommodate the divergence from reality. The expectation is that "trashing" a disk will delete its contents, yet the interface designers needed a way to eject a disk and the trashcan came closer than anything else did. Once learned it becomes an idiom that works fine, but it is initially counter-intuitive to the point that it is shocking.

The vertical aspect of the desktop also subverts the metaphor. It is closer to a refrigerator on which one can randomly place differently shaped magnets, or the old-fashioned displays on which TV weathermen placed various symbols. The fact that the desktop metaphor has to be explained to first-time users is an indication that it might not be terribly intuitive.

Metaphors are perceived as being useful. As in all other situations, the usefulness of a global metaphor is dictated by the overall goals of the interface. If the goal of the interface is to present a non-threatening face on a system that will be used primarily by non-technical first-time users, a global metaphor might be useful.

3.2.3. Intuitiveness

It is generally, perceived that the most fundamental quality of any good user interface should be that it is intuitive. The problem is that "intuitive" means different things to different people. To some an intuitive user interface is one that users can figure out for themselves. There are some instances where this is helpful, but generally, the didactic elements geared for the first-time user will hamper the effectiveness of intermediate or advanced users.

A much better definition of an intuitive user interface is one that is easy to learn. This does not mean that no instruction is required, but that it is minimal and that users can "pick it up" quickly and easily. First-time users might not sense how to operate a scroll bar, but once it is explained they generally find it to be an intuitive idiom.

Icons, when clearly unambiguous, can help to make a user interface intuitive. Nevertheless, the user interface designer should never overlook the usefulness of good old-fashioned text labels. Icons depicting portrait or landscape orientation, for example, are clearly unambiguous and perhaps more intuitive than the labels themselves, but without the label of "orientation," they could make no sense at all.

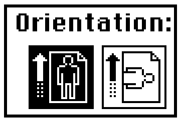


Figure 3.3. Orientation.
(Source: http://cfg.cit.cornell.edu/cfg/design/concepts.html#global)

Labels should be concise, cogent, and unambiguous. A good practice is to make labels conform to the terminology of the business that the application supports. This is a good way to pack a lot of meaning into a very few words.

3.2.4. Consistency

The use of labels and icons must always be consistent. The same label or icon should always mean the same thing, and conversely the same thing should always be represented by the same label or icon.

There is a different panel for every address that can be updated, each with its own set of fields to be displayed and modified. Note that each panel is clearly labeled, with the label appearing in the same location on every panel. A button bank appears in the same place along the left side of every panel. Some buttons must change to accommodate the needs of any given panel, but positionality was used consistently. The closer buttons are to the top the less likely they are to change, and the closer to the bottom the more likely.

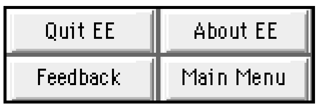


Figure 3.4. Permanent objects.
(Source: http://cfg.cit.cornell.edu/cfg/design/concepts.html#global)

They are known as "permanent objects." Early navigators used stars and constellations as unchanging reference points around which they could plot their courses. Similarly, modern aviation navigators use stationary radar beacons. They know that wherever the plane is, they can count on the radar beacon always being in the same place.

Designers should always provide permanent objects as unchanging reference points around which the users can navigate. If they ever are lost or disoriented, they should be able to quickly find the permanent objects and from there get to where they need to be. On the Macintosh, the apple menu and applications menu are examples of permanent objects. No matter what application the user is in, those objects will appear on the screen.

Most all Macintosh applications provide "File" and "Edit" as the first two pull-down menus. The "File" menu generally has "New" "Open" "Close" "Save" and "Save As" as the first selections in the menu, and "Quit" as the last selection. The "Edit" menu generally has "Cut," "Copy," and "Paste" as the first selections. The ubiquity of these conventions has caused them to become permanent objects. The users can count on finding them in virtually all circumstances, and from there do what they need to do.

3.2.5. Simplicity

The complexity of computers and the information systems they support often causes us to overlook Occam's razor, the principle that the most graceful solution to any problem is the one that is the most simple.

A good gauge of simplicity is often the number of panels that must be displayed and the number of mouse clicks or keystrokes that are required to accomplish a particular task. All of these should be minimized. The fewer things users have to see and do in order to get their work done, the happier and more effective they will be.

A good example of this is the way in which the user sets the document type in Microsoft Word version 5.0 as compared to version 4.0. In version 4.0, the user clicks a button on the save dialog that presents another panel in which there is a selection of radio buttons indicating all the valid file types. In version 5.0, there is simply a popup list on the save dialog. This requires fewer panels to be displayed and fewer mouse clicks to be made, and yet accomplishes exactly the same task.

3.2.6. Prevention

A fundamental rule of graphic user interfaces is that it is preferable to prevent users from performing an inappropriate task in the first place rather than allowing the task to be performed and presenting a message afterwards saying that it could not be done. This is accomplished by disabling, or "graying out" certain elements under certain conditions. Consider the average save dialog. A document could not be saved if it has not been given a name. Note how the Save button is disabled when the name field is blank, but is enabled when a name has been entered.

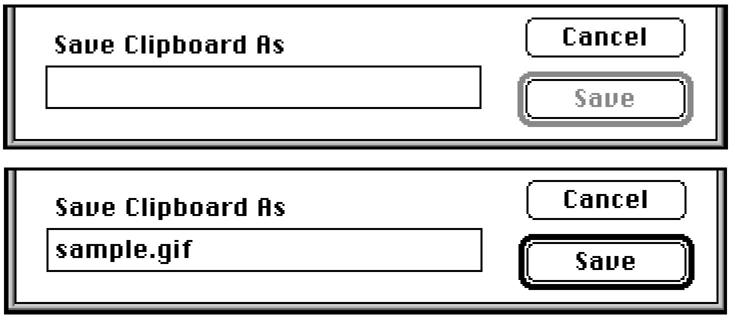


Figure 3.5. Save.(Source: http://cfg.cit.cornell.edu/cfg/design/concepts.html#global)

3.2.7. Forgiveness

One of the advantages of graphic user interfaces is that with all the options plainly laid out for users, they are free to explore and discover things for themselves. A good tip to keep users from inadvertently causing damage is to avoid the use of the Okay button in critical situations. It is much better to have button labels that clearly indicate the action that will be taken.

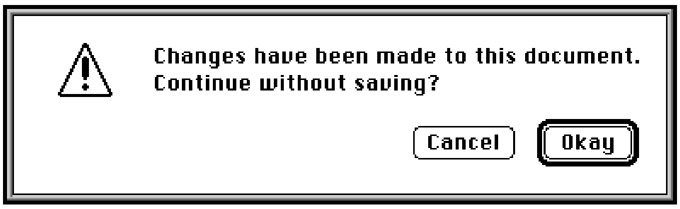


Figure 3.6. Okay.(Source: http://cfg.cit.cornell.edu/cfg/design/concepts.html#global)

Consider the example when the user closes a document that contains changes that have not been saved. It can be very misleading to have a message that says "Continue without saving?" and a default button labeled "Okay." It is much better to have a dialog that says, "Document has been changed" and a default button labeled "Save", with a "Don't save" button to allow the user not to save changes if that is, in fact, the desired action.

Figure 3.7. Delete.(Source: http://cfg.cit.cornell.edu/cfg/design/concepts.html#global)

Likewise, it can be helpful in potentially dangerous situations to have the Cancel button be the default button so that it must be a deliberate action on the part of the user to execute the function. An example is a confirmation dialog when a record is being deleted.

3.2.8. Aesthetics

It is important that a user interface be aesthetically pleasing. It is possible for a user interface to be intuitive, easy to use, and efficient and still not be terribly nice to look at. While aesthetics do not directly influence the effectiveness of a user interface, users will be happier and therefore more productive if they are presented with an attractive user interface (See Figure 3.8).

Figure3.8. Icons of Aqua look Finder for MacOS X.
(Source: www.liquidinformation.org/dock/index_internal.html)

3.3. Phases of Design Process

The objective of any user interface developer should be to design and implement quality user interfaces. The best way to ensure quality of user interface design is to use an orderly and well-defined design process that is specifically geared to producing quality results. This applies to the design of the application that the user interface supports as well as the design of the user interface itself. All application design methodologies break the development process down into discrete phases. Below are some typical phases. WEB_11 (2004)

Table 3.2. The Process of User Interface Design.
(Source:www.lge.com/products/homenetwork/internetproduct/
washingmachine/monitoring.jsp)

Phase	**Description**
Requirements	Determine the requirements for the application
Conceptual Design	Model the underlying business that the application will support
Logical Design	Design in general terms how the application will operate
Physical Design	Design in specific terms how the application will be constructed
Construction	Construct the application
Usability Testing	Test the usability of the user interface

Requirements

Before the design process begins in earnest, there is a lot of work that needs to be done. If the application is to be accepted by those who have a stake in it, it is imperative that inventors be involved from the very beginning. Investors should be polled as to what they consider their requirements for the application to be. Below, there are some steps that will help leaded to a successful requirements phase. WEB_11 (2004)

- Assemble the design team
  - Identify all investor groups
  - Select representatives to participate on the design team
- Gather Requirements:
  - Interview as many investor as is practical to determine:
    - What the underlying business problems are that this application should address
    - What benefits the application should provide
    - What the critical success factors are
- Define the scope of the project
  - Review the requirements that have been gathered
  - Make decisions about what will be included and what will not
  - If the scope of the project gets too large, consider breaking it down into stages.

The Conceptual Design Phase

This phase is concerned with modeling the underlying business that the application will support. User interface considerations are not addressed at this time. The objective is to model the business irrespective of any implementation issues.

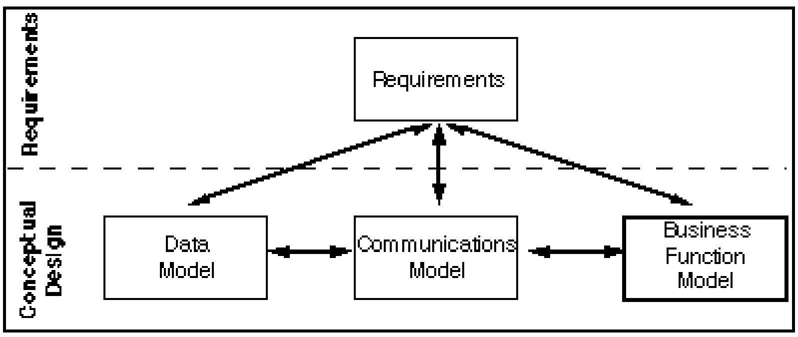


Figure3.9. Parts of Conceptual Design.
(Source: http://cfg.cit.cornell.edu/cfg/design/concepts.html#global)

One approach divides the conceptual design into three parts. The Data Model identifies data entities and defines the relationships between them. The Business Function Model defines the scope of the business with respect to the application, and breaks it down into component business functions. The Communications Model, also referred to as a Data Flow Diagram, maps the interactions between the component business functions and the data entities.

Logical Design

The Logical Design phase gets into more specifics about how the application will support the business that was modeled in the Conceptual Design phase. The prototyping of user interfaces should kick off the Logical Design phase. By determining what events will occur on the client (e.g. clicking a button or selecting something from a scrolling list), the logical processes that support them can be designed. These events and processes are then broken down into "system functions."

Determining the specific technology (i.e. hardware and software) in which the application will be developed is somewhat of a chicken-and-egg process. The earlier the technology is determined, the more decisions can be made about what the user interface will and will not be able to do. However, for the same reason, the requirements about what the user interface should be able to do can drive the decision of what technology ultimately is selected. The bottom line is that the sooner decisions are made regarding the technology, the more successful the logical design will ultimately be.

Along these lines, it is important to determine the minimum hardware configuration the application will cater to. For example, a particular user interface might look very good on a large color monitor, but be very difficult to use on a small black and white monitor. The decision must be made as to whether the user interface will cater to the small black and white monitor, or if it is okay to design around the large color monitor. Both solutions are valid, depending on the circumstances, but it must be a conscious decision.

Physical Design

The Physical Design phase is concerned with determining how the logical design will be implemented on specific physical platforms. The technology in which the application will be developed must be conclusively determined before the Physical Design phase can begin.

This phase will not directly affect user interface design; unless it is revealed that, it is not possible to physically implement certain aspects of the logical design.

Construction

It is in the construction phase that the application is actually programmed. The most important thing to consider at this point is that just because the application is being constructed does not mean that the design process has concluded. When the users get something in their hands that actually functions, they will inevitably change their minds as to how they want things to work.

For this reason, it is important to get functional interfaces in the users' hands as early as possible. If they request a change that winds up being somewhat fundamental, less re-designing will be required the earlier the change is identified.

Usability Testing

Usability Testing is a technique that can validate the user interface design and reveal areas in which it requires refinement. The basic concept is to simply observe users as they operate the interface. They should be instructed to verbalize their thought process as they go along. It should be noted that this is often more an exercise in testing how easy a user interface is to learn than how easy it is to use. If the learnability of the user interface is the primary goal of the design, uninitiated users should be selected, they should be given minimal instruction or guidance, and the observers should look for areas in which the testers are having trouble figuring the user interface out. If the ease of use of the interface is the primary goal, novice users should be selected and the observers should look for areas in which the testers are having trouble generally using the interface or remembering how certain things work.

Either way it is very important that this technique not be used as a substitute for fundamental interface design. It is a mistake to de-emphasize the design process with the rationalization that shortcomings will be revealed during usability testing. That would be like ignoring the recipe for a meal because it is possible to add salt and pepper later. Usability testing is a process of validation and refinement. It is not part of the design process itself. The more testers that participate in this exercise, the better the results will be. If one or two users have trouble in one particular area, which might not necessarily indicate a problem. However, if majorities of testers run into the same problem or similar patterns emerge, it can be apparent that certain parts of the user interface require attention.

3.4. Standarts for Human Computer Interaction

It is often assumed that a standard means a precise specification. Such standards have brought benefits in many fields, eg: ATMs that can read credit cards and computers that can read programming languages. Some human computer interaction standarts are also of this type: many design guides provide a detailed specification of the nature of the user interface. Although standard user interfaces provide the benefit of consistency, they become out of date as technology changes, and are usually only appropriate for limited types of users and tasks (Bevan and Holdaway, 1993). Thus, most work on international standards for human computer interaction has not been about precise specification, but instead has concentrated on the principles that need to be applied in order to produce an interface that meets user and task needs. These standards broadly fall into two categories. One is a "top-down" approach that is concerned with usability as a broad quality objective: the ability to use a product for its intended purpose. The other is a product-oriented "bottom-up" view, which is concerned with aspects of the interface that make a system easier to use. The broad quality view originates from human factors, and standards of this type are applicable in the broad context of design and quality objectives. The product-oriented view concentrates on the design of specific attributes, and relates more closely to the needs of the interface designer and the role of usability in software engineering (see Bevan, 1995). This section explains how standards could be used to provide a means of meeting the requirements for the operator-computer interface in the European Directive on Display Screen Equipment.

Usability oriented standards relate to usability as a high level quality objective, and usability is defined in this way in ISO 9241-11:

Usability: the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. Standards of this type can be used to support the following activities:

- specification of overall quality and usability requirements and evaluation against these requirements (ISO 9241-11 and ISO/IEC 14598-1)
- incorporation of usability into a quality system (ISO 9241-11)
- incorporation of usability into the design process (ISO/IEC 13407).

Product-oriented standards related to **i**n the product-oriented view, usability is seen as one relatively independent contribution to software quality, and is defined in this way in ISO/IEC 9126:

Usability: a set of attributes of software which bear on the effort needed for use and on the individual assessment of such use by a stated or implied set of users.

It describes standards which deal with usability in terms of attributes which must be designed into a software product to make it easy to use:

ISO 9241: Ergonomics requirements for office work with visual display terminals: Part 10, 12-17: dialogue design

ISO/IEC 10741-1 Dialogue interaction - Cursor control for text editing

ISO/IEC 11581 Icon symbols and functions

ISO/IEC 9126 Software product evaluation - Quality characteristics and guidelines for their use

These standards can be used in the following ways:

- To specify details of the appearance and behaviour of the user interface
- To provide detailed guidance on the design of user interfaces
- To provide criteria for the evaluation of user interfaces

However, the attributes, which a product requires for usability, depend on the nature of the user, task and environment. A product has no intrinsic usability, only a capability to be used in a particular context. ISO 9241-11 helps understand the context in which particular attributes may be required.

ISO 9241-11 Guidance on Usability explains how usability can be specified and evaluated in terms of user performance and satisfaction. User performance is measured by the extent to which the intended goals of use are achieved (effectiveness) and the resources such as time, money or mental effort that have to be expended to achieve the intended goals (efficiency). Satisfaction is measured by the extent to which the user finds the use of the product acceptable.

ISO 9241-11 also emphasises that usability is dependent on the context of use and that the level of usability achieved will depend on the specific circumstances in which a product is used. The context of use consists of the users, tasks, equipment (hardware, software and materials), and the physical and organisational environments which may all influence the usability of a product (see Figure 3.10).

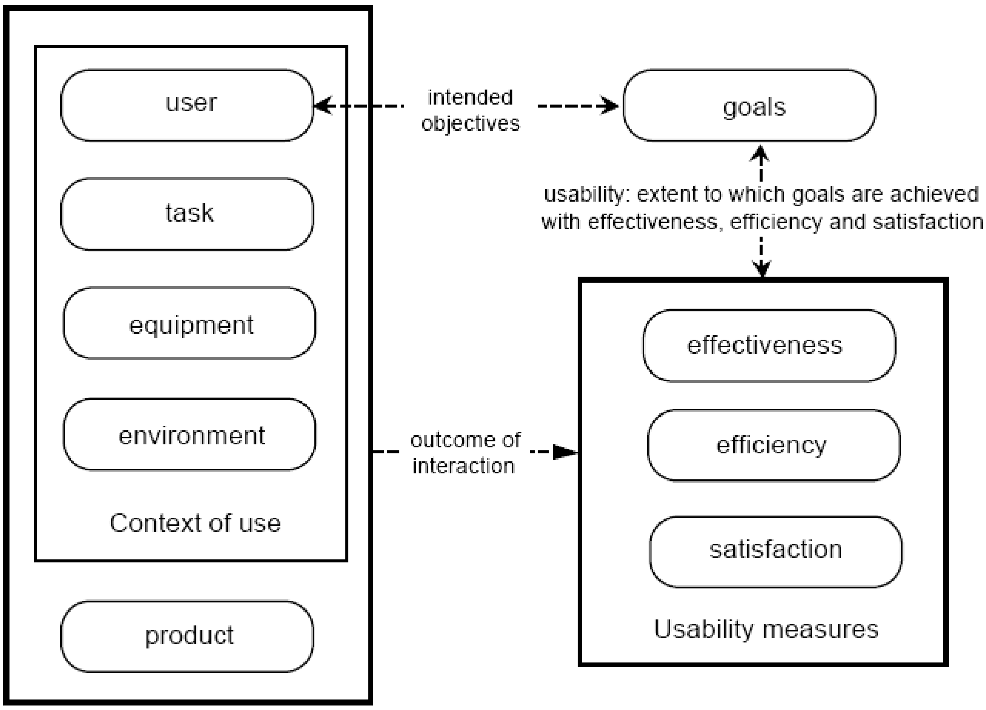


Figure 3.10. Usability framework (Source: Bevan 1995)

Dealing with usability as part of a **Quality Systems and ISO 9001** for design and development of products, as specified in ISO 9001, involves the systematic identification of requirements for usability, including usability measures and verifiable descriptions of the context of use. These provide design targets which can be the basis for verification of the resulting design. ISO 9001 specifies what is required for a quality system. A quality system is a documented set of procedures intended to ensure that a product will meet initially stated requirements. A quality system is a desirable (though not sufficient) condition for achieving quality of the end product. ISO 9241-11 describes how the usability of a product can be defined, documented and verified as part of a quality system which conforms to ISO 9001 (Figure 3.10). The overall context of use should be identified, usability requirements should be specified, usability issues should be monitored during development, and the usability achieved should be evaluated.

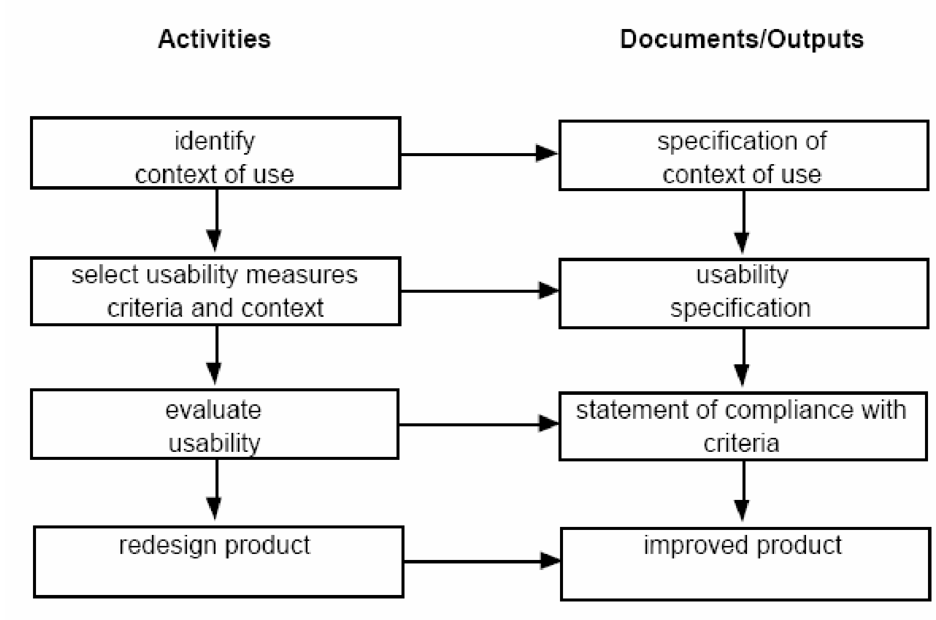


Figure 3.11. Quality Plan (Source: Bevan 1995)

Overall context of use: Information about the characteristics of users, their goals and tasks and the environments in which the tasks are carried out provides important information for use in the specification of overall product requirements, prior to development of specific usability requirements.

Usability requirements: Prior to development of a custom system, the purchasing organisation should specify the usability requirements which the system must meet and against which acceptance testing may be carried out. Specific contexts in which usability is to be measured should be identified, measures of effectiveness, efficiency and satisfaction selected, and acceptance criteria based on these measures established.

Monitor usability: At various stages during the development process the developer should measure the usability achieved against these targets. This information enables objective decisions to be taken about the need for design changes to enhance usability, and about tradeoffs which may be appropriate between usability and other requirements.

Usability evaluation: The characteristics of the context in which a product is likely to be used need to be identified. To ensure the validity of test results the users, tasks and environments used for the evaluation should match the real context of use as closely as possible.

ISO 9241-11 introduces the concept of a work system, consisting of users, equipment, tasks and a physical and social environment, for the purpose of achieving particular goals. Measures of user performance and satisfaction assess the quality of the work system in use, and, when a product is the focus of concern, these measures provide information about the usability of that product in the particular context of use provided by the rest of the work system.

ISO 9241-11 defines the quality of a work system in use as:

Quality of a work system in use: the extent to which specified goals can be achieved with effectiveness, efficiency, and satisfaction in a specified work system. The difference between usability and the quality of a work system in use is a matter of focus. When usability is evaluated, the focus is on improving a product while the other components of the work system (user, task, equipment, and environment) are treated as given. If the aim is to improve the quality of the overall work system in use, any part of the work system may be the subject of design or evaluation. For example, it may be appropriate to consider the amount of user training to be provided, changes in lighting, or re-organisation of the task. In this case, the element, which is the object of design or evaluation, is considered to be subject to potential variation, while the other elements of the work system are treated as fixed.

Software quality evaluation

ISO 8402 (Quality Vocabulary) defines quality as:

Quality: the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs.

This defines quality in terms of the characteristics of a product. To the extent that user needs are well-defined and common to the intended users it implies that quality is an inherent attribute of the product. However, if different groups of users have different needs, then they may require different characteristics for a product to have quality.

ISO/IEC 14598-1 (Information Technology - Evaluation of Software Products – General guide) distinguishes between the concept of quality as an inherent characteristic of the product, and quality of use:

Quality of use: the extent to which an entity satisfies stated and implied needs when used under stated conditions The ultimate objective of software quality evaluation is to ensure that the product provides quality of use - that it meets the needs of the users. (Users may include operators, recipients of the results of the software, or maintainers of software.) This definition of quality of use is very similar to the definitions of usability and the quality of a work system in use in ISO 9241-11. The only difference is that ISO 9241-11 specifically defines the needs in terms of user performance and satisfaction, and the stated conditions in terms of users, goals, and environments. Internal software quality attributes (such as the functionality, usability, and efficiency attributes defined in ISO/IEC 9126) can be used as indicators to estimate final software quality. The specific internal attributes, which are relevant to final quality of use, will depend on the intended conditions of use - for an interactive product this will depend on the needs of the eventual end users and the tasks.

To achieve the overall objective of usability and quality of use requires a human-centred approach to design. This is the subject of a standard under development: ISO 13407 (Humancentred design process for interactive systems). This standard is expected to cover topics including: planning the usability process, incorporating human-centred design activities in interactive system development processes, and assessing the benefits of human-centred design.

Usable products may be designed by incorporating product features and attributes known to benefit users in particular contexts of use. ISO 9241 provides requirements and recommendations relating to the attributes of the hardware, software and environment which contribute to usability, and the ergonomic principles underlying them. The following parts of ISO 9241 and other standards deal with attributes of the software:

ISO 9241-10: Dialogue principles which is a part of ISO 9241 deals with general ergonomic principles which apply to the design of dialogues between humans and information systems: suitability for the task, suitability for learning, suitability for individualisation, conformity with user expectations, self descriptiveness, controllability, and error tolerance

ISO 9241-12: Presentation of information, which is a part of ISO 9241, contains specific recommendations for presenting and representing information on visual displays. It includes guidance on ways of representing complex information using alphanumeric and graphical/symbolic codes, screen layout, and design as well as the use of windows.

ISO 9241-13: User guidance: This part provides recommendations for the design and evaluation of user guidance attributes of software user interfaces including Prompts, Feedback, Status, On-line Help and Error Management.

ISO 9241-14: Menu dialogues. This part provides recommendations for the ergonomic design of menus used in user-computer dialogues. The recommendations cover menu structure, navigation, option selection and execution, and menu presentation (by various techniques including windowing, panels, buttons, fields, etc.). Part 14 is intended to be used by both designers and evaluators of menus (however, its focus is primarily towards the designer).

ISO 9241-15: Command language dialogue. This part provides recommendations for the ergonomic design of command languages used in user-computer dialogues. The recommendations cover command language structure and syntax, command representations, input and output considerations, and feedback and help. Part 15 is intended to be used by both designers and evaluators of command dialogues, but the focus is primarily towards the designer.

ISO 9241-16: Direct manipulation dialogues. This part provides recommendations for the ergonomic design of direct manipulation dialogues, and includes the manipulation of objects, and the design of metaphors, objects and attributes. It covers those aspects of "Graphical User Interfaces" which are directly manipulated, and not covered by other parts of

ISO 9241-17: Form-filling dialogues. This part provides recommendations for the ergonomic design of form filling dialogues. The recommendations cover form structure and output considerations, input considerations, and form navigation. Part 17 is intended to be used by both designers and evaluators of command dialogues, but the focus is primarily towards the designer.

ISO/IEC 10741-1 Dialogue interaction - Cursor control for text editing. The standard specifies how the cursor should move on the screen in response to the use of cursor control keys.

ISO/IEC 11581 Icon symbols and functions - Part 1: General. This part contains a framework for the development and design of icons, including general requirements and recommendations applicable to all icons.

ISO/IEC 11581 Icon symbols and functions - Part 2: Object icons. This part contains requirements and recommendations for icons that represent functions by association with an object, and that can be moved and opened. It also contains specifications for the function and appearance of 20 icons.

Before designing appropriate usability attributes into the software following the guidance and requirements of the standards listed above, a software designer needs to identify the anticipated users, tasks and environments using ISO 9241-11. However, using attributes which conform to these standards cannot guarantee that a product reaches a required level of usability, as these standards do not provide an exhaustive specification of how to apply the general principles that make a product usable.

3.5. Future Trends

In the early days of information and communication technology, there were only a few computers for many users. As the number of computers increased faster than the number of users, it was the second phase, appropriately referred to as Personal Computing with one computer per person. As the number of computers continues to grow faster than the number of users, third phase becomes where many computers distributed throughout our everyday environments serve one user. This development, predicted by Weiser and labelled ubiquitous computing (Weiser, 1991), literally enforces a reconsideration of the uneasy person-computer relations of Personal Computing. These phases are shown in Figure 3.12.

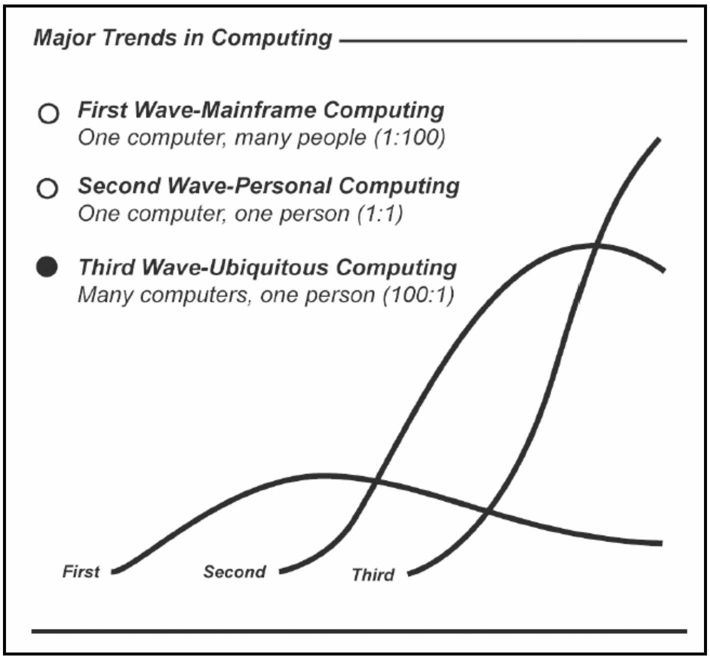


Figure 3.12. Major trends in computing. (Source: Weiser 1991)

The aspect of being both general and centralized implies that activities have to come to the computer. For a long time, more and more of the physical world seemed to end up *inside* the computer, with ‘virtual reality’ as the most extreme vision.

According to Baecker (1992), Human-computer interaction is affected by the forces shaping the nature of future computing. These forces include:

- Decreasing hardware costs leading to larger memories and faster systems.
- Miniaturization of hardware leading to portability.
- Reduction in power requirements leading to portability.
- New display technologies leading to the packaging of computational devices in new forms.
- Assimilation of computation into the environment (e.g., VCRs, microwave ovens, televisions).
- Specialized hardware leading to new functions (e.g., rapid text search).
- Increased development of network communication and distributed computing.
- Increasingly widespread use of computers, especially by people who are outside of the computing profession.

- Increasing innovation in input techniques (e.g., voice, gesture, pen), combined with lowering cost, leading to rapid computerization by people previously left out of the "computer revolution."
- Wider social concerns leading to improved access to computers by currently disadvantaged groups. (young children, the physically/visually disabled, etc.).

Partially based on the above trends, future for Human-Computer interaction is expected to have some of the following characteristics (Baecker 1992):

Ubiquitous Communication: Computers communicates through high speed local networks, nationally over wide-area networks, and portably via infrared, ultrasonic, cellular, and other technologies. Data and computational services become portably accessible from many if not most locations to which a user travels.

High Functionality Systems: Systems have large numbers of functions associated with them. There are so many systems that most users, technical or nontechnical, have no time to learn them in the traditional way.

Mass Availability of Computer Graphics: Computer graphics capabilities such as image processing, graphics transformations, rendering, and interactive animation become widespread as inexpensive chips become available for inclusion in general workstations.

Mixed Media: Systems handles images, voice, sounds, video, text, and formatted data. These will be exchangeable over communication links among users. The separate worlds of consumer electronics (e.g., stereo sets, VCRs, televisions) and computers partially merge. Computer and print worlds continue to cross assimilate each other.

High-Bandwidth Interaction: The rate at which human and machine interaction increases substantially due to the changes in speed, computer graphics, new media, and new input/output devices. It leads to some qualitatively different interfaces, such as virtual reality or computational video.

Large And Thin Displays: New display technologies finally mature enabling very large displays and also displays that are thin, light weight, and have low power consumption. It has large effects on portability and will enable the development of paper-like, pen-based computer interaction systems very different in feel from desktop workstations of the present.

Embedded Computation: Computation passes beyond desktop computers into every object for which uses can be found. The environment becomes alive with little computations from computerized cooking appliances to lighting, and plumbing fixtures to window blinds, to automobile braking systems to greeting cards. To some extent, this development is already taking place. The difference in the future is the addition of networked communications that allows many of these embedded computations to coordinate with each other and with the user.

Group Interfaces: Interfaces to allow groups of people to coordinate become common (for meetings, for engineering projects, for authoring joint documents). These will have major impacts on the nature of organizations and on the division of labor. Models of the group design process become embedded in systems and cause increased rationalization of design.

User Tailorability: Ordinary users routinely tailor applications to their own use and use this power to invent new applications based on their understanding of their own domains. Users, with their deeper knowledge of their own knowledge domains, increasingly become important sources of new applications at the expense of generic systems programmers (with systems expertise but low domain expertise).

Information Utilities: Public information utilities (such as Compuserve, Prodigy, home banking, and shopping, etc.) and specialized industry services (e.g., weather for pilots) speed up. The rate of proliferation is accelerated with the introduction of high-bandwidth interaction and the improvement in quality of interfaces. One consequence of the above developments is that computing systems appear partially to dissolve into the environment and become much more intimately associated with their users' activities.

CHAPTER 4

GRAPHICAL FOUNDATION OF OVEN CONTROL PANEL

In this chapter, in order to try get static rules about design principles of an oven control panel. General design inputs are explored. So, parts of oven controls, how it is shaped, additionally color principles for iconic representation are explained. Graphical foundation of oven design depends on mainly, functions of system and how the user interpretends with controls. Oven control panel includes the body parts which are push buttons, display, touch screens, etc.

4.1. Parts of Oven Control Panel

To design a oven control panel, some basics about the main body structure of an oven are explored and how display systems should be configured is above explained.

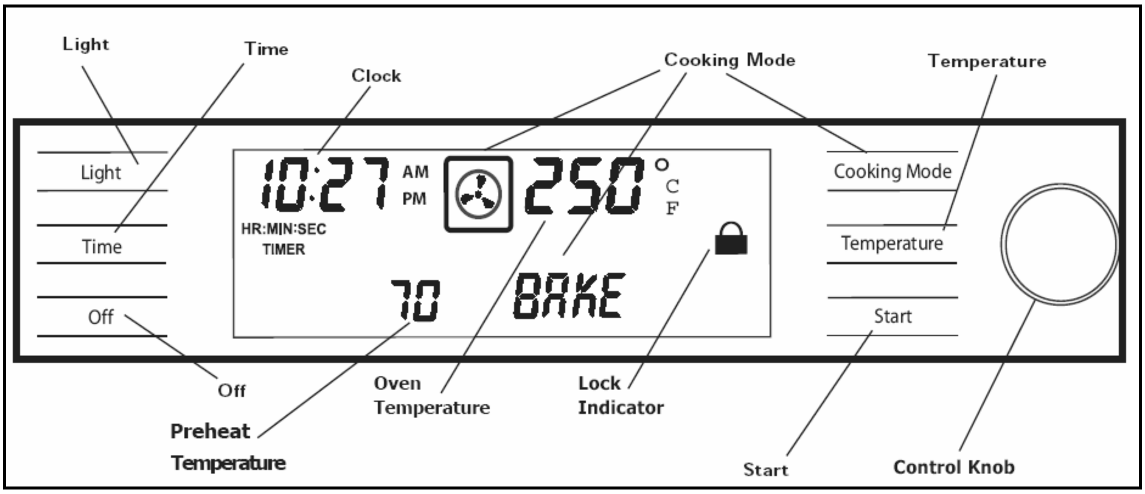


Figure 4.1. Bosch oven-digital graphical user interface.
(Source: http://www.arcelik.com.tr/pdfs/9730.pdf)

Oven control panel is generally included these parts;
Clock shows the time of day with a 12-hour or 24-hour clock option.
Cooking mode is placed on a touch pad to display cooking mode.
Cooking or timed mode shows the number of hours and minutes the oven will be "on." Cooking Mode Icon is also displayed when cooking mode is selected.
Control knob is used to set the clock, timers, select cooking mode, and temperature. It is used for turning clockwise to increase and turning counterclockwise to decrease.
Elements display elements that are active during a cooking mode.
Light is placed on a touch pad to turn oven light on or off.
Door lock indicator Icon is displayed during the self- clean mode when the door is locked. It tells that do not attempt to open the door until the lock symbol is no longer present.
Off is placed on touch pad to turn off oven and/or warming drawer.
Oven temperature shows the oven temperature selected.
Preheat displays temperature of oven during preheat mode. Also displays internal temperature of meat when probe is in use.
Start is placed on touch pad to complete an entry.
Temperature is placed on touch pad to select cooking temperature.
Timer counts down the time in hours and minutes. With less than 60 minutes remaining, the timer also displays seconds.

According to oven functions, icon representation style could be varied. Figure 4.2 shows the functional types of cooking icons and meanings, WEB_12 (2004)

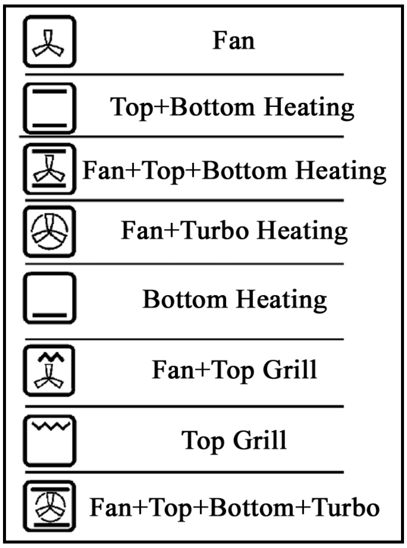


Figure 4.2. Iconic representations of cooking modes.
(Source: http://www.arcelik.com.tr/pdfs/9730.pdf)

Development of computer systems and their existence in house appliance becomes more and more over. By the increase of digital systems in control panel, user product interaction has been the main problem of design. The success of interaction takes shape by the convenient foundation and design of controls. However, more computerized mediums forces user in complicated interaction styles. Form, expression, and product identity should represent the functional nature of the product, its reason for being, or should form decorate and augment function, broadening the communicative qualities of the product. Bosch oven control panel is the one of recent examples. Its interface is shown in Figure 4.3.

Figure 4.3. Bosch oven control panel and its interface.
(Source: http://www.bosch.com/products/fulllaundry/logicxx)

4.2. Evolution of control panels

As technology evolves product properties such as activation force, user feedback, construction and visual form change. Technology opens up new possibilities for designing and has an influence on prevailing interaction styles. The evolution of technology influences the interaction styles, indirectly. For being a good example, the research on Danfoss product development shows the evolution of control panel styles by technology (Buur, 2000).

The Danfoss Museum contains a complete chronological display of products from 1933 until today. Figure 4.4 shows the chronological evolution of heating controllers from 1960 to 1999.

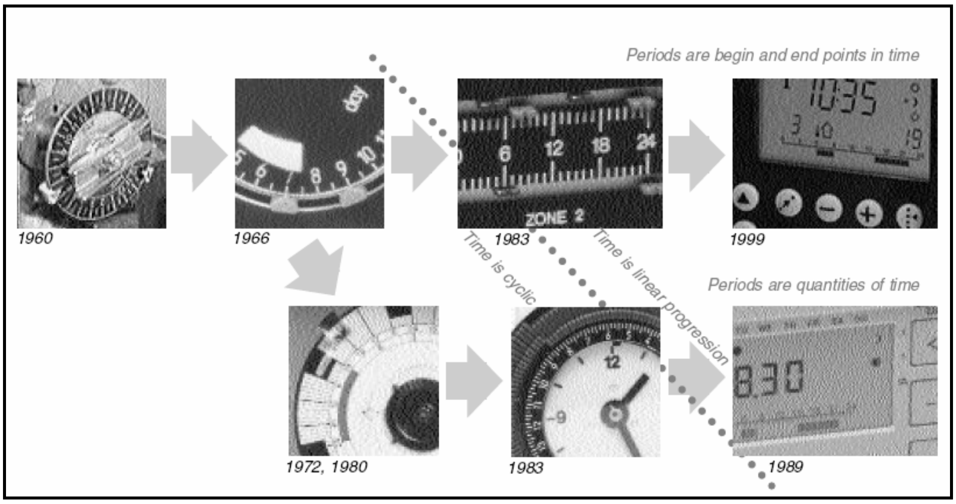


Figure 4.4. Evolution of Danfoss heating controllers. (Source: Buur 2000)

Period 1 (1933–1969): Interaction requires heavy activation forces and provides direct tactile feedback; there are few buttons and few operations. Interface design and aesthetics is not important. Interaction is working with tools or machine-like controls. Controls are often hidden inside the product or part of the structure.

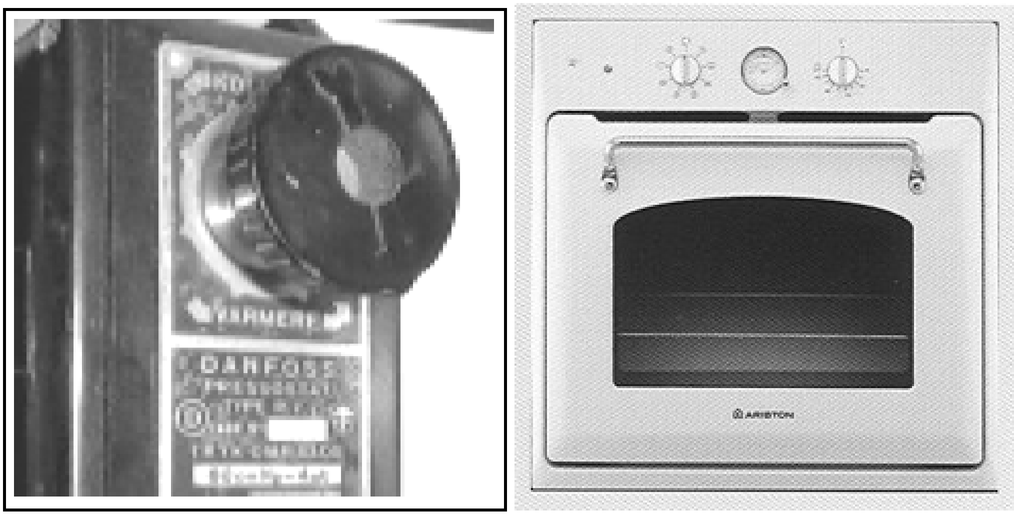


Figure 4.5. Control style in Period 1. (Source: Buur 2000)

Period 2 (1970–1979): Analogue electronics takes over control of the mechanism. Activation forces are reduced and direct feedback disappears. The LED is introduced into the interfaces. The trend towards miniaturization of product and interface starts. User interfaces have a clean functionalistic style. Instructions and product graphics are given higher priority. As computing and automation become reality, fear of being replaced by the machine grows in society. Parameters are manipulated before hand to set up the system.

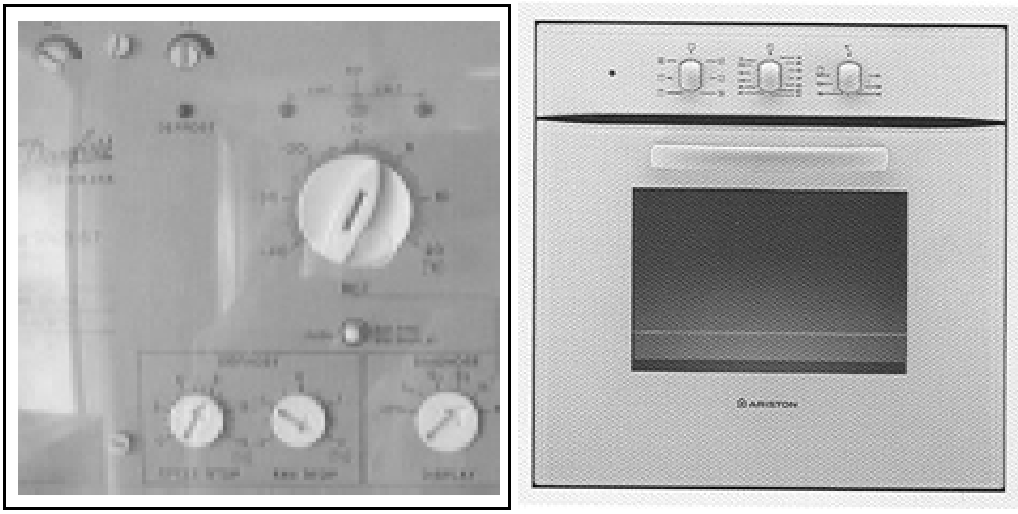


Figure 4.6. Control style in Period 2. (Source: Buur 2000)

Period 3 (1980–1994): Miniaturization reaches the limit; interfaces stabilize on a practical size. LCD screens and plastic foil buttons with weak feedback dominate. Electronics goes from analogue to digital and the number of parameters to control starts an exponential growth. Interaction is built around a menu-tree structure instead of the one-control-one-function design. PCs are introduced to everyday lives. Technology is no longer the domain of scientists. Everybody use hi-tech.

Figure 4.7. Control style in Period 3. (Source: Buur 2000)

Period 4 (1995 - ….): Remote controls and communication busses are the new interface components. User interaction moves away from menu juggling towards direct control and manipulation. Developers become aware that they know too little about users and customers.

Figure 4.8. Control style in Period 4. (Source: Buur 2000)

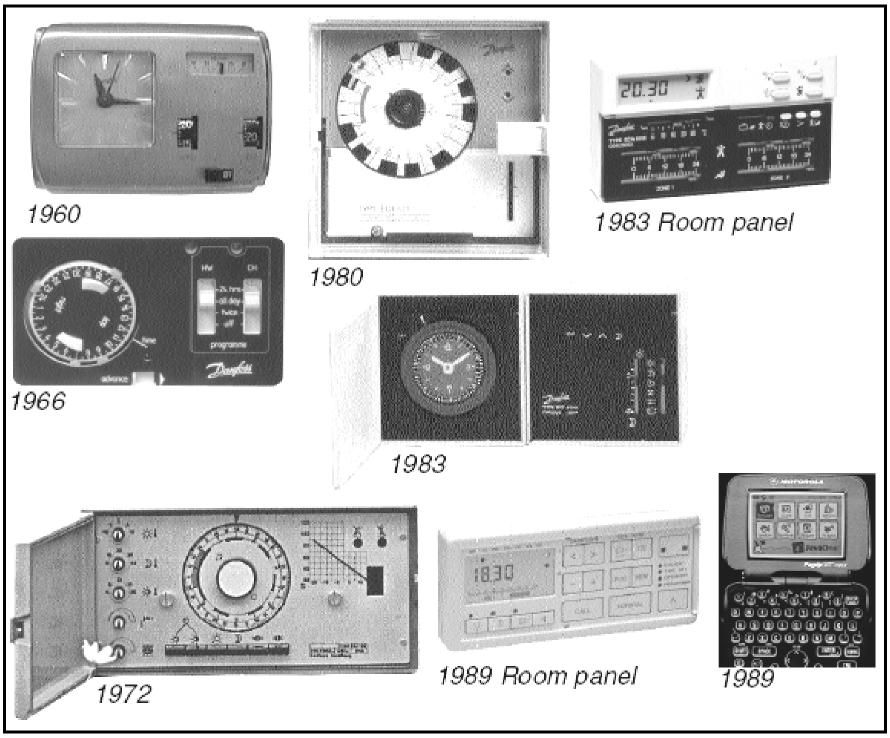


Figure 4.9. User interfaces of six generations of Danfoss heating controllers. (Source: Buur 2000)

Graphical user interfaces change by the development of technology. As shown in figure 4.9, interaction styles tend to be more digitalized. Buttons like machine parts becomes icons on flat LCD touch screens. However, there is still a question waiting for answer; how many this kind products are usable and user-centered.

The graphical foundation of control panel should be trained in terms of usability principles. Usability paradigms are related with human cognition. Form serves function, in such a way that the parts of control panel and graphical foundation should be synchronized. In the next section, thesis explores control panel of an oven and explains the functional tasks to be ground as required in design knowledge.

4.3. Displaying Information and Designing Controls

A picture is worth a thousand words, if it is the right picture. There are numerous types of control devices available today. Certain types of controls are best suited for certain applications.

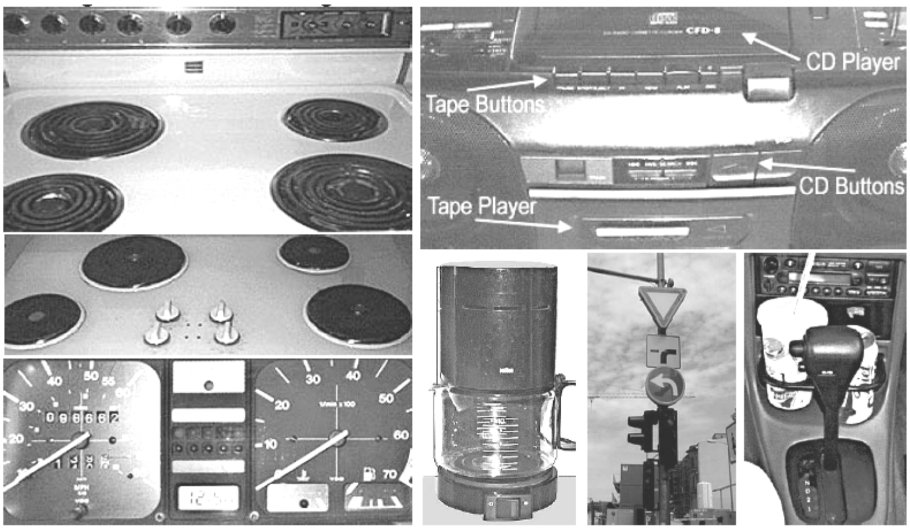


Figure 4.10. Examples of graphical user interfaces. (Source: Bevan 1994)

Human information input and processing operations depend on the sensory reception of relevant external stimuli. These stimuli contain the information we process. Typically, the original source is some object, event, or environmental condition. Information from the original resources may come to us directly (such as by direct observation of an airplane), or it may be come to us indirectly through some intervening mechanism or device (such as radar).

Display is a term that applies to virtually applies to virtually any indirect method of presenting information, such as a highway traffic sign, a family radio. When designing or selecting a display, it is critical that all information needs of the user be fully understood.

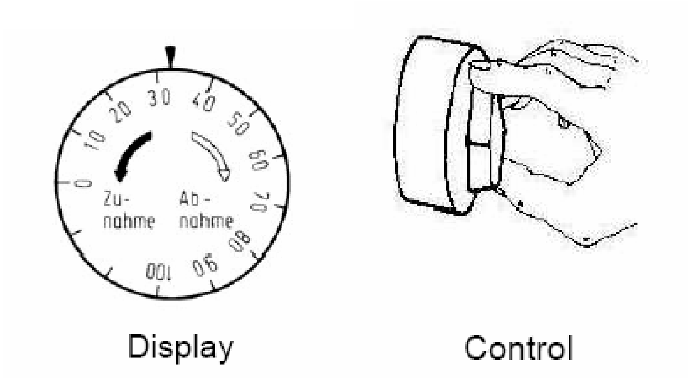


Figure 4.11. Display and control. (Source: Bevan 1994)

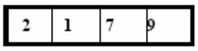
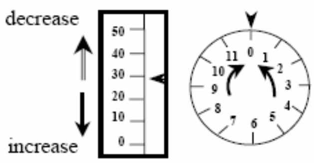
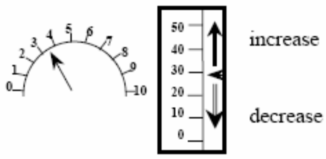
Displays cover quite a spectrum, including those that represent quantitative, qualitative, status, and representational information (see figure 4.11.). In selecting or designing displays for transmission of information in some situations, the selection of the sensory modality is virtually a foregone conclusion, as in the use of vision for road signs and the use of audition for many various purposes.

Table 4.1. Types of information presentation. (Source: Bevan 1994)

type of information	examples	
	visual presentation	auditory presentation
binary (two-state)	signal lights, warning lights	hooters, simple audio alerts
continuous (metric scale)	dials, meters	revolutions per minute
discrete (fixed states)	alphanumeric displays	sirens, audio alerts, different noises
complex information	video display terminals (VDT)	language, sounds, noises

In general, there are three types of displays. These are shown in figures at below. Displays can be divided as analog, digital and hybrid systems (mixed system of digital and analog).In general, which types .of displaying system is used prevent usability. According to which type is used, user could be confused by designing unapproriate display systems.

Table 4.2. Digital and analog display systems. (Source: Bevan 1994)

	digital display	analog displays	
		moving scale, fixed pointer 	fixed scale, moving pointer 
quantitative readings	best suited	less suited	less suited
qualitative readings	unsuited	unsuited	best suited
tracking tasks: position control	best suited	less suited	best suited
tracking tasks: rate control	unsuited	less suited	best suited

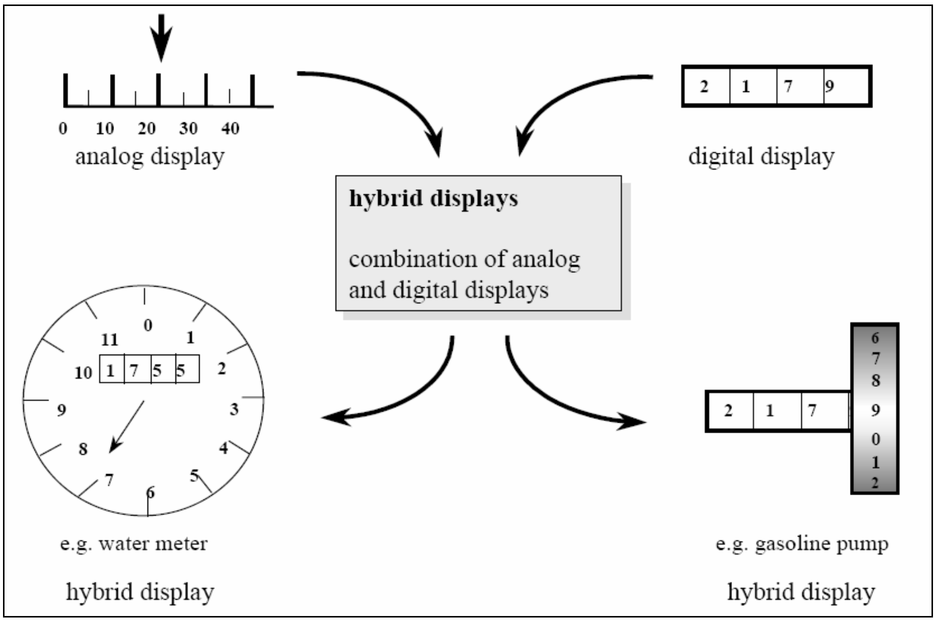


Figure 4.13. Hybrid displays. (Source: Bevan 1994)

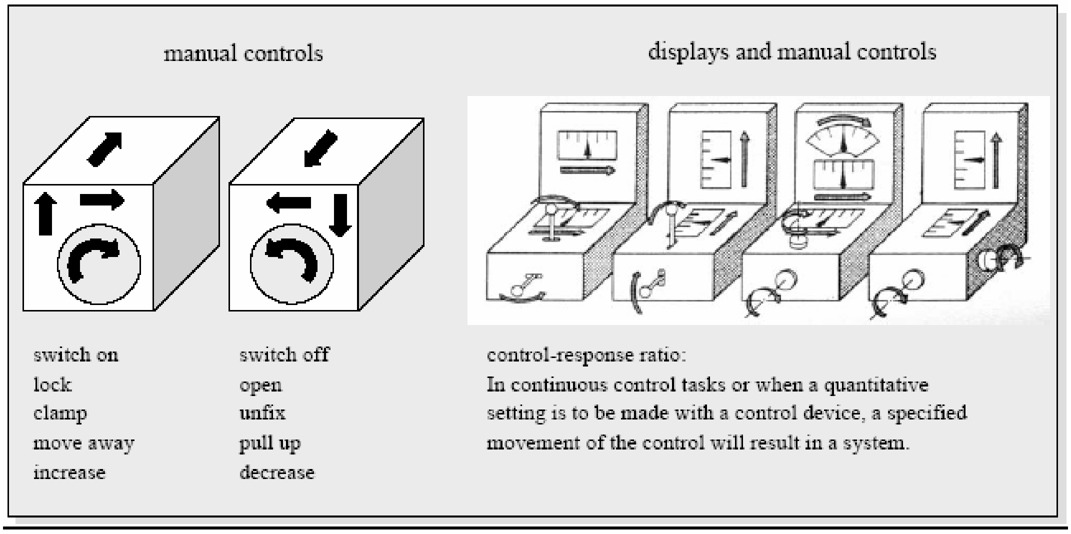


Figure 4.14. Recommended Movement Relationships. (Source: Bevan 1994)

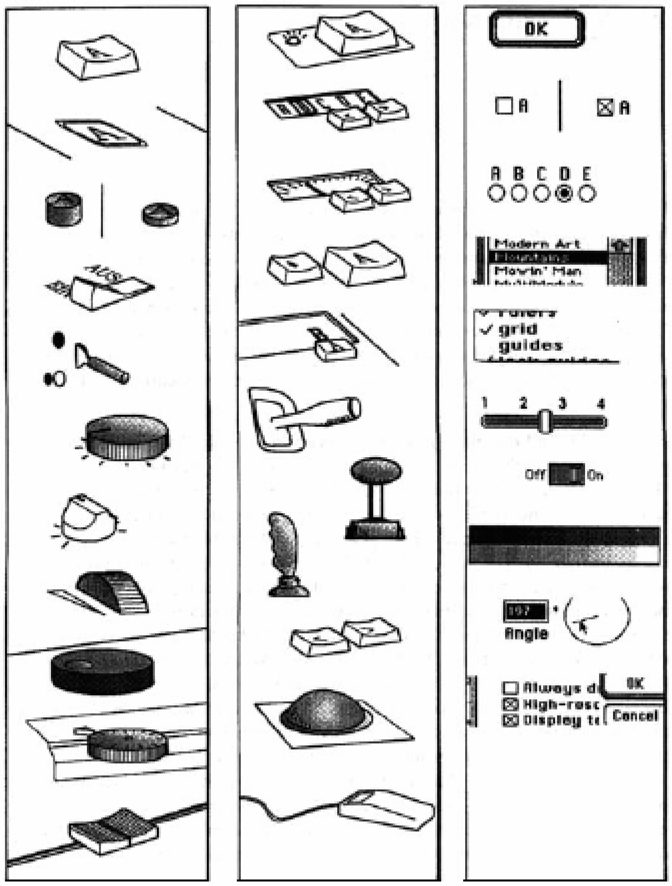


Figure4.15 Mechanical, Electronic, and Virtual Manual Controls. (Source: Bevan 1994)

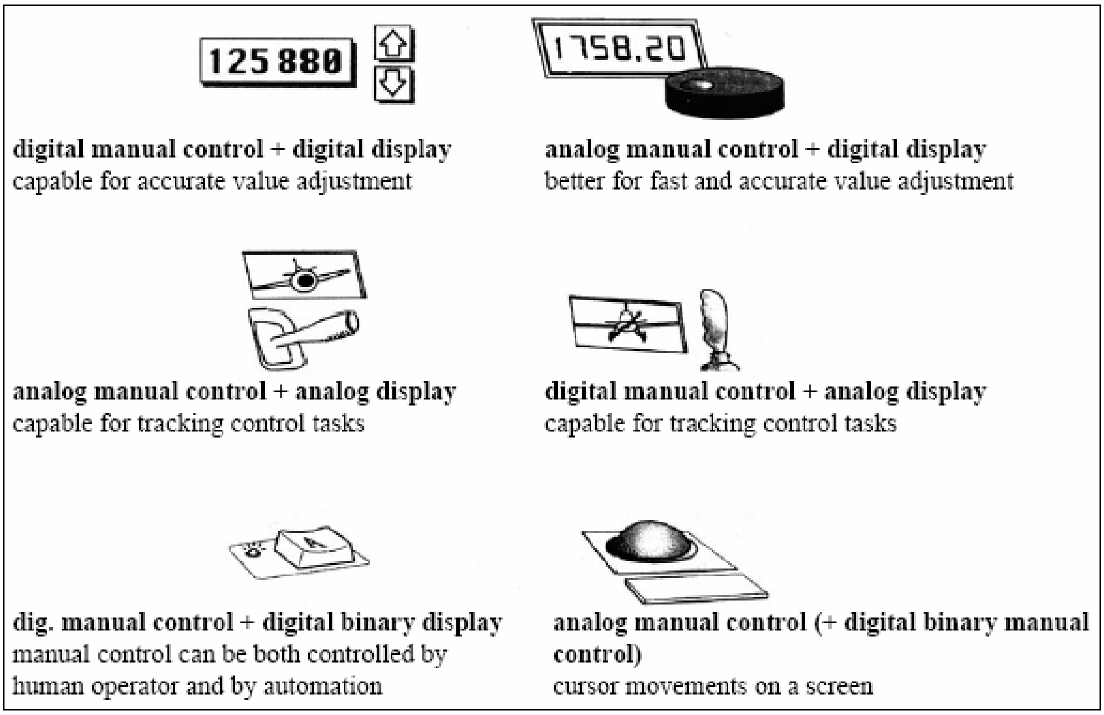


Figure4.16. Examples: appropriate combinations of displays and manual controls. (Source: Bevan 1995)

Movement compatibility relationships depend in part on features of the controls and displays as well as their physical orientation to the user (such as whether they are in the same or different planes relative to the user). Based on research experience, certain principles of movement compatibility have merged. In continuous control tasks or when a quantitative setting is to be made with a control device, a specific movement of the control will result in a system response. The system response may be represented on a display or it may not, as in turning the steering wheel of a car. We call the ratio of the movement of the control device to the movement of the system response the control response ratio (C/R ratio). In the past, the C/R ratio has been called the control-display ratio (C/D ratio).

Compatibility Principles: Compatibility refers to the degree to which relationships are consistent with human expectations. As such, expectations have profound impact on human performance. Where compatibility relationships are designed into the system,vlearning is faster, reaction time is faster, fewer errors are made, and user satisfaction is higher.

In some circumstances, it may be necessary to violate one compatibility relationship to take advantage of another one in the design of some systems.

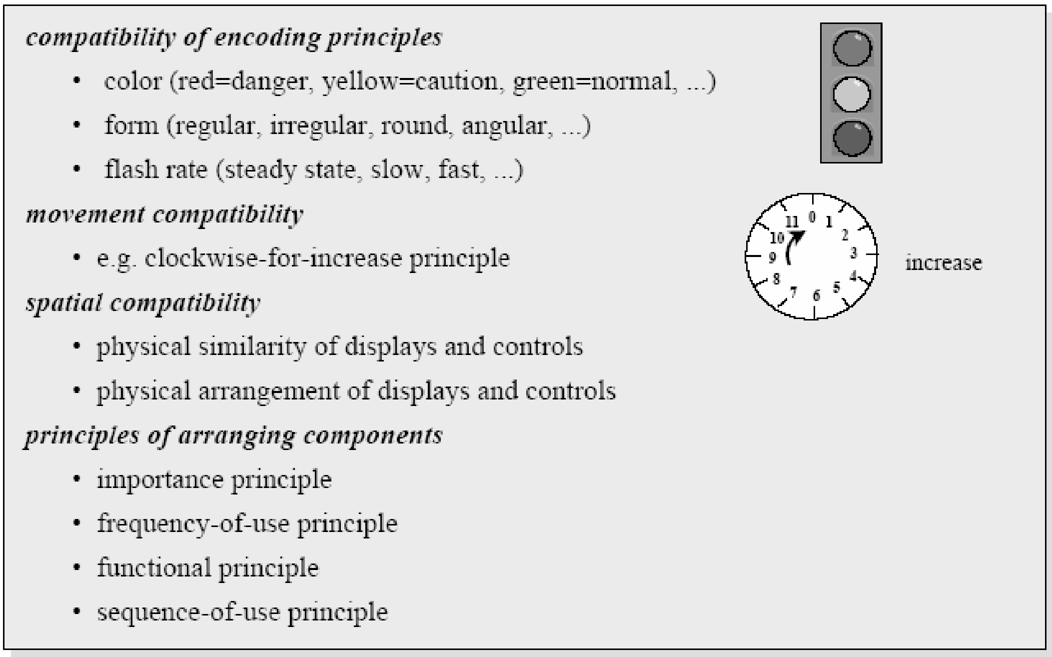


Figure 4.17 Compatibility relationship. (Source: Bevan 1995)

Conceptual compatibility deals with the degree to which codes and symbols correspond to the conceptual associations people have. In essence, conceptual compatibility relates to how meaningful the codes and symbols are to the people who must use them. An aircraft symbol used to denote an airport on a map would have greater conceptual than would a green square.

4.3.1. Colour guidelines

Color guidelines are the basic fundementals of designing interface. Using colour contrasts are very effective because the human eye has an edge enhancement mechanism). It arises interest, is a stylistic device in painting or point to important information.

A strong contrast can be achieved by using the primary colours red, yellow and blue. The intensity gets weaker when you use secondary mixed colours like green, orange or violet.

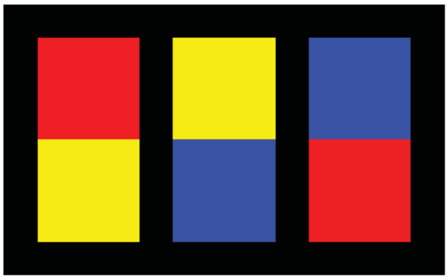


Figure 4.18. Primary colour contrasts. (Source: Chang 2001)

Here two colours with different brightness values are opposed. The greater the difference, the better the contrast. The highest contrast is reached with the achromatic colours black and white.

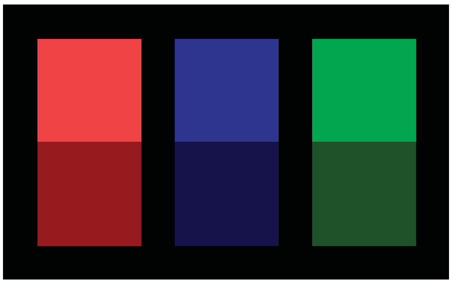


Figure 4.19. Brightness contrasts. (Source: Chang 2001)

Warm colours like yellow, orange, magenta, and red are opposed to cold colours like cyan, green, and blue. With these contrasts ambiances are presentable like “sun and shadow” or “near and far”. The classification of cold and warm colours is only a social convention (in the Middle Ages blue was considered as a warm colour for example) and may originate from the associations with fire, water and ice.

Figure 4.20. Warm to cold colour contrast (warm above). (Source: Chang 2001)

Adjacent colour areas that are not exactly complementary influence each other so that one colour seems to be shifted. They repel one another and vibrate as the eye tries to bring them closer to their precise complementary colour. This effect occurs because the human brain tries to view the complementary colour next to every colour seen. The use of such contrasts makes chromatic compositions more interesting and livelier. For example a grey square that is surrounded by a red area looks like it has a green tone because green is the complementary colour of red.

Figure 4.21. Concurrent contrast: left grey square appears greenish.
(Source: Chang 2001)

These contrasts are perceived harmonically and with a high difference. The complementary colours can be found as the opposite colour on the colour wheel in Figure 49 or on the online colour wheel from Hewlett Packard .

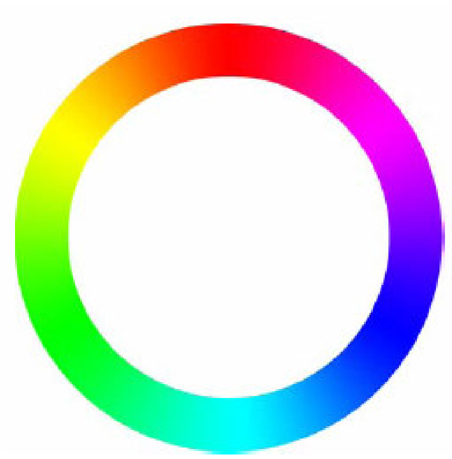


Figure 4.22. Complementary colour wheel. (Source: Chang 2001)

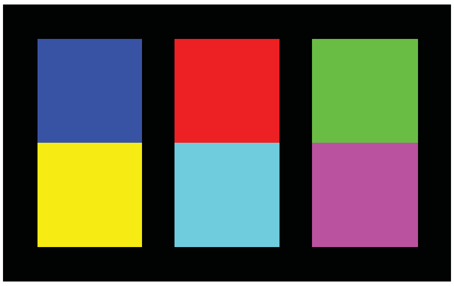


Figure 4.23. Complementary colour contrasts. (Source: Chang 2001)

The juxtaposition of saturated and unsaturated colours or using bright and a grey-tinted colours results in quality contrasts. This contrast only exists if the unsaturated colours are dominant.

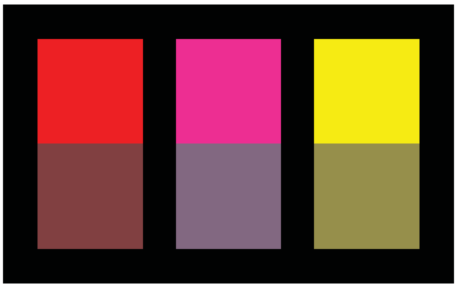


Figure 4.24. Quality contrast. (Source: Chang 2001)

Quantity contrast uses the effect of different sized colour areas. The surface devoted to each colour influences their impact on the composition. The more saturated or brighter a colour is, the greater is its impact on the composition leading to a lower need for space. In Johann Wolfgang von Goethe gave the following values: yellow: 9, orange: 8, red: 6, violet: 3, blue: 4, green: 6. To use red (6) and violet (3), you have to use 6:3 parts red:violet, that means the red surface has to be twice as big to perceived harmonically.

Figure 4.25 Quantity contrast: violet (2) : red (1). (Source: Chang 2001)

It should be considered colour blind people. About ten percent of the male population and about one percent of the female population suffer from some form of colour blindness. These defiances are the lack of one colour pigment. The most common form is the red-green blindness, where either the red or the green pigments are missing. People having this deficiency are unable to distinguish red and green. To test colour blindness test plates like in Figure 4.26 and 4.27 are used. That is why you should not show differences only by colouring them differently.

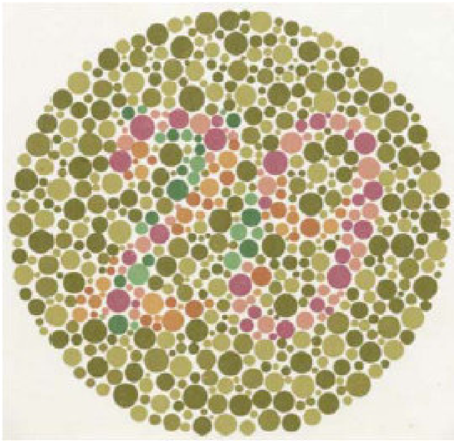


Figure 4.26. Test plate for colour blindness. (Source: Chang 2001)

It should not be displayed fine detail only with chromatic differences. In Mullen found out that the red-green and yellow-blue chromatic channels from the eye to the brain are each only capable of carrying about one-third the amount of detail carried by the black-white (luminance). That is why you should not code fine detailed information like text only by chromatic differences and the same luminance.

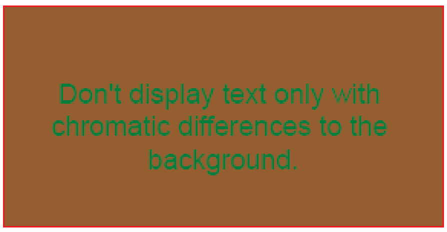


Figure 4.27 Text and background only with chromatic difference.
(Source: Chang 2001)

Antis and Cavanaugh found out in that a pattern that is equiluminous with its background and only contains chromatic differences appears to move slower than the same pattern coded with black and white moving at the same speed. Therefore, motion perception is primarily based on information from the luminance channel.

If an object is only shaded by a purely chromatic gradient and not the usual luminance gradient, the impression of the shape of the surface is much reduced. That means that the perception of shape also appears to be processed mainly through the luminance channel.

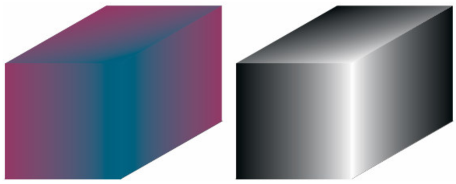


Figure 4.28. Shading with chromatic gradient versus luminance gradient. (Source: Chang 2001)

The impression of a colour is always influenced by the background colour. A grey patch on a dark background looks lighter than the same grey patch on a dark background for example. This effect is known as "simultaneous brightness contrast" and occurs because of the lateral inhibition in the eye.

Figure 4.29. Brightness contrast example: (Source: Chang 2001)

The upper row of rectangles are an identical grey. The lower rectangles are lighter gravy, but are also identical. The following list of twelve colours are recommended for use in coding: red, green, yellow, blue, black, white, pink, cyan, grey, orange, brown, purple (see figure 4.29) These colours are reasonably far apart in the colour space and have widely agreed-upon category names. The first six colours are the end-colours of the three channels, in which the human brain gets the visual information (red-green channel, yellow-blue channel, black-white channel).

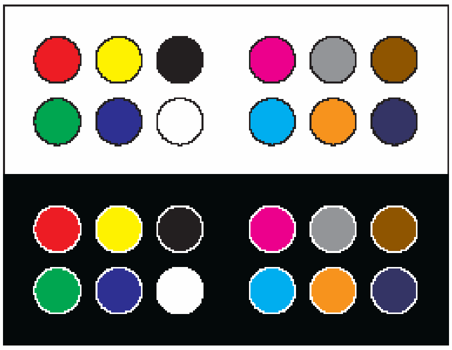


Figure 4.30 Twelve distinct colours for use in labelling. The same colours are shown on a white and a black background. (Source: Chang 2001)

Different wavelengths of light are focused at different distances in the human eye because it is not corrected for chromatic aberration. Short wave-lengthened blue light is refracted more than long wave-lengthened red light. This means that both colours can not be focused simultaneously. Thus red text on a blue background is very hard to read and vice versa. In addition to this, red and blue can give a strong illusory depth effect.

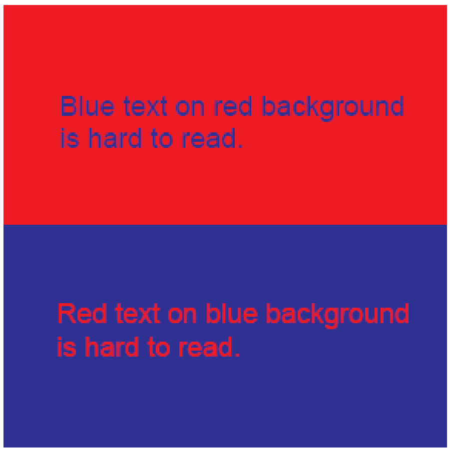


Figure 4.31. Red text on blue background is hard to read. (Source: Chang 2001)

Colours look more vibrating and gaudy when they are in front of a black background.

Figure 4.32. Colour on black in comparison to colour on white. (Source: Chang 2001)

Using blue for fine details is not recommended, because of the chromatic aberration of the eye there are less S-cones (sensitive for blue light) and therefore the resolution of blue is very low. So you should not use the colour blue for fine details. To design maps more readeable, you should chose colors in design according to;

- Black to white, red to green, yellow to blue or saturation sequence should be used if the sequence should be perceptually orderable.
- To display data with a high level of detail you should use a colour sequence based mostly on luminance (because the luminance channel can carry more detail).
- When identifying values of a map using a colour key is required, use many different colours, so that contrast effects do not alter the recognition.

Consider that different people like different colours. The conclusion of a German survey was that blue, red, and green are the preferred colours of most people. Brown, orange, and purple are the most disliked colours. Differently aged people have different preferences. For example, 75 percent of all school kids liked purple the best. That changed as they grew older (to orange, green and then blue).

It should be used red light to preserve dark adoption. Red light does not prevent the eye to adapt to the dark because rods do not respond to red. So you should use red light for instruments or information that are viewed at night and should not spoil the dark-adoption.

Figure 4.33. Red illumination of a Seat Leon. (Source: Rebecca 1994)

4.3.2. Psychology of colour

From the early past up to now colour had a great importance in human psychology. The observer links colours to determined feelings and properties. Many scientists think that this links are collective patterns in all humans. Furthermore colour therapists claim that colour has different effects on the physical and mental health. In a German study from the top three colours of seventy percent of all asked were blue, red and green. The most disliked colours were brown, with twenty seven percent, orange, with eleven percent, and violet also with eleven percent. Interestingly there were only differences in age. Seventy five percent of all asked children liked violet the most.

Second most liked colour

700 nm: purest red seen
Range: 620-780 nm
580 nm absorption maximum of the L-cones

Range: from orange (585 nm) again to orange-red (780 nm)

RGB 255, 0, 0

CMYK 0%, 100%, 100%, 0%
Magenta absorbs the green light and yellow the blue light. Only the red light is reflected.

Associations: love, hate, anger, heat, fire, warm, lips, rose, mouth, cherry, red wine, heart, danger, Ferrari, tomato, blood, hell, war, aggression, strength, courage, fertility, urgency

Figure 4.34. Red.(Source: Lidwell 2003)

There are two fundamental associations with the colour red: As fire it is connected with light and heat and as the colour of the blood it is connected with life and sacrifice. It is associated positively with strength, love, courage and fertility. Hate, anger, war, aggression and blood spilling is linked negatively with red. Today red is a sign for stopping and a warning colour. It is used in ads because it is fast recognizable and distinguishable. In the medicine red is known to increase the appetite, the blood supply and aggressions. In China red is linked with luck and wealth.

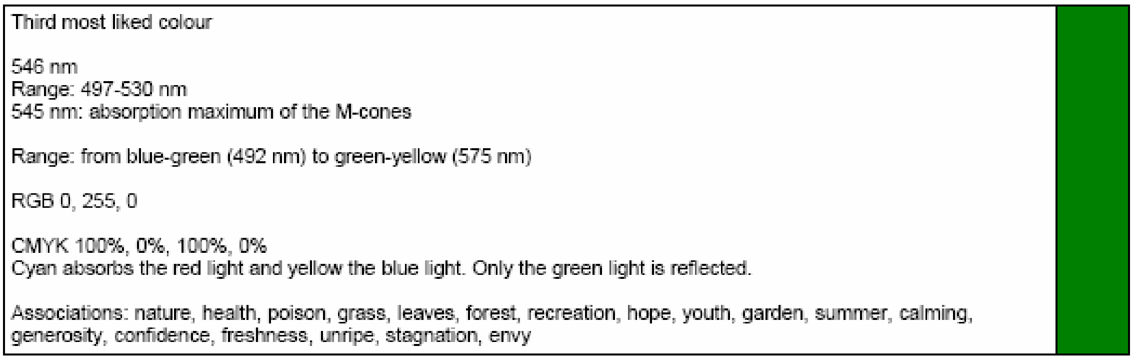


Figure 4.35. Green. (Source: Lidwell 2003)

The fundamental association of green is nature because it is the dominant colour of the vegetation. Generally, people associate green positively with youth, generosity, confidence, freshness, and nature, and negatively with unripe, poison, stagnation, envy and careless. Most of this association can be derived from the green nature.

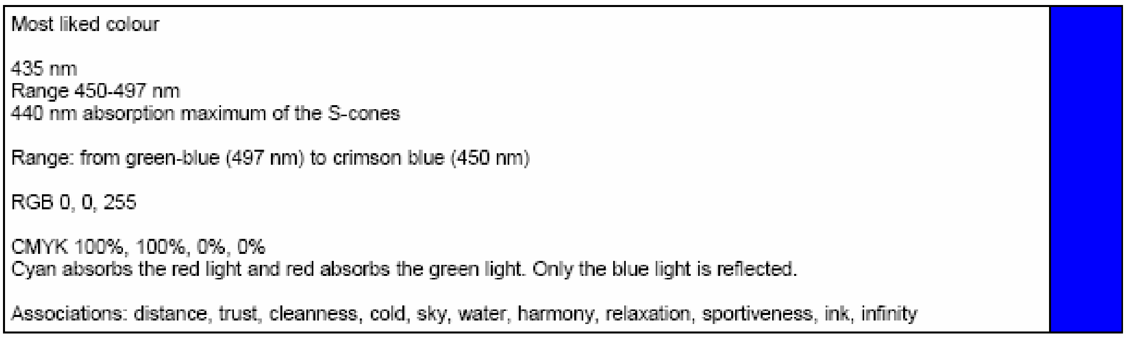


Figure 4.36. Blue. (Source: Lidwell 2003)

Blue is one of the oldest colours used by humans and was one of the most expensive up to the development of synthetic colours. That is why blue was the colour of kings and gods. It is the colour of the sky and of water because of refraction. Because of this refraction mountains look blueish in the distance. In arts blue stands for the distance, the religious, and divinity. In the psychology blue is known to have the exact opposite effect than red. This means it relaxes and calms down. Furthermore blue is the colour of dreaming, longing, the unconscious, the dreaming, depth, truth and faithfulness. Negative associations with blue are the cold, lies, and alcoholism. Blue is very often used in the fashion industry. Ads also use blue very often because it is a friendly and gentle colour.

580 nm
Range 575-580 nm

Surrounding: from green-yellow (530 nm) to yellow-orange(585 nm)

RGB 255, 255, 0

CMYK 0%, 0%, 100%, 0%
The blue parts of the yellow light are absorbed and red and green is reflected.

Associations: sun, sunflowers, summer, moon, gold, post, grain

Figure 4.37. Yellow. (Source: Lidwell 2003)

Yellow is the brightest of all colours and is a mixture of red and green light. However, a human observer sees it as a pure and unmixed colour. This is because of the colour separation in the human retina. In the Asian culture yellow stands for happiness and wisdom. Positive properties associated with yellow are fun, friendliness, and optimism. On the other hand, negative properties are envy, egoism, jealousy, stinginess, and untruthfulness. Yellow is the most important colour for colour therapists. Especially in the dark wintertime, it should have healing capabilities. In the nature yellow is the colour of ripe fruits and of the autumn. Gold is just a yellow material with metal reflections.

490 nm,
Range 487-492 nm

Surrounding: from blue (482 nm) to green (530 nm)

RGB 0, 255, 255

CMYK 100%, 0%, 0%, 0%
Red light is absorbed by the cyan colour. Blue and green light is reflected to the eye.

Associations: sky, sea, swimming pool, cold, hygiene, clean

Figure 4.38. Cyan. (Source: Lidwell 2003)

Cyan is very important for printing because it is one of the four components in the CMYK colour scheme, which is used mainly with printers (the C in CMYK). It is exactly in the middle between blue and green and people see it as a hygienic and clean colour. Furthermore, most people sense cyan as the coldest colour of them all.

Mixture of blue (450 – 482 nm) and red (620 – 780 nm)

RGB 255, 0, 255

CMYK 0%, 100%, 0%, 0%
Green light is absorbed by magenta pigments and red and blue light is reflected to the eye.

Association: red, blue

Figure 4.39. Magenta. (Source: Lidwell 2003)

Magenta is also important for printing because it is part of the CMYK process. It is also called cold red and there is no single wavelength that can be perceived magenta. That is why no magenta coloured laser can be produced.

590 nm

Surrounding: yellow-orange (580 nm) to orange-red (620 nm)

RGB 255, 127, 0

CMYK 0%, 50%, 100%, 0%
Blue light is absorbed and the half of green light is absorbed. The rest of the green light and the red light is reflected

Association: orange, fire, carrot, autumn leafs

Figure 4.40 Orange. (Source: Lidwell 2003)

With brown, orange is the most disliked colour in Germany. It has its name from the same named tropical fruit. Positive associations with orange are activity, energy, chumminess, high spirits, sociableness, change, youth and autumn. Negatively associated are importunity, nonseriosity and easygoing. Substandard impressions from orange objects are because of the cheap orange plastic products in the last decades. Orange is the colour of the royal Dutch coat of arms and was the the colour of the sexual revolution. In other cultures, orange has a different meaning. Indians for example are proud on their skin colour, which they call orange and in the Buddhism orange stands for the highest human enlightenment. Because of its luminosity orange is used as a warning colour for clothes of roadmen and dustmen or for security markings

590 nm like orange but less intensity

RGB 127, 51, 0

CMYK 0%, 60%, 100%, 50%
Red light is reflected and blue absorbed. Some of the green light is reflected, some is absorbed.

Association: coffee, chocolate, earth, skin, leather, wood, clay, dirt, swamp, shit

Figure 4.41. Brown. (Source: Lidwell 2003)

Brown is only a dark orange and has therefore the same wavelength of 590 nm. That is why it can only be mapped to three dimensional colour models and not two-dimensional. It can often be seen in nature in rotting plants like dead leafs or wood. Dark brown can be seen in chocolate, tea, coffee, hot chocolate, and old apples. It is one of the most disliked colours in Germany (twenty seven percent) and negatively associated with accommodativeness, laziness, and petty bourgeoisie. On the other hand, it is connected with rootedness, duteousness, cosiness, sensuality, and security. Furthermore, tanned brown skin is seen as sportive and good looking on white people in spite of the risk of skin cancer.

Pure black is no colour but the absorption of all colours.

RGB 0, 0, 0

CMYK 0%, 0%, 0%, 100%
CMY 100%, 100%, 100% looks in reality brown-green because the absorptions spectra of the used colours are not ideal.
All light is absorbed and none reflected.

Association: cosmos, night, soot, coal, coffee, elegant, black hole

Figure 4.42. Black. (Source: Lidwell 2003)

Black is an achromatic colour. Physically it is the absence of all colours. That means if no light hits our retina we perceive a pure black. The normal black we see in our environment (black objects) is a very dark white. Stands for finality, unaccommodating, cold bloodedness, severity, strictness, negative, evil and nothing. Black is often used in figure of speeches in a negative way (for example black sheep, black Friday or black magic). Black animals are believed to bring no luck or death (black crow, black cat) On the positive side black is seen as an very elegant colour and in Africa black is seen as the most beautiful colour of them all. For designers black is very important because it shows the highest contrast with white and is therefore used as a text colour on white paper for best readability.

All wavelengths from 380 to 800 nm

RGB 255, 255, 255

CMYK 0%, 0%, 0%, 0%
All colours (red, green and blue) are reflected, none is absorbed.

Association: snow, cold, paper, sail, marriage, sail, laundry, moon, salt

Figure 4.43. White. (Source: Lidwell 2003)

White is also an achromatic colour (with black and all grey shades) and is seen when all three cones on the retina are evenly stimulated. It stands for wisdom (white haired old people), peace (white dove), purity, innocence, cleanliness (doctors wear white), maidenliness, and capitulation (white flag). On the other hand, it symbolizes aggression and killing (white whale from Moby Dick or white shark). White is seen as the counterpart of black and the two are associated with “good and evil” or “yin and yang” and so on.

from 400 to 740 nm

RGB 127, 127, 127

CMYK 0%, 0%, 0%, 50%
All colours are reflected.

Association: fog, mice, elephant, wolf, rain weather, old people

Figure 4.44. Grey. (Source: Lidwell 2003)

Grey is also an achromatic colour and the link between black and white. Therefore, it is also absent in all two dimensional colour models. Furthermore, it has no complementary colour. In the psychology, it mostly stands for negative things like desolation, uniformity, abject, iciness of the heart and monotone (grey routine). Grey, foggy, rainy days are seen annoying and bring in a bad mood. On the other hand, grey is connected with soberness, meditativeness and practicality.

CHAPTER 5

CONCLUSION

Design is a profession that is concerned with the creation of products, systems, communications and services that satisfy human needs, improve people's lives. Industrial and graphical designers use the word design in a different way than e.g. software engineers, system developers and behavioural scientists. Design involves problem finding, problem solving, analysis, invention and evaluation guided by a deep sensitivity to user centered concerns and aesthetic, cultural and functional needs. Industrial designers tend to concentrate on the needs of people and the ways in which products can be made safe, easy to use, and a comfortable fit with the way people live. Human factors and human-centered design are terms used in design to highlight the special concern of the interface designer with the problems of improving the quality of man-machine relationships.

The aim of this study is to put forward the importance of design in regards of well-balanced interaction between graphical user interface and user. The success of human interface interaction can be established by means of the relations that user establishes with the functions of product.

Human computer interaction covers all aspects of how people communicate and interact with computer systems. It encompasses many disciplines including engineering, computer science, social science, human factors, and psychology.

Whether technology helps us to gather information, provide services, or produce goods, its benefits are usually manifested in a physical form. Therefore, it is often necessary for us to interact with technology in a physical manner. To address this interaction, three sub-fields of study concerned with how humans physically interact with the computer have arisen:

1.Ergonomics

2.Human factors

3.Human-computer interaction.

While ergonomics deals with the physical shape of the machine, and human factors deals with physiological concerns, human-computer interaction looks at the cross- relations of computer science, psychology, and design in order to evaluate and improve the way we use computers.

This study aimed at analyzing the basic elements of graphical user interface, by means of this; it intended to achieve the general design principles. Since there are complicated parts like human, computer systems in this issue, these concepts are examined in a general way.

Thanks to developments in technology, graphical user interface is evolving rapidly. The development of digital control panels have become indispensable elements of product interfaces in the last century in which mechanical systems started to replace with digital systems.

Graphical user interface is an interlayer that transits the functions of product to user. Therefore, the product designed within the principals of human centered design will be successful product due to not only its aesthetics but also its usage.

Graphical user interface design is a system solution. Input from user, output from computer system, their relations and distinctions, should be considered all together. It is exclusively related to the space and human factors.

Graphical user interface is an interdisciplinary area. The subject matter covers numbers of different design steps such as organizing the flow charts to simplify the use of product and being consistent of configuration of interface elements internally.

Iconic representation is a universal language. However, human cognitive skills are various. As a result, the language of the product should be universal. The functional path created by using icons simplify the use of product, prevents memory overloads. Knowing visual memory is the most easily recalled memory. Icon based control panel designs should not tire the user. As a result, icon based control panels simplify the use of product functions.

Human gets in contact with product by means of their cognition (seeing, hearing, touching etc.). Therefore, Gestalt theory and color theories have been examined during studying human factors throughout this thesis to guide through future directions.

Individual factors (cultural, social etc.) that affect cognition process have been studied under general titles. Upon design process, all these factors should be evaluated.

As a result, a well-designed product can fail with an unsuccessful interface. Conversely, a product has not good design values can become successful with its well-designed interface. The most important result of this study; a good graphical user interface interaction can only be achieved if the user factor is perpetually considered during the entire product design process.

Technology, which has influence on every part of our lives today, will have influence not only on product design process but also on interdisciplinary relations and user-product interactions in the future. The developments in product interfaces are directly related to developments in computer systems.

However, the general functions of product interface have not much changed, thanks to integration of digital systems with products. They now have more complicated interaction styles day by day. At this point, the more important than end-product itself is its being easy-learn, human centered and not frustrating.

Most importantly, the interface designer is the interdisciplinary designer. Because the creation of interactive technology is so varied in nature, the interaction designer needs an understanding of disciplines of engineering such as electronics, computer science, and mechanical engineering, while maintaining an understanding of the social sciences such as anthropology, psychology and communication. Additionally, there is much to be learned from professional of experiential design. Furthermore, the interface designer is a technology-artist, a designer of the engineered, not a design philosopher. It is important for him or her to have a through understanding of art and design.

Generally, it is thought that the technology is a tool for making our lives easier. However, using technolocigal opportunities extremely in all interfaces of design can not be obviously user friendly and human centered. So, the language that is designed to make our lives easier should be simplified in terms of interaction and function. So, design is creation. It is a means, and innovating human experience is the goal.

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