Hitotsubashi Journal of Commerce and Management 29 (1994) pp. 35-51. © The Hitotsubashi Academy

HUMAN INTERFACES AND PRODUCT MARKETING

PATRICK REINMOELLER*

Abstract

Just offering products with displays is no longer enough to secure the continued interest and loyalty of the customer in a global information industry. Today the pace is set by market-oriented Interface Design. The concept of Human Interface as a possible competitive asset is presented and analysed. The remarkable progress made by Japanese manufacturers is visualized by several product examples. The fundamental changes in the rapidly evolving information technology and the effects on Interface Design are pointed out. The underlying currents in hardware and software development are described. The article concludes with a discussion of competitive strategies in Human Interface Design. Cost advantages in hardware as well as in software production are considered. The focus on emotionalizing Human Interfaces derives from the need to differentiate the flow of information between customer and product. Links of Human Interface Innovations to multimedia and virtual reality are tentatively indicated.

I. *Introduction*

The commercializations of new developments in technology and design open up new dimensions for improving customization. Offering products with displays is no longer enough to secure the continued interest and loyalty of the customer. Today the pace is being set by market-oriented Interface Design, a specialism concerned above all with the flow of information between customer and product.

* The author wishes to express his gratitude to Professor Hirotaka Takeuchi, Ph.D. who supervised his research at the Hitotsubashi University during a twelve month research visit in 1991-1992. He also wishes to thank these Japanese companies who assisted him in the preparation of this paper [by giving interviews and answering countless questions. Finally he would like to thank the members of the Takeuchi-Seminar at Hitotsubashi University in general, and Mr. Yoshinori Fujikawa, M.A. in particular, for assisting him with his research.

In its "The Best of 1991" presentation, Business Week[1] selected among others the following new products: Hewlett Packard's 95LX, a "brilliant palm top computer"; Tandy's Grid Pad Computer with a touch sensitive screen and an electronic pen that recognizes hand-printed block letters; the Apple Power Book—combining the advantages of compactness, light weight, design quality and the Apple Interface. All of these products are American. And they all reflect a fundamental shift in design: the growing importance of Interface Design. Although American companies have historically held a lead in this field, Japanese companies are catching up.

This paper will take a closer look at the concept of Interface and consider its growing importance in design and product marketing. By demonstrating how Interface related considerations have influenced the products of several leading manufacturers, it will argue that Interface represents a crucial new site of commercial competition. Particular attention will be paid to a number of Japanese products which seem to support this thesis.

II. *Interface Design*

The term Interface refers to both the flow of information between two different entities and their point of contact. The greater the difference between these entities, the more urgent the need for a well designed Interface to facilitate their smooth interaction. There is, of course, nothing radically new about the concept of Interface as such; it has always been around as a topic of Industrial Design. At the most basic level, for example, a door handle represents the Interface between a door and the person who opens or closes it.[2] Whether they be door handles or computer display screens, Interfaces reflect the physical properties of their interactors, the functions they perform, and the balance of power and control at play between them.

Human Interfaces, as the term suggests, are concerned with the interaction between human and non-human entities, that is: between man and machine. To create effective Human Interfaces it is necessary to study human emotions and the workings of the human mind. For this reason the cognitive sciences have claimed a position of increasing importance in the sphere of Interface Design.

Today Interfaces are primarily understood as subsystems of computing systems with which the human user deals on a regular basis.[3] Human Interfaces therefore seek to employ modes of communication which are as close as possible to everyday forms of human intercourse. They facilitate interaction between man and machine by 'understanding,' computing and displaying at speeds that seem natural to their human users (see Figure 1). This focus on 'user friendlyness' in Interface Design derives directly from the growing complexity of products on the market.

Human Interfaces started out from one-to-one relationships where input was parti-

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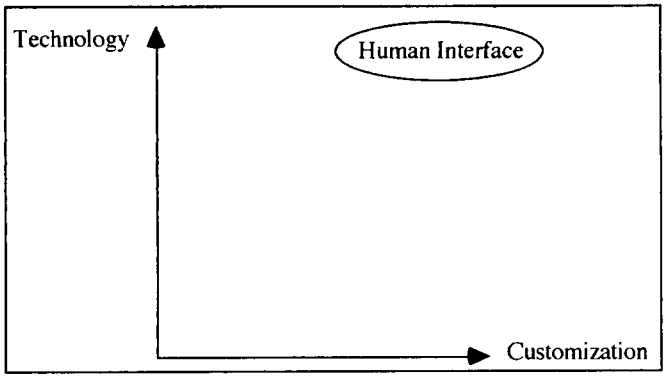
[1] See: Business Week, January 13, 1992, pp. 71–86.

[2] See: Laurel, B.: The Art of Human Interface Design, Addison Wesley 1990, p. xii.

[3] See: Feigenbaum, E.A.; McCorduck, P.: The Fifth Generation, Reading, Mass. 1983, p. 256; Krippendorff, K.: Imaging, Computing and Designing Minds, in: Design Management Journal, Winter 1991, pp. 29–36.

FIGURE 1. HUMAN INTERFACE—THE LINK BETWEEN TECHNOLOGY AND CUSTOMIZATION



cularly complex. The first, huge ENIAC computers had numerous controls, dials and scales. The next step in the development of man-machine transaction[4] was the introduction of preproduced machine-legible input, such as punch cards, where the machine itself processed input into legible commands. Later, 'menu-oriented' Interfaces introduced an element of 'conversationality' into the interaction between user and machine, mediated by the computer screen. Here the user reads, writes and elicits computer responses in his own language, while the software program makes the computer's own (binary) language disappear from the transaction. Software includes operating systems (such as the early CpM, MS/DOS, OS/2 and Unix) which are as fundamental to Interfaces as hardware is to software. It is largely these operating systems which determine the quality of the Interface insofar as usability is concerned. Thus system design and Interface Design are closely related. Today Interfaces increasingly rely on object-oriented software structures, direct manipulation and the 'What-You-See-Is-What-You-Get'-principle.[5]

Interface Design has also become a key part of Industrial Design, and it is of great importance for manufacturers to maintain conceptual coherence and consistency between the two areas. Industrial Design seeks to enhance the value of the product by 'tailoring' its functional, esthetic, symbolic and emotional dimensions ot the character and needs of the customer. Classical design features (such as materials, shape, color and signs) are not only important for hardware design, but also for the design of representational graphics in Interfaces. The development of aids to understanding through graphic Interfaces has come to constitute a new field in Industrial Design, which extends well beyond the scope of classical design features.

New opportunities are offered by 'modern' design features (Figure 2). The advent of computers, software and displays has necessitated the extensive use of signs as stand-ins for abstract realities, and the creation of effective systems of representation has consequently

[4] See: Walker, J.: Through the looking glass, in: The Art of Human-Computer Interface Design, ed. B. Laurel, Addison-Wesley 1990.

[5] See: Nelson, Th. H.: The right way to think about Software Design, in: The Art of Human-Computer Interface Design, B. Laurel (Ed.), Addison Wesley 1990; Norman, D.: The psychology of everyday things, New York 1988.

FIGURE 2. MODERN DESIGN FEATURES

'modern' design features
tangible:
speakers, microphones, displays, sensors, fuzzy systems, cameras etc.
intangible:
icons, metaphors, symbols, mental models, processes, help devices, agents etc.

become a key determinant of quality in Interface Design. The quality of the Human Interface also determines the degree to which the whole computer system will be perceived by the user as being natural, simple and 'rational.' 'Rational,' from the human point of view, does not necessarily mean 'logical.' The ideal Human Interface is the one which is most *psycho*-logically effective.

The key focus of Human Interface Design remains the perfection of software technology. The function of software is to perform tasks for the user which save effort and increase versatility. The user must be allowed to focus on the problem he is using the technology to solve, not on the computer he is trying to operate. The better the Interface Design, the less experience the user will have to bring to his computer. Ideally the user should be able to operate his computer 'intuitively', without any previous experience at all.

III. *A Look at Japanese Progress in Human Interface Design*

Japanese companies are already deeply involved in R&D[6] to ensure that Japanese Software Design maintains the highest possible standards. A large number of user friendly products, belonging to various product categories, can be found on the Japanese domestic market. These tend to perform a greater number of functions with fewer controls and rely increasingly on voice-activated input. To exemplify Japanese progress in Human Interface Design, I have chosen to focus on consumer electronics, as this can be identified as a rapidly developing Interface-driven business. The importance of coordinating the product-user Interface is comparatively greater here than that of coordinating the internal product structure.[7] (The increasing significance of Interface Design for product success is analyzed in more detail in section five).

Sony continues to develop its strategy of "smaller & better"[8] and to exploit of it's supremacy in miniaturisation. Miniaturisation technology, based partly on High Density Surface Mount Technology, is central to the typical Sony Design (what the Japanese call:

[6] See: 'Design as Interface' in: AXIS, Nr. 37, Tokyo 1990, p. 30; AXIS, Nr. 39, 1990, p. 77; 'CAD to Jinko genjitsukan' in: Design News, Nr. 215, 1991, p. 10.

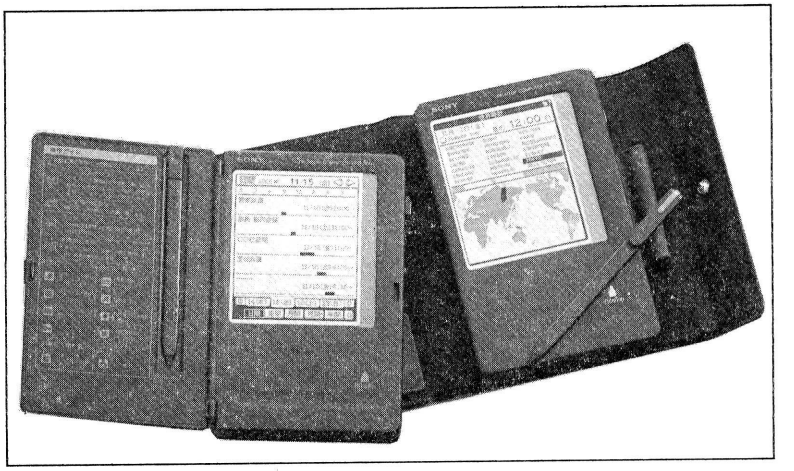
[7] See: Fujimoto, T.: Product Integrity and the Role of Designer-as-Integrator, in: Design Management Journal, Vol. 2, Nr. 2, 1991; Clark, K./Fujimoto, T.: Development Performance: Strategy, Organization, and Management in the World Auto Industry, Boston 1991.

[8] See: Takeuchi, H.: Small & Better—the Consumer Driven Advantage, in: Design Management Journal, Vol. 2, Nr. 1, 1991, p. 62.

sonyrashisa).[9] The introduction of the data discman, a read only memory device (ROM) with a large LCDisplay and the Palm Top Organizer are just two examples. The Palm Top Organizer presents a variety of functions to the user on a display. The size of a pocket notebook, it offers distinctively computer-like functions. Sony has already improved the shape. The first Palm Top brought out in 1990 was a flat board.[10] The present model is shaped more like a conventional paper notebook. The cordless pen which serves as an input device reinforces this analogy. Sony relies on use patterns familiar from conventional products to introduce new technologies, to reduce learning effort and to increase convenience. Input can even be drawn or handwritten, thanks to the LCD-Panel and fuzzy artificial intelligence, that recognizes handwritten characters. New input in files is automatically placed in other relevant files. Technology, Design and a strategically pioneering approach have thus helped to create new product types. This pioneering approach gains considerable competitive advantage by continuously striving for innovative products geared towards new markets. Because of its high price the Palm Top has only been developed for the Japanese market. The acquired experience concerning hardware and software Interface will, however, be used for forthcoming globally marketed products.

The performance of these personal intelligence products, together with the customer satisfaction it inevitably brings, depends largely on the Interface. Sony defines its own Interface as an aid to easy handling, input and simultaneous control. Its adaptability for different operation modes and amenities make it particularly marketable. The Design of a facilitated dialogue – between man and machine – is a major characteristic of this pioneering product in an intensely competitive environment. Sony recognizes considerable room for improvement, especially in software design. But Ken Iwaki, Sony's deputy president

FIGURE 3. SONY PALM TOP



[9] See: Yamaguchi, M.: "Jirei Sony Kabushiki Kaisha," in Senshin Kigyo no Dezain Senryaku, Tokyo 1992.

[10] Interview with Yamaguchi, M., Planning & Coordination, Strategy Group, Sony Corporation, Tokyo, Autumn 1992.

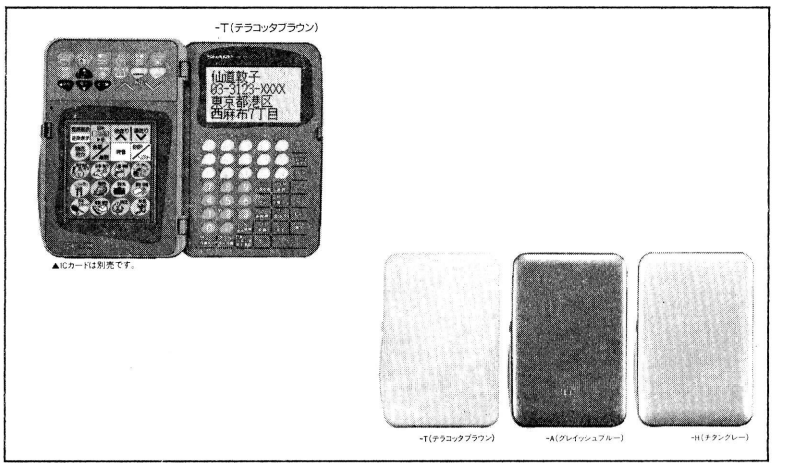
for corporate strategy clearly understated the case in claiming that software and operating systems "are nonexistent at Sony."[11] In fact, Sony is continuously learning how to produce better and more human Interfaces. An example of this is the agreement with Nintendo on CD-ROM players which provides Sony entry into the video game market.[12]

Another Japanese company, Sharp, is a successful leader in the 'personal organizer' product category with a variety of models on the market. The main features of the PA-X1 model – also a compact, light (99 g) and multi-purpose product – are an LCDisplay and exchangeable IC-Programm Cards. The hardware features are well designed, too. The materials used enable the manufacture of a lightweight product in colours tailored to market requirements. The shape is characterized by soft edges and a smooth line. The colour range (Terracotta, Titan-Blue etc.), together with the accessories, reflect the target group: the young urban working female.

The textured surface underlines the colour effect. Signs indicating general functions are placed on the body, while more specific signs referring to more particular or restricted applications are placed on exchangeable IC-Cards. The form of this computerized organizer is analogous to paper notebooks known all over the world. Again the familiar shape to some extent suggests the pattern of usage. The user intuitively operates the organizer correctly. Hard- and Software Design are integrated to provide optimal support to the functions to be performed. Both the permanent and the exchangeable display on the IC-Card together provide specialized support for each application. The first display processes information and output, while the second allows the user to change from one program to another. (For example, from language education or business programs to games or 'guides' for Tokyo's railway system.)

The different cards are designed to match the general design vocabulary of the product

FIGURE 4. SHARP PA-X1



[11] See: the article on the Sony press conference with Mr. Iwaki in Asian Wall Street Journal, 10-11. 10., 1992, p. 1, 20; on software problems concerning character recognition of handwritten characters see: Rabello, K.: The pen-PC market is moving half steam ahead, in: Business Week, March 30, 1991, pp. 61–62.

[12] See: Sony to Develop CD-ROM Players for Nintendo, International Herald Tribune, October, 2, 1992.

and the specific nature of the program. The colorful cards are directly involved in product use, as they have additional touch buttons. Different functions are introduced with each card, altering the mode of operation and the shape and colour arrangement. This accounts for the increased variability of the product base. Nevertheless the general principles of ease of use and product-specific operation are maintained for the sake of stability. Sharp effectively blends hardware and software into a distinctive Interface support. As already mentioned, the PA-X1 as a symbol for elegant intelligence targets above all 'the young working female.' Soft colours, shapes and cute, 'easy-to-understand' icons are used to create a sense of intelligent, yet emotional 'conversation'. The product constitutes a major economic success for Sharp, who see in Human Interfaces a powerful potential for competitiveness. This is illustrated by a range of different product types from the personal organizer to the washing machine.

Sharp's Wizard and Action Manager organizers are particularly good examples of the company's interest in Interface. The name, shape, colour, and texture target the male businessman. Interface is central to the success of the product. Although pen-point operation is introduced, the form of the product remains closer to the lap-top or wordprocessor than to the note pad. This insinuates a higher level of technological content and computing capabilities. Sharp considers the organizer category for this target group to be pretty well established, implying that there is no need to use the note pad analogy. To the question of a possible confusion between the categories of organizer and computer, Sharp's answer is: let the customer decide for himself. As organizers gain computing power and computers lose weight and shrink to pocket size, the customer decides on the functions of the product according to his own needs. The way in which the user exploits the Interface for his own purposes is influenced only by the number and types of applications he purchases. The pool of various, highly specialized applications with Human Interfaces offered with the hardware is therefore of integral importance for customer satisfaction.

Canon's electronic dictionary "Word Tank" provides another example of the use of conversational Interfaces to create a strong demand for new products. In terms of its classical features, the "Word Tank" may be categorized as an intelligent machine; it shares the greyish coolness of computers and word processors already well known to the customers. Shaped in similarity to larger word processors, the "Work Tank" surprises with its intelligent use of Ergonomics. To the customer, a crucial part of the products' "physical fit" is its "visual fit." The design offers key visual clues to the mode of operation (e.g. indication of front, and thumb position). The structured surface has a smooth feel, reducing the sense of artificiality that characterizes most competitor products in this range. The signs used to indicate the various functions on the keyboard are largely standardized. The customer does not have to go through a process of unlearning and relearning, but is able to "tap" the tank directly. Relying mainly on written lists of alternatives, he is able to check his input continuously on a large LCDisplay and receives the output instantaneously. The small, unrequested displsy of possible alternative functions ('jumping search') is particularly effective. The option of looking up associatively related words, for example, improves product versatility and personal interest. This jumping search is based on research in the cognitive sciences; it adapts the functions of the machine to the way the human mind actually works. Associatively gathered groups of information are typical forms of

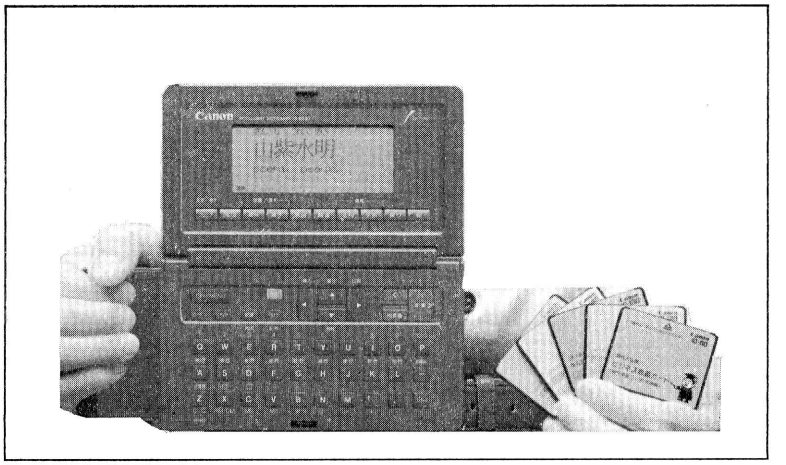
human memorization.[13] Thus here, technology is arranged to best suit and serve the human mind. Furthermore, versatility increases the number of possible applications and therefore intensifies the positive relation between man and machine. Additional cards for different purposes can be added to extend the products capacity. These provide further functions and visualizations.

One characteristic of the Interface is the comicstrip-professor who appears on the display to offer the menu. This amusing little language professor – who even cries tears of sympathy when unable to help the user – becomes a 'Gaido San'[14] for the Travel-Vobulary Card. Although the pictures change, the concept remains the same. An appropriate, humorous picture is chosen to fit each function, giving the Interface a decidedly human touch.

The 'dialogue' with these little creations is essentially an emotional means of deepening the customer's involvement with the product. The choice of humor as one emotionalizing characteristic indicates the possibilities for future differentiation. Different customer groups can be targeted not only on the basis of *functionally* specialized Interfaces, but also on the basis of *emotionally*[15] differentiated ones. As in hardware design, individualization appears to be a must. It hardly needs saying that in addition to a word memory for vocabulary exercises, unrelated functions like a calculator and calendar are included to increase the value of the product beyond that of a conventional dictionary. The present generation of intelligent products both incorporates and extends the functions of its ancestors.

What all these innovations share is a common focus on customer orientation and a commitment to bringing customer and product closer through Interface Design. The role of software know-how becomes decisive as Interfaces are increasingly used to differentiate

FIGURE 5. CANON WORD TANK



[13] See: Kaiho, H./Harada, M.: Ninchiteki Intafeesu, Tokyo 1991.

[14] I.e. travel guide.

[15] Interview with Mr. Shinohara, Industrial Design, R&D Headquarters, Canon Corporation, Tokyo, Autumn 1992; Interview with Mr. Inoue, Director of the Panasonic Product Design Center Europe, Frankfurt, August 1992.

functionally and emotionally products that perform similar basic functions. The effectiveness of Interface Design – ease of understanding and interactivity – largely determines the impact of the new products on the user. Thus effective Interface Design is a key to customer loyalty. It can build long term relationships and considerably influence the product's individual and company image.

And what of Japan's European Competitors? Philips Consumer Electronics is forced (and willing) to enter the Human Interface competition.[16] Philips is an innovator and a market leader in, among other things, interactive Photo-CD-Players. Philip's alliance with Nintendo could prove effective in gaining superior Interface Design competence. The Dutch inventor of the CD has been forced to render picture storage and presentation conversational. Expertise in Interface Design would appear to be crucial for commercial success. After all, what is at stake here is nothing less than customer loyalty, seen as a result of functionally and emotionally satisfying Human Interfaces. The new commercial potential implicit in the effective management of Human Interfaces is there to be realized. For companies like Olivetti or Siemens/Nixdorf, Interface Design represents an opportunity to add distinctive qualities to existing products, such as sound to the Olivetti 'quaderno.' The effort involved seems to be fully worthwhile.

IV. *The Fundamental Changes*[17]

In hardware as well as in software, Japanese companies have identified Strategic Technological Areas (STAs),[18] acquired sufficient know-how in fundamental technologies, gained Distinctive Technological Competences (DTCs) in areas crucial for commercial competitiveness. Today, the most valuable DTC centres on Human Interface Design. Changes in hardware and software continually propel the development of Interface Design.

IV.1 *Changes in Hardware Technology*

The development of products like the ones presented above has been made possible not by revolutionary breakthroughs, but by steady advances in memory capacity, processing speed and miniaturization. These three factors have largely contributed to the notable progress in Interface Design. Chips are developing simultaneously towards extremes of compactness and *memory capacity*.[19] Connected to capacity is *processing speed.* Parallel processing, for example, reduces the time needed to display input on the screen. The immediate *visibility* of input is essential for Interfaces. Immediate response makes a more natural dialogue possible between man and machine (principle of direct manipulation).

[16] Interview with Mr. Rodriquez, Interface Design, Corporate Industrial Design, Philips Betrijven, Eindhoven, Summer 1992.

[17] See: Porter, M. E./Villar, V. E.: How Information Technology Affects Your Business, HBR, July/August 1985.

[18] See: Frohmann, A. L.: Putting Technology into Strategic Planning, in: California Management Review, Vol. 27, Winter 1985, S. 48–59.

[19] See: Takeuchi, H.: Small & better—the Consumer Driven Advantage, in: Design Management Journal, Vol. 2, Nr. 1, 1991, p. 62.

Miniaturization has changed 'scary closets' into handy helpers. The price drop for processing power[20] makes the technology affordable.

Structural differences between the leading national industries is partly responsible for the development of national technological bases. The number of major players in consumer electronics in Japan is equalled in no other country.[21] The high dependence on the success of single products, means that, because of flexible demand, a single flop might cause *structural changes* in certain industries in Japan. The fierce *rivalry* among companies in the industry is intensified by the need to explore new areas of competition in quest of customer closeness. An example of this is the competition between Sharp's Wizard or the Action Manager and Apple's Newton. The shift in demand is encompassed by a shift in relevant competencies.

After the commercial contests surrounding the Integrated Circuit the Semiconductor (which were partly coached by the Japanese *government*, i.e. the Ministry of International Trade and Industry (MITI))[22], Japanese companies now seem to be ahead in the Liquid Cristal Display competition. Six out of the top ten manufacturers of Integrated Circuits and Semiconductors (including the top three, NEC, Toshiba and Hitachi) are Japanese.[23] Concerning Liquid Cristal Displays the situation is equally clear. Although the LCD technique was discovered back in 1970 by Hoffmann-La Roche, a Swiss chemical firm, European companies lacked market imagination. Sharp developed the first electronic calculator using LCDisplay within three years. The Japanese companies' development is partly supported by a syndicate set up by MITI. Twelve participating competitors agreed on a six year project for the production of a flat screen measuring one square meter. Japannese companies are also leaders in the active matrix business, and are on the way to monopolizing colour display production. 95% of U.S. LCD demand is supplied by Japanese manufacturers.[24] Japanese production of LCD devices increased about 41% in March 1991 compared with the previous year.[25] The introduction of colour LCDisplays and the new 'thin-film' transistor will give the industry leaders – Sharp, NEC and Toshiba – a further competitive edge, but will also spur Japanese domestic rivalry. Leading Japanese competitors still continue to invest in new production sites. The sums for initial investment appear enormous, but the market forecasts for colour LCDs are undoubtedly attractive. The trend forecasts in Japan for the development of LCD-TV, LCD projection, LCD use for personal/laptop computers, office and FAX machines etc. are all positive, predicting up to 20% growth.[26]

The hardware expertise of Japanese companies like Fujitsu, NEC, Hitachi, Toshiba, Sharp offers a good base not only for diversification in hardware but also for entry into

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[20] See: Rapaport, A. S./Halevi, S.: The Computerless Computer Company, July/August 1991, HBR, p. 70.

[21] On "clusters" see: Porter, M. E.: The Competitive Advantage of Nations, London 1990, S. 231–33, 406–414.

[22] see: Johnson, Ch.: MITI and the Japanese Miracle, Tokyo 1986.

[23] Data Quest Co., 01. 1991: Tsuushousangyousho (MITI) choosa kai: kikaisoukei nenpo, 07.1990, p. 41.

[24] See: The Economist, 'Flat out in Japan,' February 1st 1992, p. 81.

[25] See: Nihon denshi kikai kogyoukai: Denshi—Electronics, 06.1991, p. 75.

[26] Yano Research, 1991.

the software business.[27] The importance of the experience and economies of scale gained through Original Equipment Manufacturing (OEM) cannot be underestimated. The mutual dependence of OEM manufacturers and their outsourcing companies with strong market positions guarantees only fragile or emergent relations in the competitive environment of consumer electronics (*buyer/supplier-power*). The natural development from parts to OEM, and from OEM to brand follows a learning pattern. Thus, for example, Canon has emerged from OEM as an equal partner, gaining access to the market and becoming a new, respectable competitor for consumer products as well.[28]

Other companies have found ways to qualify for joint ventures with leading American companies. For example, Sony, a key *new entrant* in the field, has used its expertise in miniaturization to pave the way for a process of joint effort and joint learning with Apple to produce the Apple Power Book. This contributed to the development of new Sony products (e.g. the popular Lap Top Computer "News") that established beachheads in the computer industry. The fusion of functions – as the technological development of unrelated businesses converges – leads to numerous new entrants into formerly distinct branches of the industry. This can also be seen in the FAX business (also dominated by Japanese Companies), where optics, copier and info-technology companies have become competitors. NECs corporate vision, "C&C—Computer and Communications," can be taken as a model for a similar development in consumer electronics.

Distinctions between product categories become blurred. A large number of different products satisfying similar needs (*substitutive products*) are already on the market. As suggested earlier, it is increasingly the customer himself who chooses between substitutive products. The question of when a small computer becomes an organizer, and when an organizer becomes a small computer is decided by the customer, whose decision is informed above all, by the choice of interfacing applications.

IV.2 *The Increasing Importance of Software Technology*

In Japan several initiatives (partly funded by the *government*, namely the Ministry of International Trade and Industry) are directed at improving the software competencies of Japanese companies.[29] The MITI also supports, both directly and indirectly, research on Human Interfaces and aspects of sensitivity in product design at a comparatively early stage.[30]

Human Interface has been identified as a major factor for future success in several industries. Just as in *hardware* development, Japanese companies also follow a pattern concerning product and process technologies in the *software* business. After exploiting the positive effects of successful process innovations in software production, new market segments can be addressed on the basis of such factors as lower prices. A potential customer

[27] See also: Ferguson, C. H.: Computers and the coming of the U.S. Keiretsu, HBR, July/August 1990, p. 61; see IV. 2.

[28] 'Canon, IBM to develop a notebook' in: International Herald Tribune, September 3, 1992.

[29] See: Shimoda, H.: Sofutouea ga nihon o kaeru, Tokyo 1990.

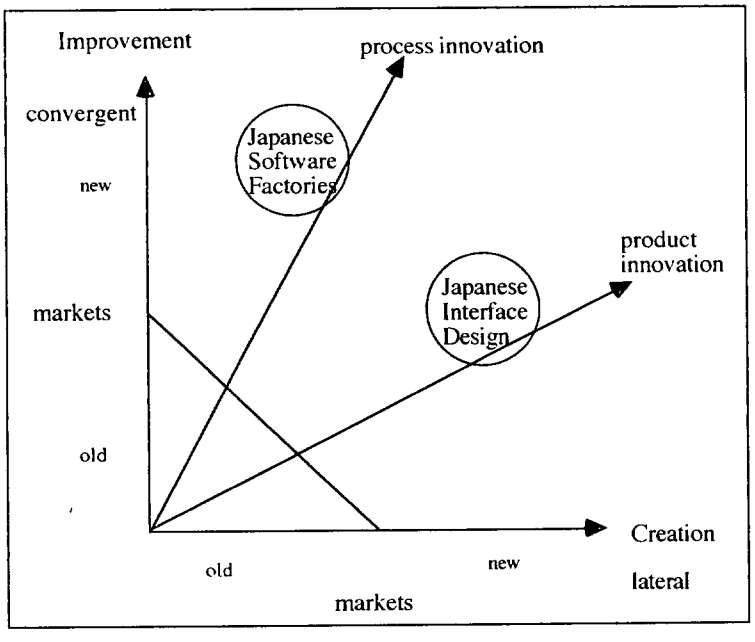
[30] Presentation at the Japan Business Machine Makers Association: Jimukikai no bijon (The Business Machine Vision), September 9, 1992, Tokyo.

base for improved technology is thus created (see Figure 6). Supported by the results of this first phase, new markets are then created in a second phase by product innovations based on Interfaces. This dualistic approach to gain global leadership is a balanced compromise close to an ideal development. Human Interface is a crucial link between improvement and creation.

Japanese improvements in process efficiency in software design are highly impressive.[31] After continuously upgrading the processes and gaining advantages through economies of scale Japanese companies have seized a leading position in the market. Efforts in product technology are being continually increased. Innovative product technology will inevitably lead the Japanese software industry closer to customers.

Customer loyalty is built primarily upon differentiated software, rather than upon hardware 'generics.' The extremely diverse performance of IBM and Microsoft serves as a powerful example[32] of this *structural shift*, reflecting the importance of software quality and customer oriented product development over hardware and mainframe concerns. Microsoft, as a market leader for basic software products, already influences the hardware manufacturers' design. The principle is that the hardware must be able to run the software

FIGURE 6. INNOVATION AND INTERFACE DESIGN



[31] For detailed analysis see: Cusumano, M. A.: Shifting economies: From craft production to flexible systems and software factories, unpublished Manuscript, September 1991: Cusumano, M. A.: Kemerer, Ch. F.: A quantitative analysis of U.S. and Japanese practice and performance in Software Development, in: Management Science, Vol. 36, No. 11, November 1990; Cusumano, M. A.: Japan's Software Factories, New York 1991.

[32] 'IBM—Minshuushugi kakumei', Shukan Touyou Keizai, 25.01.1992, pp. 62–65; Microsoft Post 55% Rise in Net, it's 8th Period of Consecutive Growth both in: Asian Wall Street Journal, 20.01.1992.

effectively.[33] Thus software is beginning to set the standards in the computer business. Microsoft plans to strengthen this evolution by making the preinstallation of the most popular 'easy-to-use' Windows Interface a focus of marketing strategy. With a Microsoft Logo, Mr. J. Lazarus, general manager for systems marketing, wants finally to establish software as the differentiating characteristic of computers: "I want to eliminate the whole concept (of IBM compatibles) for buyers—and just have them focus on Windows."[34]

This structural shift in the value constituents of products is reflected in corporate strategies.[35] Sharp makes "Human Interface" a top priority aim for its design policy. Hitachi another of the Japanese industrial giants, makes "Human Interfaces" the keystone of its Corporate Design Philosophy. These changes are also embedded in the larger shift of focus from hardware to software. Major rivals have also turned their attention to Interface competition. In Interface research Fujitsu—as well as NEC—have already initiated experiments with artificial realities, i.e. systems using computer graphics that create three dimensional realities. These Interface developments have a promising future in a range of areas, from three dimensional simulations to entertainment applications.[36]

Apple's Newton, for example, employs advanced handwriting-recognition software[37] and new intelligent software, that both anticipates and supports the user's intentions. As the first (announced) Personal Digital Assistant (PDA), the Newton has been hailed as a "marriage of computers, telecommunications and consumer electronics."[38] PDAs can be interpreted as *substitutes* for a range of other products. It is interesting to note that Apple launched its Newton well after the new entrant Sony introduced its palm top computer. The fruitful *buyer/supplier* relation will probably to be held responsible for this development.

Another example of a company which has profited from Interface Design is Ricoh, historically a copier maker. Ricoh capitalized on Interface Design and software know-how to enter the consumer electronics market (*new entrant*). Ricoh has enlarged and exploited its new competence in Interface Design by introducing new educational products for children consisting basically of large Touch Panel LCDisplays that are activated through direct contact. Touch Panel Displays might be another route to the development of natural Interfaces, but there seems to be an emotional barrier on the part of the user touching the screen directly.[39]

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[33] IBM has been seen recently to reinforce its design competence by employing star designers to create coherence between hard- and software design; see: Romanelli, M.: Richard Sapper. Leapfrog Computer, in: Domus, 2, 1994, S. 62 ff.: a project by Sapper, R. and Lucente, S. and IBM Corporate Strategic Design.

[34] See: Asian Wall Street Journal, 31.01.–01.02.1992, p. 2.

[35] Imai et al.: 'Tsukaiyasusa' no sekkei shuhouga jitsuyou ni (Towards a planning technique of 'ease of use.' in: Nikkei Electronics 10.6.1991, No. 529, pp. 107–124.

[36] See: cover story: Virtual Reality, in Business Week, October 5, 1992, pp. 53–61.

[37] Because of flaws in handwriting recognition this feature is increasingly deemphasized, until the software cannot be ridiculed anymore. Apple and other companies now increasingly focus on the pen as input device that touches the icons or metaphors of a keyboard instead of using it to write texts directly. On the other hand the potential of flexible connections to Computers, telephone lines etc. and the prospect of becoming real communication devices is emphasized by continuous upgrading.

[38] See: Potts, M.: Apples' Computer Revolution in a Pocket, in: International Herald Tribune, 14.05. 1992; Kantrowitz, B./McGinn, D.: This is your Life. Maybe - fad Gadgets: the electronic diary has arrived. But hold on to your wallets until the Hype cools down, in: Newsweek, Nov. 15, 1993, pp. 40 ff. The follow-ups of Apple and its competitors will certainly do better.

[39] Interview with Sakashita, K., Executive Director, Sharp Corporate Design Center, Osaka, Autumn 1992.

The extremely favourable demand conditions[40] which characterize the Japanese domestic market tend to stimulate *rivalry* even further. The number of fiercely competing companies, related supporting companies and, consequently, the number of *substitutes* is much larger here than anywhere else in the world.[41] Another factor contributing to the dynamism of the Japanese market is the difference in *consumer behaviour*. The high propensity of Japanese customers to react to even marginal product improvements also accounts for the rapid development of the consumer electronic business world wide.

To conclude: Software Design seems to follow the evolutionary patterns of industrial design, which began by emphasizing functionality, manufacturability and modularity, and today also pays due attention to the emotional factor. The sensitivity and emotional value of Human Interfaces will be a feature of growing importance for customers when deciding on product purchases in computer consumption.

V. *Human Interfaces and Competitive Strategies*

Naturally enough, *cost considerations* cannot be neglected. Technological innovations resulting from particular breakthroughs in research generally require huge investments. This can make a product very expensive – too expensive, indeed, – for it to become a commercial success. Even the Sony Palm Top is not marketable in all industrialized countries, as the cost of its two year development and production are simply too high. The price level in Japan, however, seems sufficiently high to ensure profit. In order to penetrate other markets, however, it is crucial to achieve economies (primarily economies of scale) to drive prices down. Japanese companies have pursued this policy with electronic calculators and TVs.

The importance of economies is equally obvious in the case of Sharp's production of LCDisplays. Sharp leads the world in the percentage of actice matrix displays[42] that have a picture quality almost as clear as that achievable with cathode ray tubes. Using interactive Interfaces in this way to add real value to different types of product increases customer satisfaction as well as boosting the scale of production for displays. Exploiting its strong position in 'optoelectronics'[43] Sharp offers large LCDisplays in various extravagant frames as products with an 'artistic' touch. One only has to think of the scale available in the combined production of LCDs for wordprocessors, calculators, organizers, computers, television, phones, cameras etc. to appreciate the advantages of such a strategy. The system design of Interface applications also leads to a drop in Interface development costs per unit.

Interface advancement in production helps reduce costs in Interface Design by increasing both manufacturability and modularity.[44] Designing software as a system of com-

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[40] See: Takeuchi, H.: Small & better – the Consumer Driven Advantage, in: Design Management Journal, Vol. 2, Nr. 1, 1991, p. 62.

[41] For this line of argument see: Porter, M.: The Competitive Advantage of Nations, pp. 234, 384.

[42] Yano Research, 1991.

[43] See: Japan—Company Datafile 1992, Toyo Keizai Inc., Tokyo 1991, p. 660.

[44] See: Cusumano M. A.: Japan's Software Factories, New York 1991.

ponents facilitates the development of software and helps to improve the process technology of software production. The systematic construction of a consistent interface not only saves money, but also reinforces impact as the same Interface can be used for a range of products in diverse categories. The user only has to learn to use the system once and can expand his knowledge intuitively thereafter.

There are three approaches to *Differentiation*[45] through Interface Design. The first is differentiation through *functions* that cannot be offered by any other competitor in the same quality or to the same extent (such as memory capacity, processing speed or innovative Interface features). In times where hardware turns into a commodity two other forms of differentiation become more important: namely differentiation through marketing the *'faszination factor' of technology*, and differentiation through the *'emotionalization'* of the product. As software design has long been treated in overly rational terms, I shall focus on the issue of emotional strategy. The market leaders in emotional design seek to put the customer at ease emotionally, while maintaining or advancing standards of functionality.

One of the leaders in this field is Apple. Apple's 'core' competence – emotional leadership through user friendly Interface – illustrates the opportunities for diversification into related industries. Largely relying on its strengths in Interface Design Apple[46] is expanding into consumer electronics where it has introduced a new product category: the Personal Digital Assistants (PDA). The uniqueness of PDAs lies largely in the further improvement they bring at the level of Interface. Through the addition of two-way visual and audio communication they are able to increase product versatility by simplifying input and output functions and by reducing the learning requirement of the user. These pocket size information products have data communication functions and offer links to other systems.[47] Their development sets Apple in direct competition with, among others, its own OEM manufacturer Sony. Fiercely competing companies like Nintendo INC. or Sega Ltd.[48] will also be affected by Apple's initiative. As suppliers of sophisticated video games they are moving towards the field of virtual reality.

Apple offers the option of combining rational display elements with more humorous elements, futurist icons with more traditional ones. Apple has designed special kits for its customers that enrich – if desired – the screen with gags and surprises. Selecting his favoured features, the customer participates in the final design by changing the interface according to his own preferences. Even more striking than these added Interface gadgets are examples of 'agents' like the 'Eager'—function. Here the Interface is characterized by the symbol of a sneering cat which accompanies a proposal to continue a task monotonous for the user. In other words the software is able to detect a pattern in a task performed by the customer and offers its services in completing the less interesting tasks of

[45] See: Koppelmann, U.: Marketing, Duesseldorf, 1991.

[46] On services-based strategies also see: Quinn, J. B./Doorley, Th. L./Paquette, P. C.: Beyond Products: Services-Based Strategy, in HBR, March–April 1990, pp. 58–60.

[47] Apple partly failed to gain customer preferences with the PDA Newton. Its software did not live up to expectations – the Interface of handwriting recognition software is weak because it frustrates. Interface-Quality is needed. Already the announcement of PDAs rapidly created a new product category with products by Sony, AT&T, Amstrad, Casio, Sharp etc.

[48] See: The Economist, 'Sega vs Nintendo—Sonic Boom,' January 25, 1992, S. 67.

input with computer speed and accuracy. Interactivity is used to accomplish tasks faster and more efficiently for the benefit of the customer. In this way technology is honed down to a human scale by Human Interface Design. In this field Apple is a pioneer whose example is bound to be hotly pursued.[49]

Based on technological performance, the mastering of new design features to create better Interfaces can establish sustainable advantages over competitors. The Interface influences a company's image, as it is the company's representative face present at the crucial moment of customer use. Interface makes High-Tech consumable and therefore desirable. Software sells hardware.

The Japanese examples presented in section 4 do not stand alone in their quest to develop emotional ties with the customer. NEC – foreseeing the amalgamation of computer and information technology – also offers hand size electronic tools (ETs), like the PC-8000 with 10 basic functions, all displayed on LCD. Name card organization, calendar, daily organization, memo sheets (for example time tables), world time conversion tables and, of course, a calculator are all provided. This time an NEC language professor uses his 'dictionaries' for the benefit of the customer, when the appropriate IC-Card has been loaded. The LCDisplay supports the organization of personal addresses and facilitates the recognition of persons by means of visual clues. Images of faces with characteristic features can be stored alongside the written information. This is another clear example of the integration of the findings of the cognitive sciences into Interface Design. The dual coding process of information in the human brain is divided into sequential and imagerial categories of processing. Images provide a more compact, vivid and emotional form of processing information.[50] NEC uses easily processable pictures to improve the dialogue of the man-machine Interface. The interactive assembly of faces is not just a source of fun, it is also an aid to user memory and provides easily recognizable visual information as output.

One final example of effective differentiation in Interface Design is Sanyo's Wordprocessor SWP-NS5. While an LCD screen forms the natural focus of user attention much effort has also been put into the design of the Interface. Targeting the high school and university student market the pictorial image of the guide for the menu displays and various functions is the Sanyo 'professor.' If there are application problems, the professor appears, accompanied by further instructions. This personalized support helps to avoid the disturbing feeling of 'computer insecurity.' It can assist students in the preparation of reports and term papers by offering humorous commentary on the more functional aspects of the word processor. Consequently Sanyo bases its whole advertising campaign on this Interface Design. A Japanese TV celebrity appears in the role of the professor (see Figure 1). *Differentiation* in Interface Design appears to be an effective route to costomer loyalty.

Another key competitive aspect of Interface Design is product innovation. *Product innovation* and new product categories are based on information technology (see above: data discman, organizers, electronic dictionaries, lap top-, palm top computers, PDA). Functions that are not offered by any other competitor are based on product innovations. The need for continuous improvement and innovation is widely acknowledged throughout the

[49] Microsoft advertisement: "Innovation means producing products people love to use."

[20] See: Paivio, A./Rohers, T.B./Smythe, P. C.: Why are pictures easier to recall than words?, in: Psychonomic Science, 1968, II, p. 137.

FIGURE 7. SANYO WORDPROCESSOR

industry. Sony's innovative Palm Top CPUs in 1992, for example, seem to respond too slowly to user commands, leading to misunderstanding. The icon, when touched with the pen, does not give an immediate visual response; thus the user is inclined to touch it a second time, with an adverse effect. In other words, the Palm Top CPUs fail to realize the principle of immediate response. Sharp has improved the organizer line remarkably with its 'Action Manager,' which by virtue of its calm hardware design and a quiet and factual Interface targets a mature clientele. Sharp, Apple, and Hewlet Packard have also started supporting Interfaces by Industrial Design, introducing items like pen-point input (compare Figures 3 and 4). Furthermore, audio elements are increasingly being incorporated.

"With the addition of multimedia – video, graphics, sounds – the computer will become a device that can handle emotion . . . , even simple graphics can touch people's hearts."[51] The ultimate aim is optimized management of psychological and emotional benefits. At its best: user interaction with a computer should be a source of entertainment. Today Human Interface Design in applications and operating systems software is approaching the quality of game Interfaces while game design is steadily approaching the realm of virtual reality. Not surprisingly, major players are already on the look out for virtual reality know-how. The future of Interfaces would appear to lie in the realm of 'Virtuality.'

UNIVERSITY OF COLOGNE

[51] See: Doi, T. (Sony Director of the Computer Science Laboratory) in: Fortune, February 24, 1992, p. 27.