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in Candidacy for the Degree of

MASTER OF FINE ARTS

A Personal Mobile Computer

(A notebook computer without a keyboard)

By

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June 29. 1995

Approvals

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Date: June 29. 1995

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INTRODUCTION

My main Objective is to design a mobile personal office based on the strategic design approach and process. During the Winter and Spring quarters of the 1993-1994 school year, I established a guide for the strategic design of products for consumer products corporations.

This design began with the concept of a notebook computer without a keyboard. An electric pen writing system was chosen as the input device. The pen pad was the prominent idea for this project. The project was composed of three main components: a writing pen/pad, a CPU and a subsidiary screen with modularity.

The title of this project, "*Comffice*" represents the meaning of a mobile personal office. It implies a compact office, a compressed office, a combination office, and a communicator for an office.

Motivation

Not only did I want to design a personal mobile office, but I wanted it to have advanced technology for today's high-tech world. This brings up another problem. Is our society being overwhelmed by technology? One main concern I have with the rapid growth in technology is the fact that we are becoming too dependent on the computer. I wanted to address this challenge.

Computer Industry determined that there are 246,154 elementary schools in the United States that use computers in the classrooms. 6.6% of these schools are computer based[1]. School children who spend a lot of time in the classroom using the computer keyboard might lose some of their skills and values gained by handwriting. The *Comffice* solves this problem by allowing students to use the writing pen and tablet instead. When

[1] Egil and Karen Juliussen, Computer Industry Almanac 1994-1995 (Dallas, Tex.: Computer Industry Almanac, 1994), 245.

the brain has a thought or a feeling about something, it triggers a response to the rest of the body to express that idea. One reaction of the body is to write or voice that idea with words or drawings. If our children are learning how to express their feelings through the keyboard instead of writing them down on paper, then they are missing out on the concept of language as an art. Instead, they learn language as a form of button pushing. The keyboard, for all its popularity, is still a very unnatural interface. It is true that the keyboard is the chief way to enter information or commands into the computer, but the keyboard also indirectly causes problems like carpal tunnel syndrome[2]. Typing requires additional training, and not everyone can do it. It demands a lot of elbow room, and it's not well suited for the graphic user interfaces. This is important because more and more users are demanding better graphic user interfaces. Computers in the future will have to include built-in pointing devices to eliminate such problems. Built-in grid systems, grid pads and/or laser pens, will eliminate these problems.

My project became more defined. I needed to develop a personal, portable office that was high-tech for our society, that allowed the user to have an alternative method of inputting information into the computer and, not only met human factor requirements, but humanity requirements as well. If we examined how we are taught to read and write as children, why should that change as we become older? Because we are older, does that mean we must give up our art of writing and be content with pushing twenty-six letter keys? I think not. This way of thinking was the basis of my design. If I could develop a computer that allowed the user to write the information instead of typing the information, this could be our first step in making the computer more in tune with our human needs.

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[2] Extending your finger forces wider upper sections of the tendon into the tunnel and compresses the median nerve.

Goals In my research for my thesis project, I intended to tackle three different points of concern.

The first point was the benefits and counter-results of using a computer. The benefits would be based on the computer's ability to systemize our society, offer a better form/method of communication (both local and national), and to have a network system that can use other equipment and control systems. The counter result would be the physical strain on the computer's user, causing fatigue. Also, it is difficult to transport a computer, and even portable computers offer little memory storage.

The second point was the role of an industrial designer as a socially responsible professional. The designer's role is in the developing products that work better for people, considering the side effects of product design, and designing for safety in our environment.

The third point was the statistical research acquired from American markets. This research could give information about what kinds of products consumers want to buy and what they need. It would also explore how color, texture and brand names influence the various consumers in that marketplace. Most of all, this information should enable me to have a better understanding of the problems in order to help me forecast the needs for new products from new technologies. This would include products from videos to computers that were sensitive to a user's physical, emotional and environmental needs.

On the Basis of my research and studies, I suggested strategic design solutions for people who need portable, multi-functional working tools based on computer applications. I needed to

incorporate related technologies into *Comffice* as a modular system. I also looked closely at the aesthetic appeal of my design as a way to increase its sales.

Overview To apply my theoretical research to the real world, I chose one computer hardware item for my project: a notebook computer without a keyboard. The main objective of this project was to design a mobile personal office. When I first began to create the concept of a mobile computer, I never realized the many types of human concerns I would have to solve. Designers should be, for the most part, liable for their designs. Designers should take into consideration more than form and shape, they should also examine the consequences of their designs.

One of the first problems I attempted to solve was the need for human factors applied to design as a means for creating products that work well in human terms. My next question was, "What is technology?" I tend to believe that our modern-day society is full of many different types of technologies. I think that we are in a highstate of technological advance; therefore, our society is high-tech.

Since Industrial Design developed as one of the important parts of modern industry, the designing stages for the Industrial designers' creative and innovative activities have not changed much through the years, as compared to other related fields. In other words, the sequential process which is composed of research, idea sketches, renderings, drafting, and making mock-ups is still applied in most of design work. In order to keep up with the rapid changes in our industry, many problems in the process must be addressed: lead time, evaluation, trial and error, and so forth.

Recently we have seen various computer applications for Industrial Design. I believe it is time to change the design process to be more efficient for modern industry by way of using computer applications. If we incorporate them into our work systematically, there will be more possibilities for increasing the efficiency of our working process. In the course of my study, I realized that the design process based on computer applications and the strategic design approach was the basis that could make it possible for industrial design to play an important role in this hi-tech society. Therefore I made extensive use of strategic design and computer applications.

I used Macintosh personal computers and a workstation computer of Silicon Graphics to work on MicroStation, Strata Studio-Pro, Adobe Photoshop, Illustrator, and Pro/Engineer programs. I tried to compare two very different kinds of working systems, PC and workstation. It allowed me to reach my goal for establishing a new design process.

USER AND MARKET

Lifestyle

For this design project, I believed it was necessary-for establishing the direction and concept of design-to research consumers' needs through the analysis of lifestyle, and to understand the interface between a user and a system. Therefore, I began my design work by getting thorough information about projected users on the basis of lifestyle, consumers' needs and user interface.

According to the Statistical Abstract of the U.S. 1994, the total population of the United States was about 257 million in1993 and it would be 276 million in 2000[1] (figure1 and 2).

The Lifestyle Market Analyst 1994 showed that 52% of the current population is male. The adult population (those who are 18 years old or older) accounts for about 73%(191,152,327) of the total. 55.2% of the adults were married and 29.3% of the total households (95,883,242) have more than one child. 64.8% of households own their own home and have an average income of $33,833 a year (figure 3 and 4).[2]

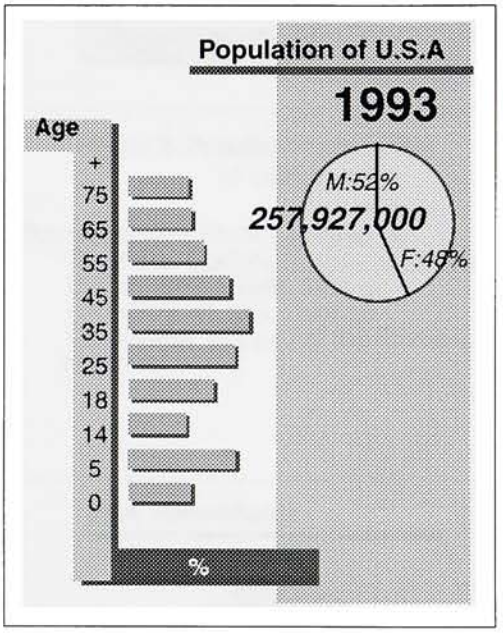

Figure 1. Population of USA in 1993

Source: United States. Bureau of Statistics, Statistical Abstract of the United States 1994,14th ed (Washington: U.S. Dept. of Commerce, Bureau of the Census, 1994), 5.

[1] United States. Bureau of Statistics, Statistical Abstract of the United States 1994,14th ed (Washington: U.S. Dept. of Commerce, Bureau of the Census, 1994), 5.

[2] National Demographics & Lifestyles, The Lifestyle Market Analyst 1994 (Wilmette, IL.: Standard Rate and Data Service, 1994), A-32-33.

The statistics for the American labor force break down into these categories: 25.2% professional/technical, 15.31% homeworker and 10.1% administrative. A sizeable 20.1% of the population (38,421,618) is retired (Figure 5).

Statistics show that 63.3% of households subscribe to cable TV. Of the people surveyed, 50.7% considered travel in the United States or foreign countries as an indicator of a good life style. 37.5% of the people enjoyed watching sports on television. 43% enjoyed camping and fishing, and 46.5% said they enjoyed listening to music. 43.3% said they owned their own CD player. 32.7% of those surveyed in 1993 owned a personal computer. In 1995 those in New York State owning a personal computer jumped to around 45%.

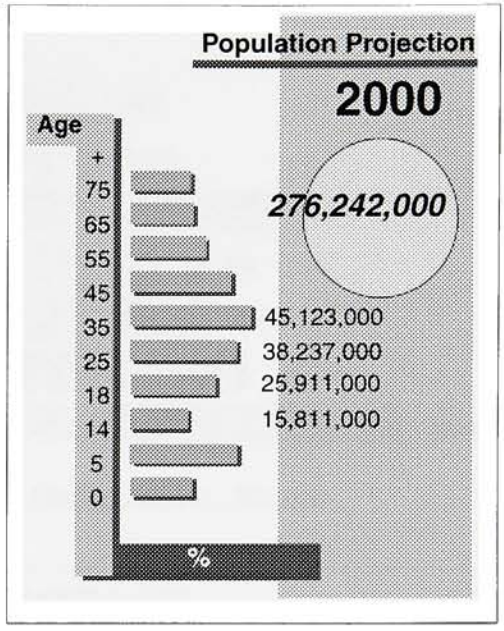

Figure 2. Population projection of USA in 2000

Source: United States. Bureau of Statistics, Statistical Abstract of the United States 1994,14th ed (Washington: U.S. Dept. of Commerce, Bureau of the Census, 1994), 5.

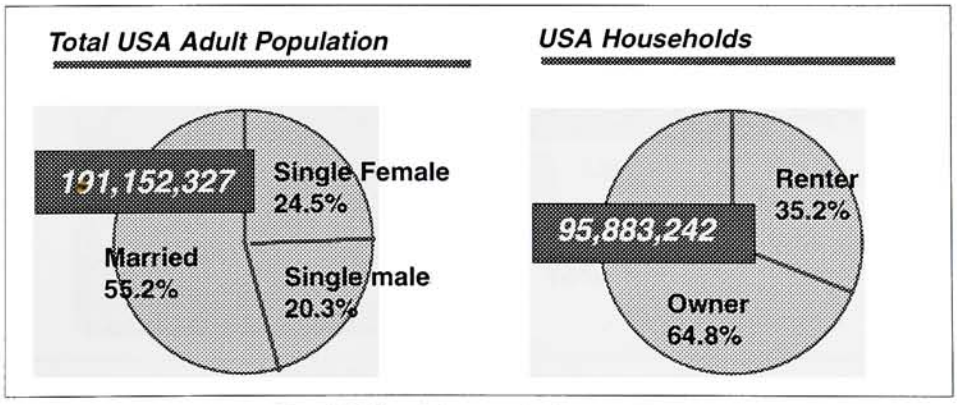

Figure 3. Total USA adult population and households

Source: National Demographics & Lifestyles, The Lifestyle Market Analyst 1994 (Wilmette, IL.: Standard Rate and Data Service, 1994), A-10-12.

This research was focused on the customers of the near future. Therefore, the chief buyers of consumer products will be 14 to 44 years of age, and will be about 45% of total population (Figure 2).

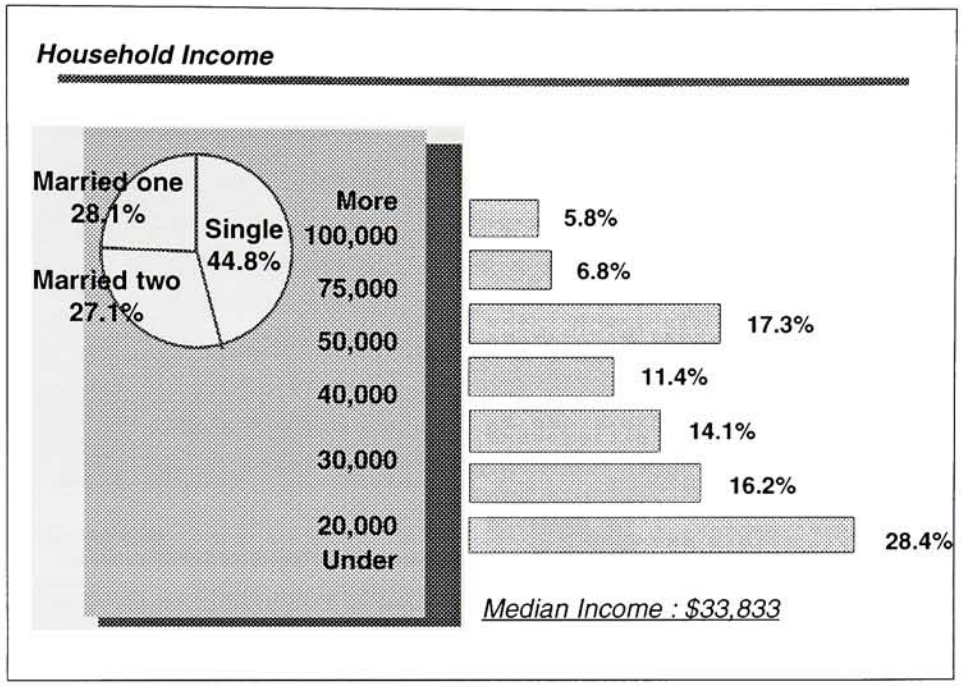

Figure 4. Household income
Source: National Demographics & Lifestyles, The Lifestyle Market Analyst 1994 (Wilmette, IL.: Standard Rate and Data Service, 1994), A-32.

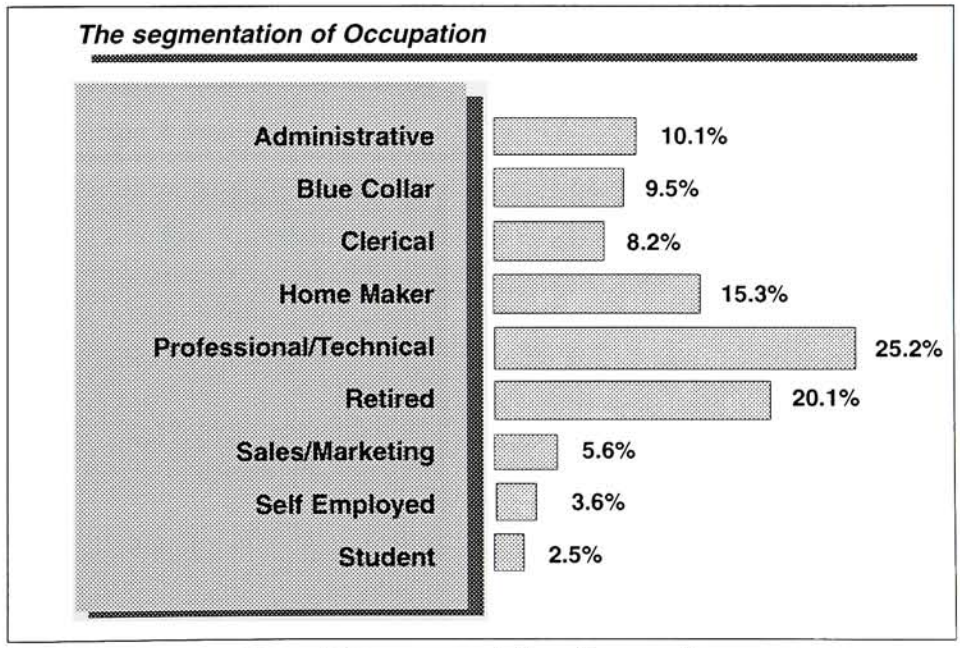

Figure 5. The segmentation of occupation

Source: National Demographics & Lifestyles, The Lifestyle Market Analyst 1994 (Wilmette, IL.: Standard Rate and Data Service, 1994), A-32.

In Figure 4, we can account for about 38 million people (20.1% of the total adults) in the U.S. who were working in the field of sales and marketing in 1993. Also over, 4 million adult students in the U.S. represent a good potential computer market of students.

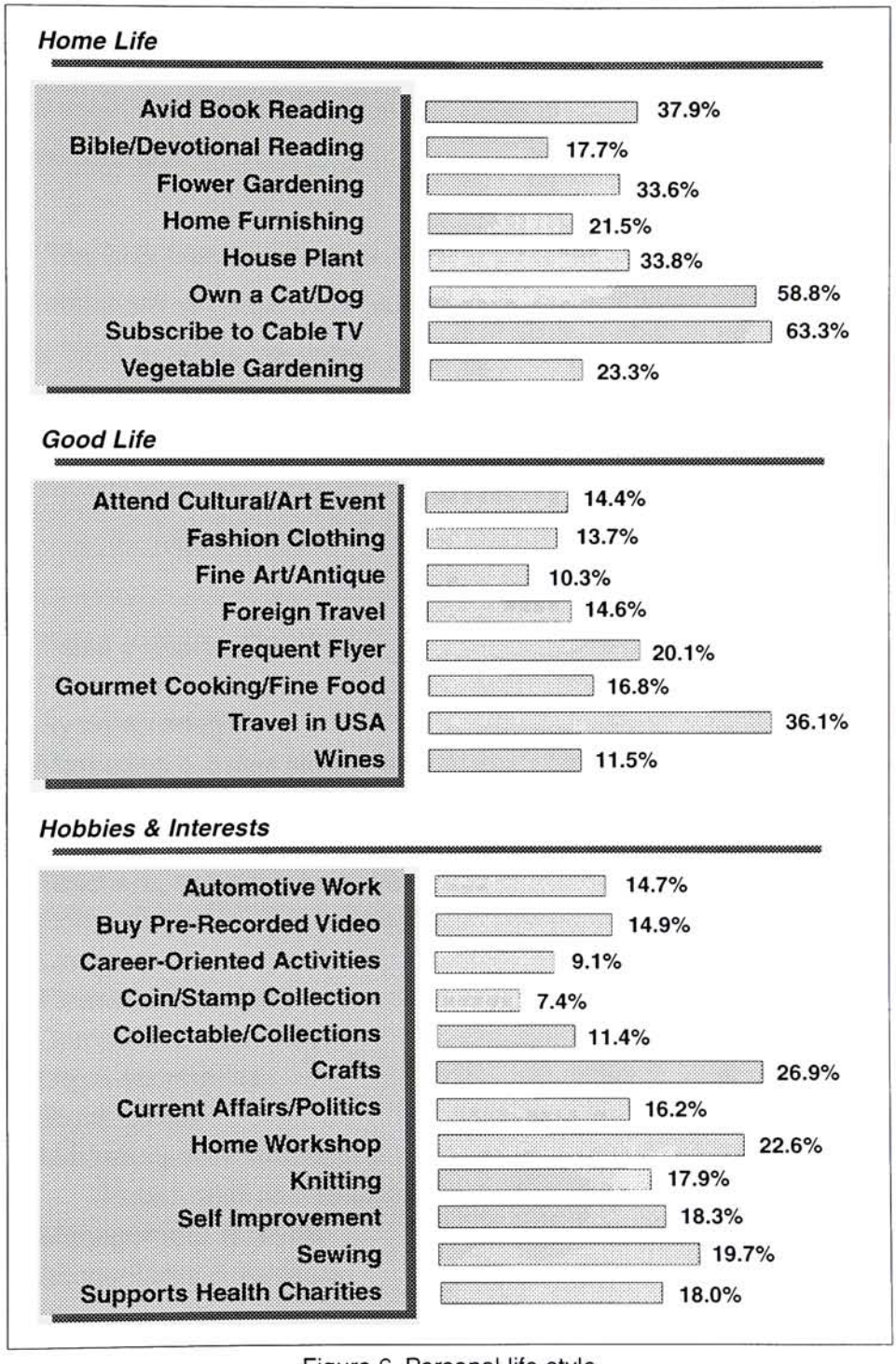

Figure 6. Personal life style

Source: National Demographics & Lifestyles, The Lifestyle Market Analyst 1994 (Wilmette, IL.: Standard Rate and Data Service, 1994), A-33.

User Needs and Consumption Trends

To understand the consumers' needs for computer and computer related products, I examined the statistical material of the following products in sales: micro computers, mobile computers, Macintosh peripherals, color page printers, ink jet printers, factory sales of electronics and estimated household penetrations by computers (Figure 8 to Figure 14) to know what the volumes of the markets in computer and computer related products are.

The U.S. Bureau of Labor Statistics projected that employment of computer engineers and scientists would increase 111.9% during 1992 to 2000, education 74.4%, and legal secretaries 57.1% (Figure 7). All would be required to work on a computer more and more. I considered this as a positive indication for growth in the

OCCUPATION	EMPLOYMENT(1000)		PERCENT CHANGE 1992-2005
	1992	2005	
Sales persons, Retail	3,660	4,446	21.5
Registered nurses	1,835	2,601	41.7
Systems analysts	455	956	10.1
Marketing & Sales worker supervisor	2,036	2,443	20.1
General managers & Top executives	2,871	3,251	13.2
Receptionists & information clerks	904	1,210	33.8
Teachers, special education	358	625	74.4
Computer engineers & Scientists	211	447	111.9
Lawyers	626	821	32.1
Financial managers	701	875	24.8
Computer programmers	555	723	30.4
Legal secretaries	280	439	57.1
Stock clerks	1,782	1,940	8.8
Marketing, mathematical &	432	588	36.1
Public relation managers	337	444	31.5
Management analysts	208	297	42.7
Accountants & Auditors	939	1,243	32.3

Figure 7. The projection of job growth from 1992 to 2005

Source: United States. Bureau of Statistics, Statistical Abstract of the United States 1994,14th ed (Washington: U.S. Dept. of Commerce, Bureau of the Census, 1994), 410.

mobile
computer market of the near future.

I estimated that the domestic shipment of personal computers would be about 10.2 million units in 1995 (Figure 8). If we assume that the product life cycle of a computer is seven years, around 5.4 million units of computers per year will be sold for replacement demands (current supplied units, 38 million divided by a product's life cycle,7). Of the potential buyers (29 million = 30% of the total households which earn more than $20,000 a year), if at least 10% of them will purchase a personal computer each year, about 2.9 million units will be required for new buyers, and the rest of the total units (1.9million units = 10.2 - (5.4 + 2.9)) might be for additional purchase. That means about 0.02% of total households will purchase additional computer a year.

Year	Units	$M
1990	7,050,000	17,980.0
1991	7,540,000	19,200.0
1992	8,140,000	21,200.0
1993	8,790,000	22,900.0
1994	9,495,000	24,500.0
1995	10,255,000	26,200.0
1996	11,075,000	27,900.0
2002	17,010,000	40,700.0

Figure 8. Domestic shipments of micro computers

Source: Egil and Karen Juliussen, Computer Industry Almanac 1994-1995 (Dallas, Tex.: Computer Industry Almanac, 1994), 319.

Shipments (K)	1992	1993	1994	1995	1996
Notebooks	1,900	2,700	3,510	4,563	5,476
Mutants	0	200	1,500	2,200	3,000
Tablets	49	98	220	515	1,030
Total	1,949	2,998	5,230	7,278	9,505

Figure 9. Mobile computer market

Source: Egil and Karen Juliussen, Computer Industry Almanac 1994-1995 (Dallas, Tex.: Computer Industry Almanac, 1994), 324.

Year	Units (M)	Unit Growth (%)	Revenues ($B)
1989	3.3	.	5.11
1990	4.0	82.5	6.00
1991	4.9	81.6	6.95
1992	5.8	84.5	7.84
1993	6.5	89.2	8.88
1994	7.2	90.3	10.57
1995	8.1	88.9	12.39
1996	9.1	89.0	14.17
1997	10.4	87.5	16.19
1998	12.0	86.7	18.49
1999	14.0	85.7	21.12

Figure 10. Macintosh peripherals market

Source: Egil and Karen Juliussen, Computer Industry Almanac 1994-1995 (Dallas, Tex.: Computer Industry Almanac, 1994), 332.

U.S. Units Shipped	1993	1994	1995	1996	1997
Desktop Color Laser	750	12,000	31,000	55,000	115,000
Growth, Desktop Units(%)		1,500.0	158.3	77.4	55.4
Production Color Laser	7,675	9,750	12,300	15,450	18,900
Growth, Production Units(%)	36.0	27.0	26.2	25.6	22.3
Total Color Laser Units	8,425	21,750	43,300	70,450	103,900
Growth, All Color Units(%)	49.2	158.2	99.1	62.7	47.5
Ink Jet Color Page Printers	8,800	11,000	13,750	17,200	21,500
Growth (%)	170.8	25.0	25.0	25.1	25.0
Total Color Page Printers	17,225	32,720	57,050	87,650	125,400
Growth (%)	93.6	90.1	74.2	53.6	43.1

Figure 11. Color page printers

Source: Egil and Karen Juliussen, Computer Industry Almanac 1994-1995 (Dallas, Tex.: Computer Industry Almanac, 1994), 334.

Estimated Units Shipped(K)	1992	1993	1994	1995	1996	1997
Monochrome Inkjet	1,300	2,875	4,050	5,500	7,250	9,100
Growth(%)	33.3	121.2	40.9	35.8	31.8	25.5
Color Inkjet	375	1,050	1,500	2,150	2,950	3,800
Growth(%)	200.0	180.0	42.9	43.3	37.2	28.8
All Inkjet Printers	1,675	3,925	5,550	7,650	10,200	12,900
Growth(%)	52.3	134.3	41.4	37.8	33.3	26.5

figure 12. Ink jet printer market

Source: Egil and Karen Juliussen, Computer Industry Almanac 1994-1995 (Dallas, Tex.: Computer Industry Almanac, 1994), 335.

	1983	1986	1990	1991	1992	1993
LCD Color TV	.	14	50	56	60	60
TV/VCR Combinations	.	.	178	265	375	599
VCR Decks	2,162	3,978	2,439	2,454	2,947	2,851
Camcorders	303	1,338	2,260	2.013	1.842	1,958
Laserdisc Players	81	26	72	81	93	123
Portable Audio Equipment	1,102	1,389	1,645	1,780	2,096	2,187
Cordless Telephones	400	295	842	1,125	1,091	1,046
Telephone Answering Devices	190	464	827	1,000	934	1,026
Cellular Telephones	.	266	1,133	962	1,146	1,257
Home Computers	1,950	2,890	3,795	4,160	4,524	4,861
Home Fax Machines	.	.	219	220	247	332
Home Security System	.	.	1,150	1,250	1,250	1,315

Figure 13. Factory sales of electronics U.S. ($M)

Source: Egil and Karen Juliussen, Computer Industry Almanac 1994-1995 (Dallas, Tex.: Computer Industry Almanac, 1994), 322.

Product	%
All Televisions	98
Home Radios	98
Color TV	97
Audio Systems	94
VCR Decks	81
Compact Audio	67
Telephone Answering Machines	57
Cordless Telephones	49
Home CD Players	43
Video Game Software	42
Home Computers	37
Camcorders	21
Cellular Telephones	10
Projection TV	9
Home Fax Machines	4

Figure 14. Estimated households penetration by product (as of 1/95)
Source: Egil and Karen Juliussen, Computer Industry Almanac 1994-1995 (Dallas, Tex.: Computer Industry Almanac, 1994), 323.

Through this statistical research, I could understand the scale and the characteristics of the current personal computer market. The fact that the mobile computer market is expanding year by year gives me considerable confidence about the needs for *Comffice* (Figure 8).

I needed to analyze the aspects of various consumer products so that I might apply desirable trends for my project. I collected the pictures of contemporary art works from art magazines and the best products from industrial design magazines (Figure 15 and 16) and then I analyzed current trends in art and design.

Contemporary Trends The best designed examples were well organized in the variation and unification of their elements. They projected a simple and clean image, but had many various components comprising the shape. I noticed a trend away from boxy shapes toward more

organic ones. A cube was divided into big and small ones, some of which were transformed into round shapes. A broad surface was divided by striped geometric lines. There were trends toward more simplified control panels with flat planes and round buttons. Round corners were substituted for sharp edges. Many products strived to be thin and displayed a layered look.

Figure 15. Contemporary trends

User Interface Lon Barfield defined the meaning of user interface design as, "designing those parts of a system that the user comes into contact with so that they are easy to understand, easy to grip, and easy to work with efficiently."[3]

The system in this context means all the visible or invisible products from a swing door to the most complicated computer graphic system, and the user includes a range from ordinary unskilled people to the experts. A designer needs to grasp the elements and characteristics of both the user and the system, and should incorporate the communication methods between them when designing a product.

Barfield further described illustrated user interface design as follows:

> There are certain elements of user interface design which are part of the designer. There is a transfer of information from the designer to the system; the system itself is an embodiment of designer's ideas, and there may be some transfer of information from the users to the designer, either through direct contact or through studies of the user group.[4]

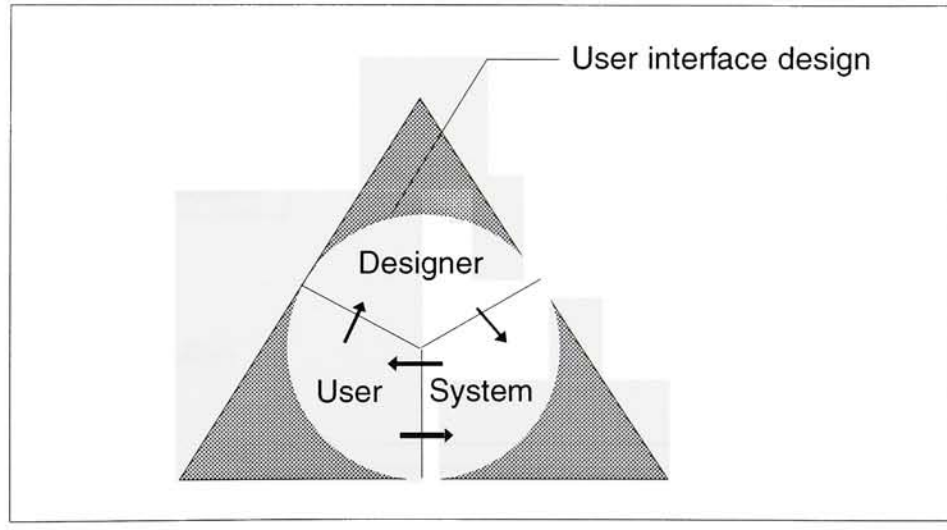

Figure16. The user interface and the designer

Source: Lon Barfield, *User Interface Concept & Design*, (England, Addison-Wesley,1994), p. 3

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[3] Lon Barfield, User Interface Concept & Design (Wokingham, England: Reading. Mass: Addison-Welsey Pub. Co., c1993), 2.

[4] Ibid., 3.

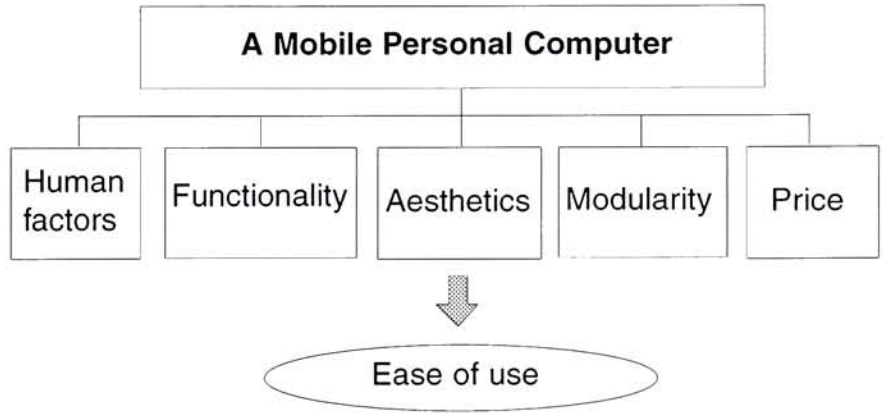
I derived my user interface design specifications for optimum configuration by means of the following sequential process:

1. Defining the system
2. Stating important factors
3. Illustrating ideal configuration

From the definition of *Comffice*, A Mobile Personal Computer, I drafted five important factors which are: human factors, functionality, modularity, aesthetics and price. I had to generate the ideal configurations of important factors for the tentative specification of the project.

1.Defining the System

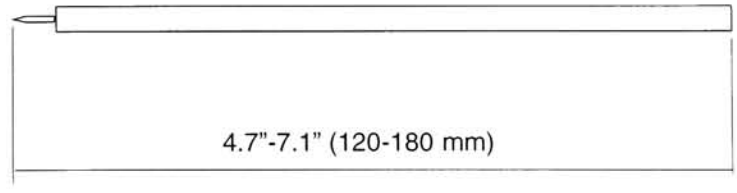
2. Stating Important Factors



3. Illustrating Ideal Configurations

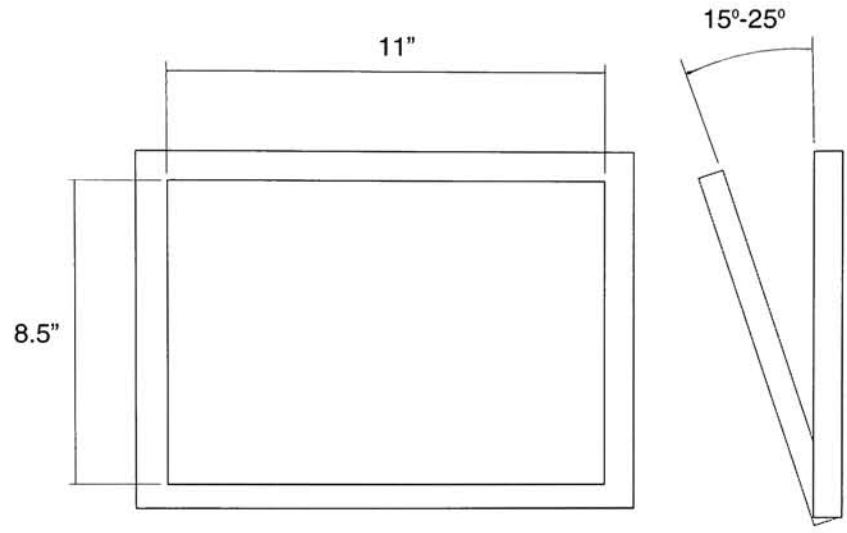
Human factors

- A Writing Pen

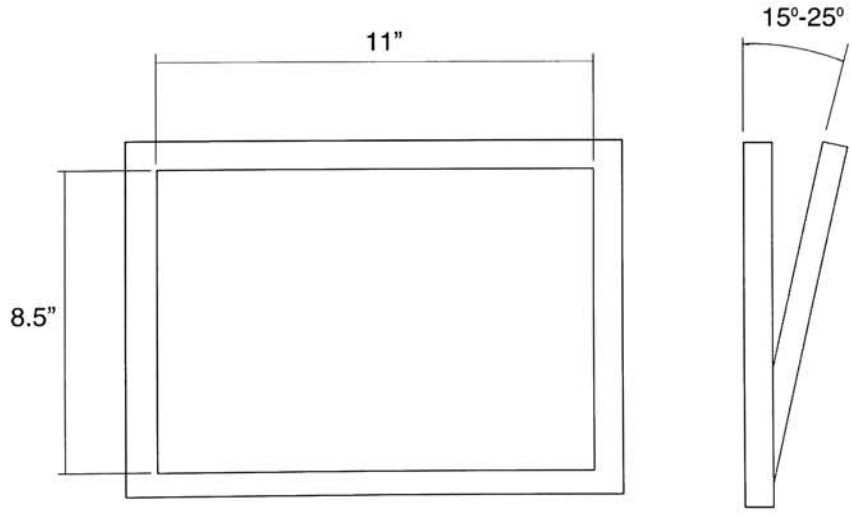


Source: Barry and Peggy L. Tillman, Human Factors Design Handbook, 2d ed (Wesley; New York: McGraw-Hill Inc., 1992)

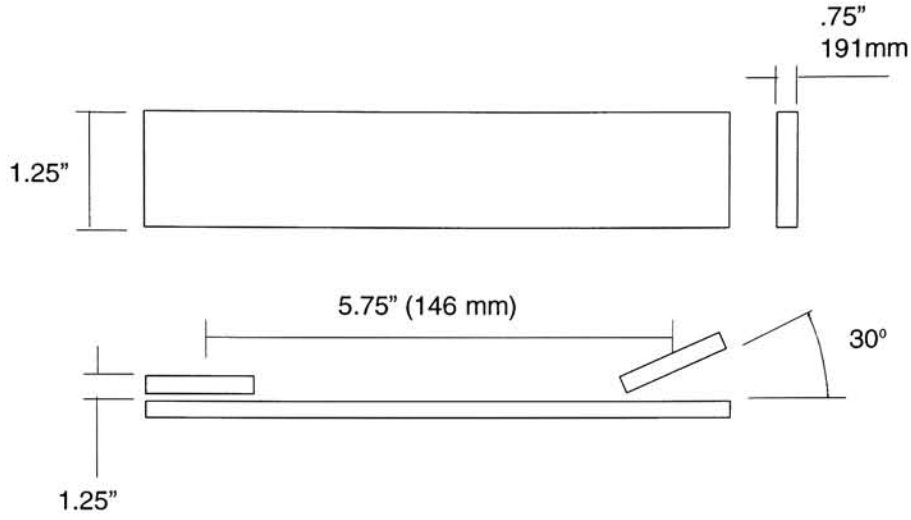
- A Writing Pen Pad



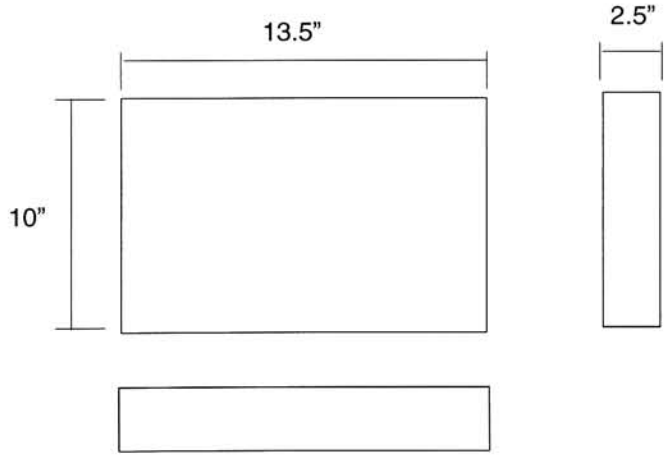
- A Screen



- A Cellular Phone



- The Whole Units



Functionality

Writing Pen	Pointing, writing, drawing (select & erase) Paging
Writing Pad	Substituting for a keyboard Inputting and outputting the works of a writing pen Working on the paper Achieving high resolution and sensitivity
Sub-Screen	High resolution User interface translator
CPU	Large memory High speed Small size
Printer, Scanner	High speed Small size High density

Modularity

- The independent working of each unit
- The easy attachment and detachment of each unit
- The consistency of each unit
- Image coordination between the units

Potential Users

Equipment advances have made possible the growth of an important new trend; a workforce that no longer requires a traditional environment in order to be effective. Three key components comprise the workforce change: mobile professions--people who spend a significant amount of time away from their desks, whether travelling, at other nearby company facilities, or just down the hall at a meeting; telecommuters--people who skip the commute three times a month or more and work from home instead; and soho workers--small office/home office employees who now have access to the same kinds of advanced technology, products and services that were once available only to large corporate.[5]

I would add students as an additional key component and cluster three potential market user groups for *Comffice.*

1. Individual business men and women
2. The people who need to work at home
3. Students

The designs for each group should be considered to fit with the group's characteristics and the scale of the market. For the first concept design of this project, I wanted to concentrate on the first group because its size is the largest in the market (Figure 17).

	1992	1993	1994	1995
Total households(M) [b]	94.5	95.8	96.4	97.5
Total Income-Generating	37.0	38.8	40.0	41.5
& After Hours Home Offices(M)				
After Hours Home Office(M)	21.6	22.7	23.6	24.7
Telecommuters(M) [c]	4.5	5.0	5.6	6.3
a: By 1995 about 43% of U.S. households will have some form of home office				
b: Some households contain both income generating and after hours home offices				

Figure 17. Home Office Market

Source: Egil and Karen Juliussen, Computer Industry Almanac (Dallas, Tex.: Computer Industry Almanac, 1994), 365.

[5] Egil and Karen Juliussen, Computer Industry Almanac (Dallas, Tex.: Computer Industry Almanac, 1994), 365.

TECHNOLOGIES

Input Devices

A conventional keyboard is the most common computer input device, and it is an important interface between a computer and a human being. It is most suitable for performing data entry and selection tasks, but the keyboard is still an unnatural interface tool because typing requires training, produces frequent data-entry errors, demands a lot of working space and is not suitable for graphical user interface.

Device	Space Required	Suitability for Pointing	Suitability for Data Entry (Alphanumeric)	Suitability for Graphic Input	Ease of Use	Suitability for Prolonged Use	Amount of training required
Conventional keyboard (with cursor keys)	Medium-Large	Poor Sp=G Ac=F	Good Sp=G Ac=G	N/A	Fair	Good	Low-High
Chord keyboard	Small	N/A	Good Sp=G Ac=G	N/A	Poor	Good	High
Mouse	Medium	Good Sp=F Ac=G	Poor Sp=P Ac=G	Good Sp=F Ac=G	Good	Fair	Low
Trackball	Small	Good Sp=G Ac=G	Poor Sp=P Ac=G	Fair Sp=F Ac=F	Fair	Good	Low
Graphic tablet (with puck or stylus)	Medium-Large	Good Sp=F Ac=G	Poor Sp=P Ac=G	Good Sp=G Ac=G	Fair	Fair	Low
Joystick	Small	Fair Sp=G Ac=F	Poor Sp=P Ac=F	Fair Sp=G Ac=F	Fair	Fair	Low
Touch screen	Small-Large	Fair Sp=g Ac=F	Fair Sp=F Ac=G	Poor Sp=G Ac=F	Good	Poor	None-Low
Light pen/ Light gun	Small	good Sp=G Ac=F	Fair Sp=F Ac=G	Good Sp=G Ac=F	Good	Poor	Low
Voice	Small	N/A	Fair Sp=F Ac=F	N/A	Good	Good	None-Moderate

Sp=Speed, Ac=Accuracy

Figure 18. Comparison of input devices for computers

Source: Egil and Karen Juliussen, Computer Industry Almanac (Dallas, Tex.: Computer Industry Almanac, 1994), 200.

To improve on the drawbacks of earlier computer input devices, these tools have been introduced: mouse, track ball, graphic tablet, joy stick, touch screen and speech recognition. Speech recognition is the most desirable for the next generation computer. It has the potential for both ease of use and high productivity. The differences between these input devices are shown in Figure 18.

Output Devices There are two basic types of output devices. Hard-copy peripherals such as printers and plotters save a visually readable copy of the data. Soft-copy peripherals such as displays and sound devices leave only temporary images.

Display Technology

In the PC market, color monitors have overtaken the use of monochrome monitors, and now color monitors account for 90% of all monitors. The display resolution of workstations is 1,024 by 1,280 pixels. Nick Baran wrote that the price of LCDs was the most serious concern for the high resolution and the size of the displays. *"While most laptop displays offer VGA resolution of 640 by 480 pixels, Japanese display manufacturers have produced monochrome supertwist LCDs with resolution of 1,024 by 768 pixels."*[6] The color LCD for a laptop computer still has many problems in display resolution and manufacturing. It needs more powerful backlighting and its resolution is one-third that of monochrome resolution. Because it is hand-assembled, it has very low manufacturing yields.

Printers

Printers are the most important hard-copy output peripherals. There are three printer categories: page printers, line printers and character printers. The page printers are used with all types of

[6]Nick Baran, "LCDs and Beyond", Byte, vol. 16 (February 1991): 229-30.

computers from PCs to super-computers. Laser printers account for over 30% of the units sold and over 60% of the revenue.[7] Color printers can use most of the above technologies, and their sales for PCs have recently increased strongly.

Memories Mass storage capability is the most important part of the computer. It decides the overall capabilities of the computer. Its various categories are as follows: magnetic disks, floppy disks, Winchester disks, magnetic tapes, optical disks, and semiconductor memory boards. Optical storage is an emerging technology that shows great future promise. There are three kinds of optical disks: read-only disks, write-once disks and erasable disks. Erasable disks can be both written and erased, and will be used for removable media. Semiconductor memory boards are used primarily for the main memory. Egil Juliussen and Karen P. Juliussen emphasize the importance of the semiconductor memory board as follows:

> A recent development is the use of removable semiconductor memory cards for use with handhold or pocket computers. These PCs are so small there is no room for current disk drives. Standards for the memory card were agreed upon in 1990 and updated in 1992 to include other peripheral devices. The result will be increased usage of semiconductor memory cards with pocket computers. Notebook and sub-notebook PCs are also likely to use these memory cards and desktop PCs may not be far behind.[8]

Telecommunication This industry is broadly divided into suppliers serving the communications markets for local exchanges, long distance (toll), international cellular and mobile radio, satellite, and data communications including value-added network service (VANs). the U.S. Industrial Outlook 1994 projects the cellular and paging industries as follows:

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[7] Egil and Karen Juliussen, 14.

[8] Ibid., 176.

The U.S. cellular market will reach an estimated 35 million subscribers by 2000. Paging subscribers and revenues are forecast to continue near the 20 percent growth rate seen over the last two years, aided by the wide availability of alphanumeric paging and subscriber information services, as well as by the possible introduction within this forecast of two-way messaging.[9]

Voice Capturing Devices

Speechrecognition technology has had problems in both its vocabulary understanding and its price. When PC-based speechrecognition has the capability of thousands of words, its usage will increase rapidly. Computer Industry almanac 1994-1995 reported, *"If speech-recognition takes off soon, it is likely to impact handwriting recognition in a negative way and could prevent usage of handwriting recognition."* [10]

Speech synthesizers are used in specialized applications such as voice mail and sound for recreational software. The technology will allow us to use them for multimedia computers and voice mail communications at inexpensive prices.

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[1] U.S. Industrial Outlook 94, 35th ed (Washington, Bureau of Competitive Assessment and Business Policy), 29-13.

[2] Egil and Karen Juliussen, 179.

The Definition of The Project

Background

The main points for the improvement of a computer are memory, speed and size of the hardware in general. These three elements divide computers into micro-computers, mini-computers and mainframe computers.

The demand is especially strong for desk top, lap top and notebook computers in the micro-computer category because most people want to work on their own computer wherever they might be. With the rapid improvement of technologies, consumers need something much more simple, speedy, and more functional than what is available today. I believe the answer to this problem is a mobile office computer. I call it "a personal mobile office" which is composed of several functions: a computer, input and output device, printer, facsimile and cellular phone.

Objective

My objective was to suggest a notebook computer without a keyboard, which I call "a personal mobile office."

Human needs call for a portable computer that is technologically advanced. The users of the future will want to have a personal computer which offers many conveniences for their working and personal life. They will want to bring their powerful computers wherever needed. They will require a computer which can conduct various sub-functions like video phoning, printing, scanning, and enjoying movies and music as well as computing. Additionally, I couldn't help thinking about solving the problems of the input device, which was my major goal for this project.

In this project I concentrated on a writing pad, input device, as the main idea. I believe it will solve many problems which a

keyboard does not address. The writing pad can be used independently or in conjunction with the computer. A user can work on the paper above the writing pad using normal pencil instead of using an electronic pen to save his or her work and keep the original paper at the same time. The writing pad has to have a sliding sub-menu panel to make it easy to use. If the user wants to increase the diversity and function of the unit, he or she can add other units to the original: a CPU, sub-screen, pager, cellular phone, printer, speaker, or an audio and visual capturing device.

I named my designs *Comffice* as a combination of a portable computer and an office. It can be useful for students. They can see the contents of their textbook in the sub-screen while taking notes or drawing something on the writing pad.

Description I included both vertical and a horizontal types of designs so that I could give alternatives to users. Each design has the same configuration and shows its open shape and closed shape (Figure 19). Both are 8.5" by 11".

High density color LCD monitor technology was applied to both input and output devices, and reinforced HIPS (High Impact Poly styrene) or Polycarbonate was adopted for their housing material.

Both horizontal and vertical types have three layers which consist of a detachable writing pad, a sub-screen and CPU. They open automatically by inputting four digit numbers in the front window.

The front window uses touch screen technique and displays

simple information for a pager. It was designed for receiving fax or for checking the user's schedule, as well as for ten numbers and icons for some input commands.

I applied blue-black and gold-silver for the main colors, which would be quite compatible with most working environments. Also, I proposed a harmonious combination of light blue and lilac for the younger generation. I want to call it the coloration of Post-Post Modernism because I borrowed the color scheme from that design movement.

Figure 19. Two types of design proposal

The concept for the vertical type (Figure 20), which can reduce the space needed to work, came from looking at sand castles (which shows that the strategic design approach and process is not the only way to a good solution). It takes about 20" by 14" of working space, which makes it possible to work in an airplane. The user can print any files by pulling out the printer from the bottom of the main body and putting in a sheet of paper each time. I

eliminated a paper tray and auto-feed system to keep the overall size to a minimum.

A basic speaker exists on the writing pad, but I designed two side speakers for enhancing the sound quality of music and video. A 3.5" CD is sufficient enough for memory storage and for playing music and viewing movies.

Figure 20. The vertical type

For the horizontal type (Figure 21), I emphasized many layers of slim components to reinforce the ideas of functionality and compactness. The writing pad is similar to the vertical type in its shape, but it lies on the CPU and slides back and forth for the use of the printer. The wireless sub-screen removes completely from the main body, giving users flexibility for their working space and good posture. This model requires a 14" by 24" space for use.

I separated the pen and cellular phone from the main body because it would be better for users to carry them in their pocket

or hand than on the main body, and I designed the cellular phone so that it is independent of the main unit. I designed the pager and writing pen as one unit to reduce the number of objects the users might have to carry.

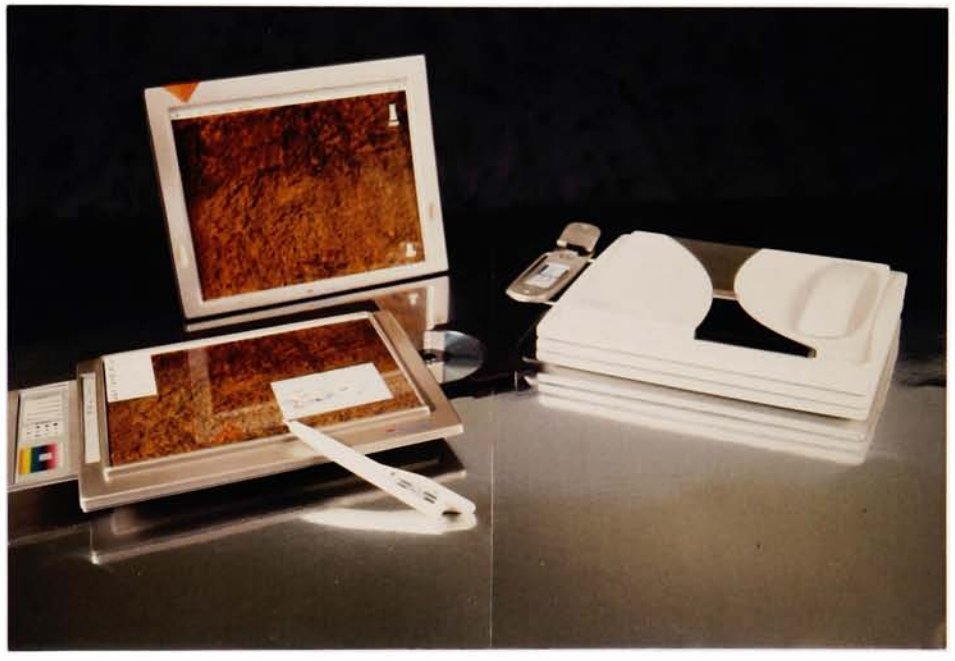

Figure 21. The horizontal type

I devised a plan so that Comffice would have the most up-dated configuration and be a high-end product. I divided the configurations into hardware and software, and used as the configurations of virtual reality PC[1] (Figure 22).

Hardware

11" by 8.5" LCD screen
11" by 8.5" writing pen pad with 100 M hard memory
An electronic writing pen with a pager
A voice and a visual capturer
A modem
3.5" or 6" CD ROM drive
2 GB Hard disc
A color page printer
Two ribbon speakers

[1] A high-end desktop home PC with added 3D graphics and display capabilities.

Software

COM (Comffice Operating Module System)

Comffice Interface

Comffice Word

Comffice Drawing

Comffice Editor

Comffice Server

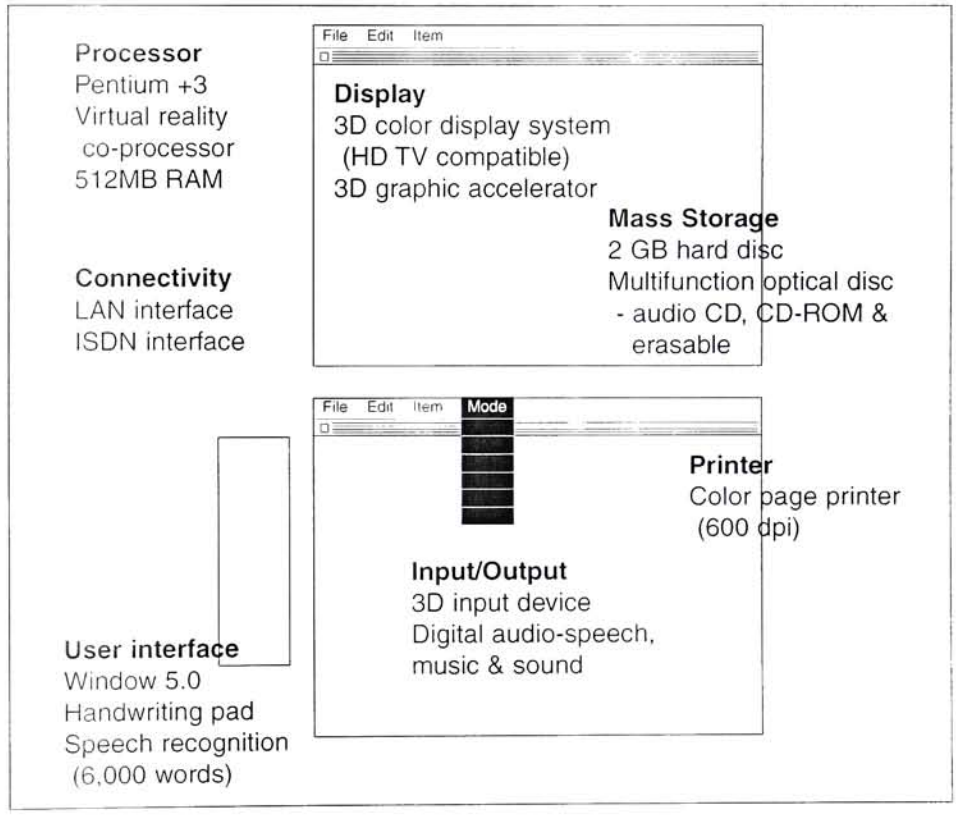

Figure 22. Configuration for virtual reality PC

Application *Comffice* is a very versatile computer. It executes various services as well as computing. It can also be used almost everywhere; in a

car, in a bus, in a train, in an airplane, in a restaurant, and at home. The main applications are shown in Figure 23 through Figure 28.

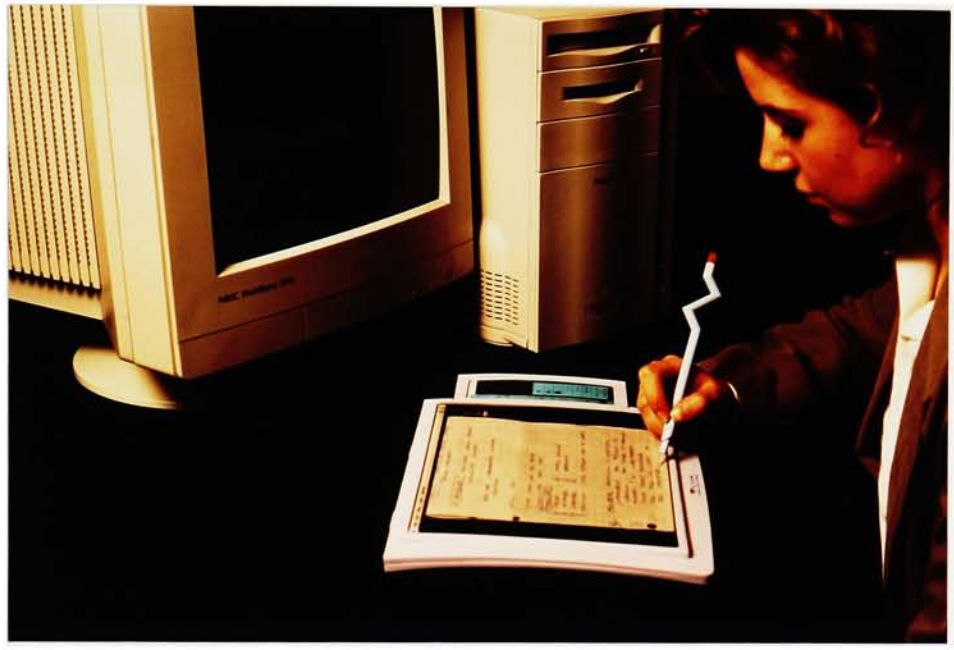

Figure 23. Writing on paper on the writing pad

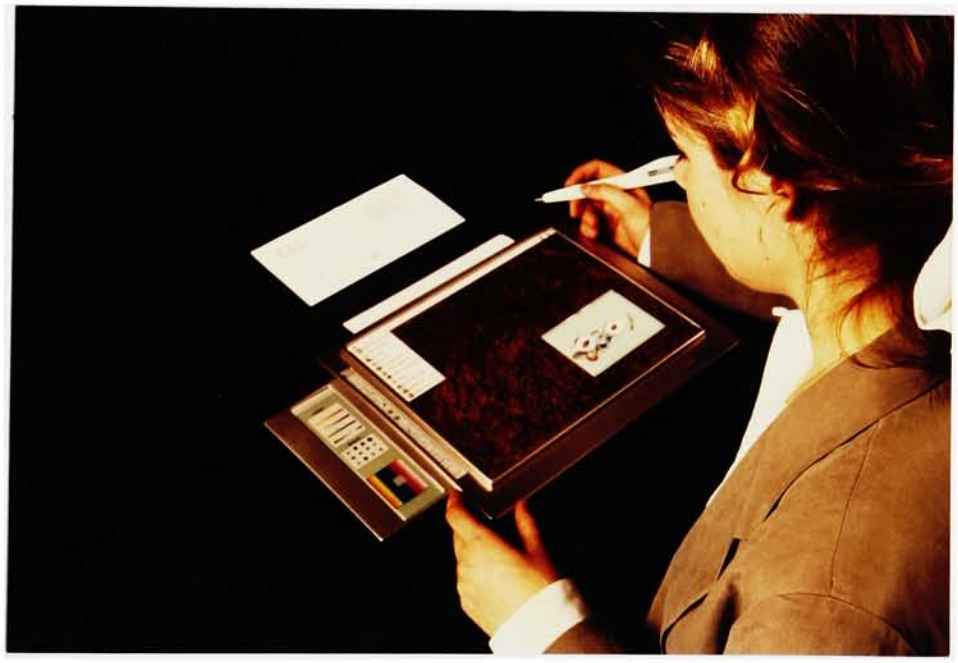

Figure 24. Using a facsmile

Figure 25. Printing

Figure 26. Speech recognition

Figure 27. Writing pens

Figure 28. Using a cellular phone and carrying

Design Plan

William H. Cushman, defines product design in his book, Human Factors in Product Design as follows *"Product design is the process of creating new and improved products for people to use."* [2] He emphasizes function, reliability, usability, appearance and cost as the primary concerns. If the goal of product design is making a well designed product, then the process of creating new and improved products must be a plan for making a good design.

In 1992, the NCR Corporate Design Center conducted research for *"unsurpassed design excellence"* and concluded that good design contains some combination of three characteristics:

(1) Appropriate problem solving, including good human factors
(2) An aesthetic which conveys enduring, elegant quality
(3) Innovation or 'fun.' [3]

The priorities of design excellence shown in Figure 29 were solicited from the employees of NCR.

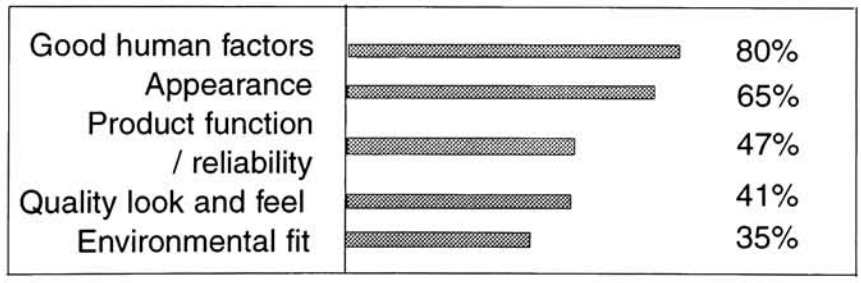

Figure 29. The Priorities of design excellence

I realized good human factors was the most important consideration in designing. These priorities should be achieved by a design plan. I made a design plan for the *Comffice* with emphasis on four important factors: modularity, strategic development, the innovation of design and design process.

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[2] Willam H. Cushman, Human Factors in product design (Amsterdam; New York: Elsevier, 1991), 1.

[3] "The Research for Design Excellence" Innovation, vol. 12:3 (Summer 1992):19.

Modularity Gerald I. Susman defines modularity as *"Decomposition in which a large problem is split into a collection of parts that are as nearly independent of one another as the task allows are referred to as modular decomposition, and the separate sub-problems defined in this way are referred to as modules."*[4] He summarized the specific features of a modular design as: Independence of design, sub-problems and abstraction, aggregation, and generalization of information.

I believed the principle of modularity or decomposition should be applied to this project rather than trying to solve the problems collectively. *Comffice* is composed of many functional units. I decided to develop first the most persuasive functional unit of *Comffice,* and induce the consumers to purchase the rest of the units selectively according to their needs and economic situation.

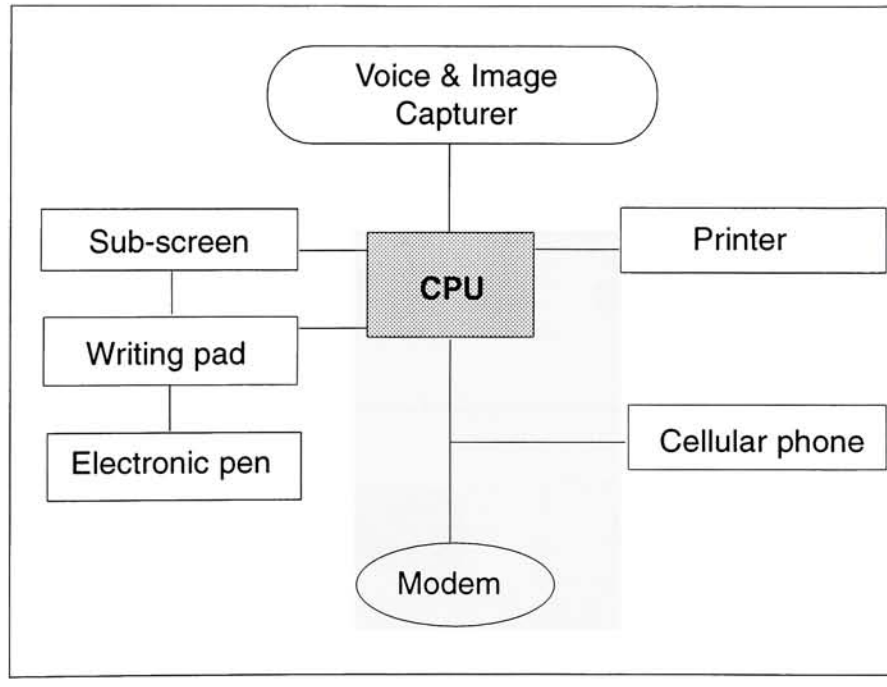

Figure 30. The composition of *Comffice*

[4] Gerald I. Susman, Integrating Design and Manufacturing for Competitive Advantage (New York: Oxford University Press, 1992), 86-7

All units' functions and aesthetics should be harmonious between them and with other equipment. The combination of the whole units is shown in Figure 30, and their selective applications are illustrated in Figure 31.

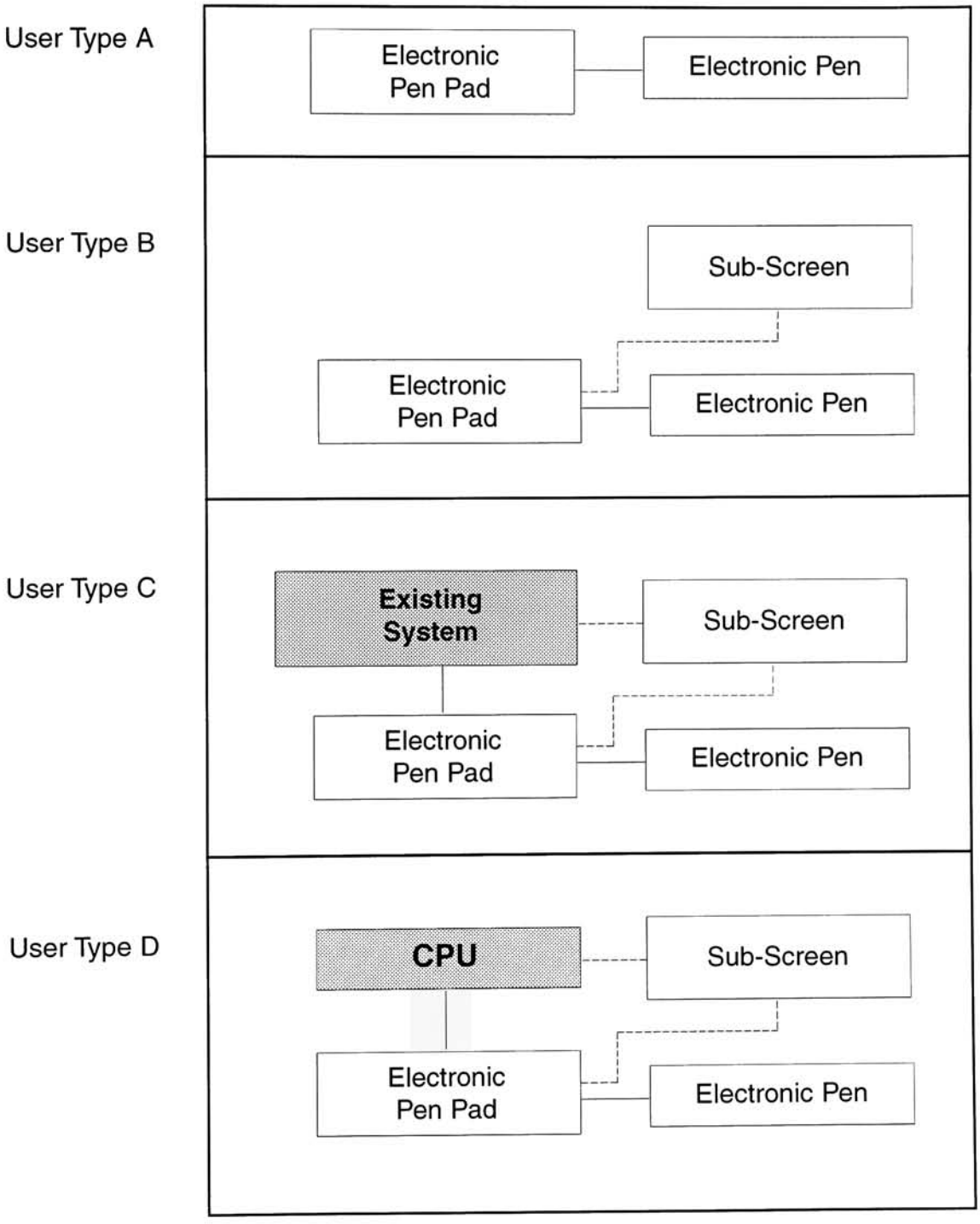

Figure 31. Selective composition

Strategic Development

Executive Marketing Director of the Marketing Institute in Cambridge, George S. Day, explains 'strategy' as follows:

> A strategy is both an explanation of the pattern of the past activities, and a guide to future initiatives and programs. The emphasis is on guidance, for good strategies are not detailed prescriptions for dealing with all conceivable eventualities and contingencies. What is needed from a strategy is the statement of directions that serve as the central theme guiding and coordinating functional actions.[5]

I believe design strategy is a plan for the directions and methods necessary to create user friendly products that are aesthetically pleasing, and this is accomplished by unceasing pursuit of research for the purpose of securing information, efforts for design quality, and the improvement of design process. *Comffice* represents high-end product which requires high-technologies for its up-to-date functions, and it should be designed on a strategic basis to enlarge its market potential. I call this kind of design "strategic development."

The modular concept for the *Comffice* design is a part of the strategic development. One goal of my design is to let the user type D (figure 31) enhance his or her operations, but also for others to have the alternative of not having to buy the whole system all at once. I expect the users to gradually purchase every unit of *Comffice.* User type A conducts basic functions for a mobile office: writing, simple drawing and keyboarding. Editing for writing and drawing is possible for user type B. User type C and D execute the complete functions of *Comffice.* For the most versatile use of *Comffice,* I suggest an ideal combination which is shown in Figure 32.

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[5] George S. Day, Market Driven Strategy (New York: The Free Press,1990), 21

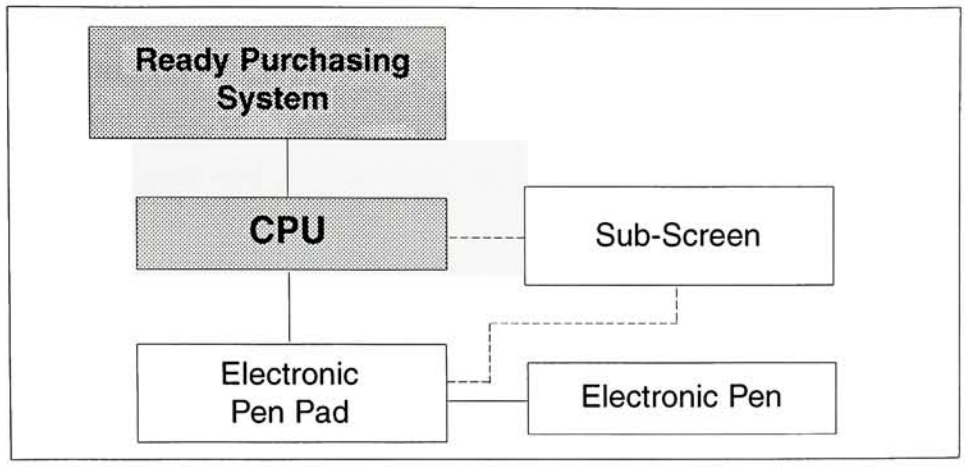

Figure 32.The ideal combination of *Comffice*

Innovation in Design

Innovation is essential for any company that wants to be a leader, survivor and a winner in the 21st century. Innovation is not the term for just product design. Innovation must come from the CEO to every employee in a firm. Everyone in a firm has to endeavor to find new approaches and methods to accomplish their goal or solve their problem efficiently and save time. To see how companies are achieving this goal, many researchers have surveyed many leading companies in many business fields to find common features of the companies.[6]

A professor of Management Science at the University of Chicago, Willard I. Zangwill, emphasizes seven essential steps on innovation in his book, Lightning Strategies for Innovation:

(1) Make innovation strategy
(2) Establish foundations
(3) Eradicate fumbles
(4) Place customer first
(5) Develop design strategy
(6) Design the actual product
(7) Improve continuously

[6] Willard I. Zangwill, Lightning Strategies for Innovation (New York: Lexington Books, 1993), 42.

As a source of innovation via design, he mentions design process, the attitude that product developers and designers have toward their work, the discovery of needs and of the interaction between user and his/her tools, and new technology.[7]

I concentrated on research and the design process for *Comffice,* and established an innovative system with a list to solve the problems for innovation (figure 33).

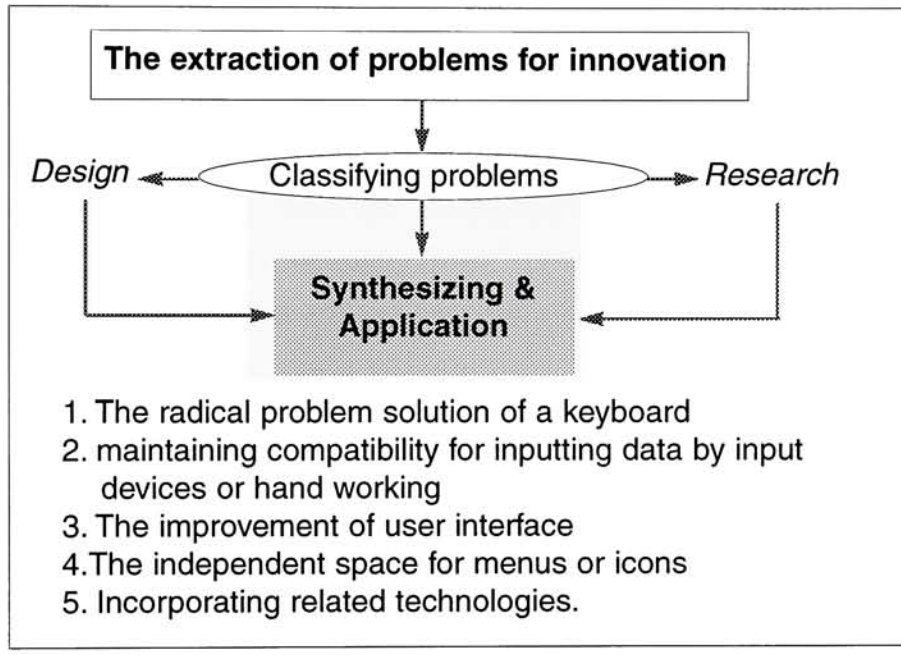

Figure 33. A system for Innovation

Design Process Design process is the important factor for establishing design strategy as a part of competitive strategy. Improving the design process to adjust to rapidly changing market needs and for shortening the development cycle and time-to-market of the product should be a primary concern for the development of products.

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[7] Ibid., 43

As considerations for improving the product design process, Robert Blaich mentions some factors: analysis and establishment of the firm's product development base, selection of a product family to develop, and establishment of design strategy with product strategy.[8]

Parallel Development Process (Concurrent Engineering)

Parallel development process means that every step for developing a product has almost the same start points and end points in time. This process is quite a different system from the sequential process, which is very conventional. Many companies achieve savings and reduction of manufacturing costs by cutting labor rates, lead time, assembly labor hours, defects and materials under the establishment of focuses for parallel design.

Zangwill describes the parallel development process as follows:

> When developing new product, first, the development team determines the product's overall technical work on the product's systems, sub-systems, and piece parts begins. Prototypes are built, and pilot models are tested. Last, manufacturing starts debugging its operations and ramming up for full production. [9]

This parallel development process is illustrated in Figure 34, and we can see four stages of Design process under that heading. I believe each stage in the design process should be conducted at the same time.

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[8] Robert and Janet Blaich, Product Design And Corporate Strategy (New York: McGraw Hill, c1993), 21-35.

[9] Willard I. Zangwill, 47.

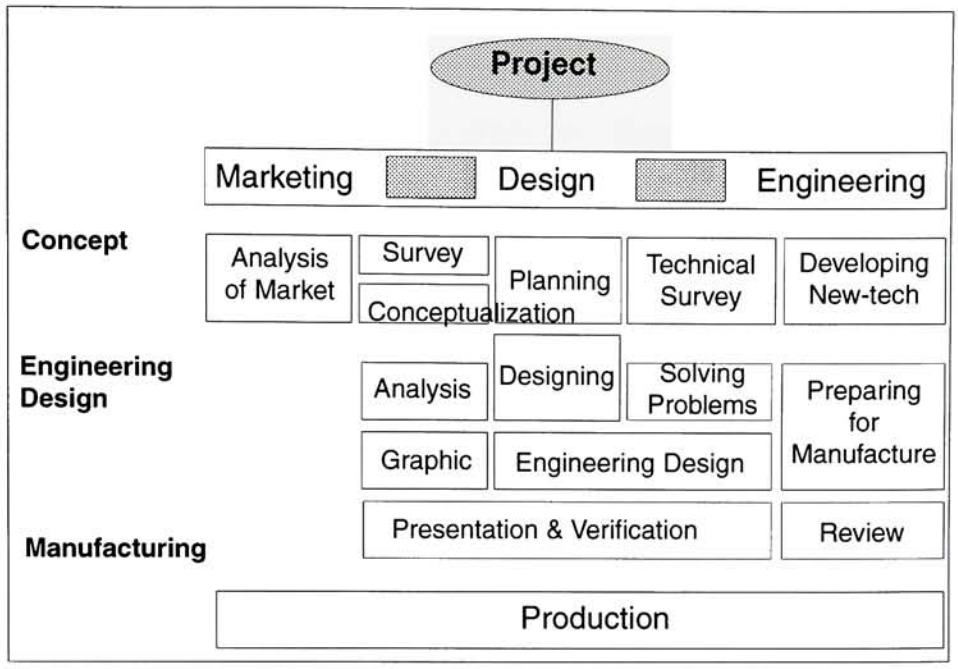

Figure 34. Parallel development process

The Multi-disciplinary Work Team

This development process includes a task force for team work. A development team for the project, composed of people who are good in each necessary field, will contribute its members' insight from the beginning. The teams are organized with industrial designers, marketers, engineering and manufacturing personnel. In general, I assume the team is more efficient, functional and innovative within a tight budgetary and time constraint.

Susan K. Roth, Assistant Professor of Visual Communication Design in the Department of Industrial Design at Ohio State University, refers to this method as follows: *" The multi-disciplinary team approach is restructuring product development in today's business... It now has a track record for successfully improving quality and reducing time to market that includes noteworthy, award- and market-winning products."* [1]

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[10] Suzan K. Roth, "The class room work place", Innovation, vol. 13 (Winter 1994): 37-41

The design Process for Comffice Design

I separated the design process into two stages: design conceptualizing and engineering design. I suggested that each stage should be conducted by a parallel development process (Figure 35).

I drew concept sketches while making the analysis panels from my research. The advantages of this method included a better directional strategy and planning initiative. Through research I learned the current trends of consumer products and what the users' needs were.

In the first stage of work I expressed my ideas in renderings. I developed these ideas in Pro/Engineer[11] and Micro-Station[12]. While working on the computers, I made a concrete plan for the details of the designs.

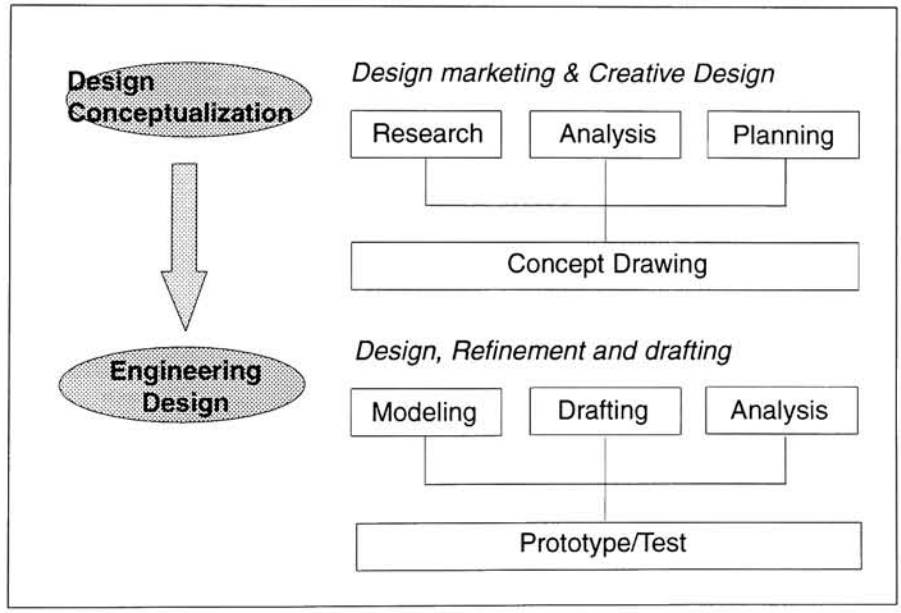

Figure 35. The Design Process of *Comffice*

[11] A CAD software of Parametrics Technologies Inc., Unix base. For workstation

[12] A CAD software of Bentley Inc., IBM base. For PC or workstation

Evaluation

Interface I had two concerns with the interface of *Comffice* : interface between a user and system, and Interface between systems. I found the former more important than the latter. A system must always concern itself first with the interaction of people.

In the research and analysis section, I mentioned the ideal configuration of my project. While designing, I applied optimal configurations to each functional unit, and I designed to make the whole operating procedure possible without any confusion.

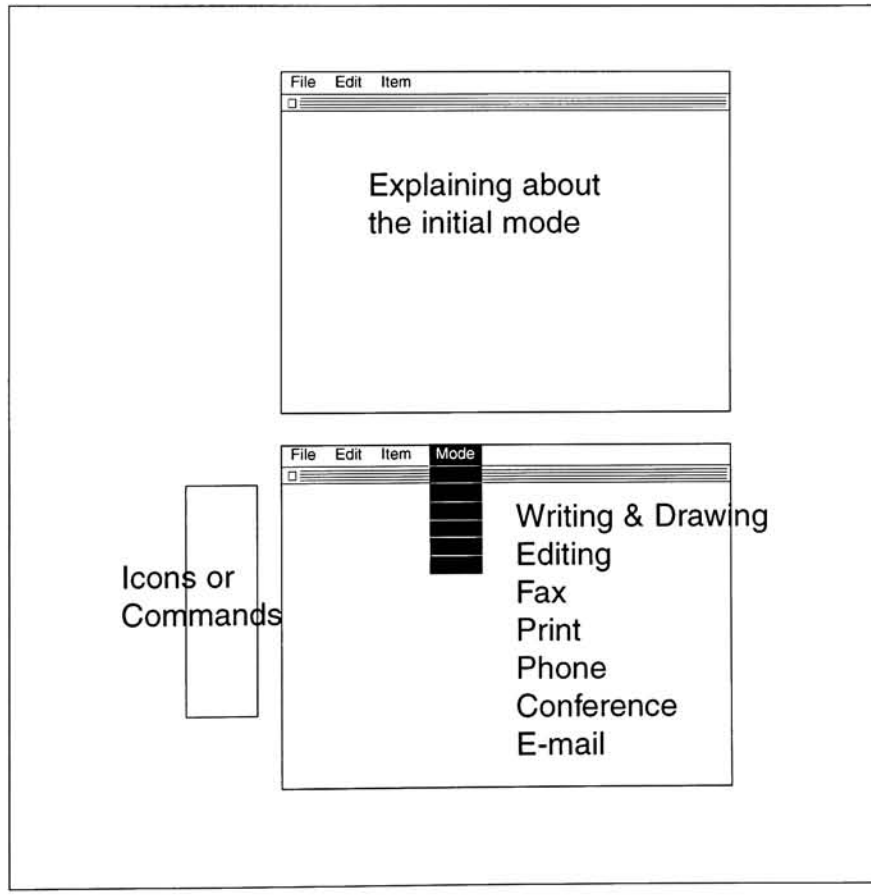

Figure 36. The initial mode of *Comffice*

After entering one's PIN number to open the package, the user can communicate with the computer on the sub-screen (the first generation of Comffice) or by voice (the second generation). The initial mode is illustrated in Figure 36. Every step for working is conducted by communicating between the user and the system. The details for processing should be programmed by the engineering designers.

Human Factors

I surveyed the responses of Comffice through individual interviews with the audience at my thesis show.

Most liked the housing size (11" by 14") because it was very comfortable to carry and to use.
They especially liked the size of the writing pad and sub-screen (legal paper size, 8.5" by 11").

The modular concept of this project was appealing as a mobile personal computer because all the units did not have to be purchased at once, but could be later complemented with other equipment.

Some who were surveyed were impressed by the hollowed or concave appearance, making it was easy to grip and hold. The curvature of the front surface fit the curve of their waists.

I placed the sub-panel at the right side for the A type and at the left side for the B type (figure 31). In response to that positioning, most right handed people preferred the left side. So, I would like to suggest that the sub-panel could be placed at any side in order that it might be used by ambidextrous and left-handed persons.

The audience agreed with the 3.5" diameter size of the CD ROM which I suggested for the sub-memory of the vertical type.

They were interested in the adjustable cellular phone. Its length is short and light enough to hold in the pocket without any problems.

One of the problems that was identified was the narrow width of the printer for the A type. In fact, its use is less than optimum, but I intended its use to be infrequent, under special situations. A better solution could be found.

Appearance

I approached the design shapes in two ways: a vertical type and a horizontal type. Because most products that are thin have a conventional, flat appearance for stability, I was challenged to come up with a style which was vertical in shape like a bookbag. But, I could not ignore the practicality of the horizontal type. I developed both concepts separately for my design.

Many of the people I surveyed liked the horizontal type because they thought it had good ergonomics and human interface qualities. More people, however, were impressed with the vertical design, saying that the form and coloration had a higher visual impact.

The majority of those surveyed felt that the speakers of the vertical design and zig-zag writing pen went beyond the users' expectation in both style and function.

The audience surveyed was concerned about how the product could be up-graded. I answered these concerns by devising a system where the units were independent and could be physically attached and detached from the main unit. Also, the units themselves could be changed internally to either up-grade them or change the aspects of the functions. Because of the material

differences between the different units, and because the system is modular, separation for recycling is simplified.

Mobile computing is growing in many directions; platform selections, communication capabilities and services, and information availability. My expectations in the future for *Comffice* designed systems is that it will exceed the demands of current mobile computers if research and development is sufficient.

The expected influences of the proposals

Mobile computing can be sub-divided into units that serve its general purposes. These units, connected with the mobile computing category, include notebook and sub-notebook PCs.

The research in Computer Industry almanac1994-1995 predicts the prospect of mobile computers:

> The popularity of mobile PCs has grown significantly. In 1990 mobile PCs accounted for 12% of PCs and nearly doubled its market share to 23% in 1993. It is likely that notebook and sub-notebook PCs will account for 27% to 30% of the total PC unit shipment by 1996.[13]

I expect my designs would make an indispensible working tool, a friendly alternative to present computer choices, and fit well into the high-tech world of the future.

Comffice would eliminate the need for today's standard studying tools such as books, notebooks and pens. Students in the future would use the mobile writing pad during lectures and at the same time be able to view the contents of their textbooks on the sub-screen. *Comffice* would become a standard trade tool for business persons and sales people in the future. Comffice users would be able to operate this product in almost every environment, including buses, planes and boats.

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[13] Egil and Karen Juliussen, Computer Industry Almanac 1994-1995 (Dallas, Tex.: Computer Industry Almanac, 1994), 324.

THE DIRECTION OF A FUTURISTIC DESIGN

A designer's attitude

We live in a technological society full of various designs that touch our lives. Especially during the style periods of Modernism and Post-Modernism, the role of design in this society became very important. Good design has made our lives more comfortable and prosperous. But, though design is a problem-solving activity for improving the quality of our lives, unless we realize our responsibility to society, poor designs which are very advanced but harmful to children, or very comfortable but contaminate the air, will have a negative effect on our quality of life.

As an example, I recently found a VCR remote control. It had many control buttons on it. Though it looked very advanced and useful, the user often had many difficulties in understanding how to use it. Many of buttons seemed rarely to be used and the printing on the most used buttons was erased. Moreover, it was difficult to keep from losing it.

A second example is a design I saw in a magazine where a coffee-maker and a computer were combined into one unit. I consider this to be a bad design because it tends to keep the user at the computer rather than taking needed breaks from it to socialize. Other disadvantages to some users might be the increased cost of the unit and the extra space required to have the coffee-maker attached to the computer.

As designers, we should look to our responsibilities from the perspective of what time, culture and environment we live in. A designer's attitude should be one that includes all possible effects that their designs have on society, now and in the future.

I would like to emphasize three key points for consideration in

designing. First, the designer must include consideration for the effect his or her product will have on the environment. Second, the design should fit in well with the ethical, legal and moral standards determined by the society's majority. Finally, the designer needs to take the responsibility for his or her designs in regards to their long term ramifications.

Design with conscience

Modern society is full of examples of many and varied design products. The function of most products can easily be deduced by the product's appearance.

For example, the long cylindrical shape of a pencil makes it easy to identify the fact that it should be grasped. The soft leaded point indicates writing. A car's wheels imply a substitution for a human's legs. Product design's sole purpose is to fulfill the emotional, physical and spiritual needs of people. Some management and manufacturing personnel lose sight of this fact. Profit and 'quick fix' mentality sometimes gets in the way of more sound product designs that better serve the public.

As designers, we make decisions after a thorough consideration of the factors that will influence the outcome of our design and of the consequences that may result from our design. While strategies and systems can improve the designer's effectiveness, ultimately it is the designer's conscientious, thorough process that will ensure that we have designed in the best possible way for the good of our society.

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