

Usability as a Hidden Dimension of Quality

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Abstract

As the products which innovated usability have succeeded in the market, the usability of products is now considered as a new dimension of product design. This paper deals with the following questions: How has usability been embedded in the design and development of products? In the usability context, why have some breakthrough products succeeded commercially and others failed? What should be learned from the successes and the failures? For the purpose of discussing these questions, the photography industry was examined and the results were used as an illustration of the important points.

Keywords: Usability, Dimension of Quality, Photography Industry

1. Introduction

Usability is considered as a new dimension of product design in recent years. Some well-known commercially successful new products, which focused on usability, include Apple's PowerBook, Microsoft's Windows, Johnson and Johnson(J&J)'s disposable contact lenses. The design focus of the PowerBook was portability - usability in a variety of environments, and it led the introduction of an internal disk drive and a large trackball in the portable computer. The

PowerBook quickly became a billion-dollar business. Apple sold 400,000 units in the first year[16]. Similarly, Microsoft in its domination of the PC market moved from a character-based operating system, DOS, to a graphical user interface, Windows[6]. J&J developed disposable contact lenses. Consumers found the lenses comfortable and easy-to-use, and cleaning was eliminated because the lenses could be replaced with a new pair each week. J&J defined a new market by launching the innovative lenses in 1987. Although major competitors targeted

this segment a year later, J&J still held a 70 percent share of the \$400 million market in 1992[21].

This paper deals with the following questions: How has usability been embedded in the development of new products? In the usability context, why have some breakthrough products succeeded commercially and others failed? In order to thrive amidst future competition, what should managers learn from the successes and the failures? In order to discuss these questions, the photography industry was examined and the results were used as an illustration of the important points in this paper.

2. Development of cameras in usability context

Before the invention of photography was announced to the Academy of Sciences in Paris in 1839, it was difficult to imagine the possibility of machine-made photographs. The invention of camera was really momentous.

Early cameras had little appeal for the general public. The size of the equipment and the multistep processing discouraged all but a dedicated few. With the invention of paper-backed roll film and the Eastman Kodak box camera, "We do the rest" became the Kodak slogan of the enthusiastic amateur camera users of 1890's[13]. The

roll-film camera invented in 1888 by George Eastman was the first camera, which was affordable and relatively simple to operate. In the early twentieth century, the goal of making quality exposures with a small camera was realized, and standardization of camera systems eventually brought down prices and opened up a new mass market. In the United States alone, people spent on photography \$5 billion in 1970, \$10 billion in 1980, and \$17 billion in 1990[8]. As several breakthrough products, such as compact, instant, single-use, filmless cameras have been introduced, the mass market of cameras has experienced significant changes. Another upheaval has begun as a result of the digital revolution. The following are brief examinations of typical breakthrough cameras in a usability context.

(1) Compact camera

The primary design focus of compact cameras has been ease-of-use, and the basic concept was a 'point-and-shoot' camera. Typical early versions provided a coupled rangefinder, large-aperture lens, bright-line view finder and a choice of shutter- or aperture-priority automation. Since then there has been a rapid evolution of the camera into a distinct design type with increasingly comprehensive specifications. Two significant developments were made. One was the introduction of an integral electronic flash unit which added little to the dimensions of

the camera, but extended its operating capabilities. The other development was an 'auto-focusing(AF)' function for the camera lens. Initially this used an image-processing comparison system, but later an active infrared ranging system or phase detection system[14]. A relatively low price, coupled with simplicity and size, has now made this kind of camera the most popular on the market.

(2) Instant camera

The idea for the first instant-picture camera was sparked by the question of a three-year-old girl. Edwin Land, the inventor of synthetic light polarizers, took a photograph of his daughter while on a family vacation in New Mexico. After the shutter clicked, Jennifer asked to see her photograph and wondered out loud why she wasn't able to. From this moment of inspiration, Land spent the next thirty years developing what he termed 'absolute one-step photography'[13].

Land introduced the first instant-picture camera to the market in 1948. The 4"x5" pack film holder was introduced in 1959, and polar-color film followed in 1963. Later development made the polar-color film pack contain its own disposable battery, and Polaroid again revolutionized the instant camera market with the fully automatic Spectra camera and film system. The breakthrough characteristic of the instant

camera lay in the elimination of time-consuming film processing.

(3) Single-use camera

The single-use camera was originally called a disposable camera. In the simplest form, it is basically a roll of film encased in a cardboard box with an inexpensive plastic 35mm lens. The pictures are taken, and the entire camera is sent out for processing and printing. It is a step back to the vintage "We do the rest" Kodak cameras[13].

The idea for a single-use camera came from focus group research on cameras conducted in the United States, the United Kingdom, and Japan throughout 1982 and 1983. Consumers were concerned about taking their cameras into high-risk environments; they wanted an inexpensive camera that would take good pictures, but if lost or dropped would not be a great financial loss. The core product concept represented six major attributes: low risk, pocketable, portable, under \$10, able to deliver quality, and care-free[21]. Fuji launched the first single-use camera in its domestic market in 1986, and the result was instant success. Fuji and Kodak launched the cameras in the U.S. market respectively in 1987.

The success of the standard single-use camera has encouraged an extension of the line to include panoramic, underwater,

portrait and telephoto versions.

(4) Electronic still camera

Nearly a century later since the first roll-film was invented, the camera which doesn't use conventional chemical-based film was introduced. In 1984, Sony launched an electronic still camera, Mavica(; the abbreviation for magnetic video camera), which used a semiconductor sensor instead of film. The camera recorded images on a 2-inch-square erasable and reusable floppy disk. With a special adapter, still pictures stored on the disk could be played back instantly on any TV set. The quality was about the same as broadcast television. The floppy disk held 50 images. The latest model included a tiny microphone for recording a ten-second description on each frame; the sound played back through TV[8].

In the usability context, the elimination of time-consuming film processing was a typical advantage of the electronic still camera. Direct transmission of the contents of the floppy disks through a telephone line was another advantage. The transmission was used at the 1984 Los Angeles and 1988 Seoul Olympic Games.

(5) Photo CD system

This was a development in the film processing system rather than an advance in camera design. Kodak introduced photo CD

in 1992. It represents a marriage of traditional silver halide photography with electronics. The compact disk can store up to 100 photos. To make the CD, conventional cameras and films are used. The only difference is in the film processing, which require photo-processing shops to have special equipments such as a film scanner, index printer, etc[20]. Through a photo CD player, the pictures stored on the CD can be played on TV or computer monitor. The user can zoom in and enlarge any part of the photo, (e.g., so that one's favorite person can fill the entire screen). It also allows the user to see a collection of photos in any sequence[11]. In the usability context, traditional bulky albums are replaced by compact CDs.

There have been many other breakthroughs in camera usability. For example, underwater cameras and camcorders represent further breakthroughs. The usability issues still exist in these cases. Nikon's Nikonos RS is the first underwater 35mm SLR camera, which revolutionized usability. The Nikonos RS has an aluminum alloy body that is waterproof to 328 feet[10]. Previously, underwater photographers had to encase their cameras in a bulky sealed housing or settle for a submersible range-finder model. Similarly, Sharp's ViewCam revolutionized the usability of camcorders. Instead of the usual tiny viewfinder, the ViewCam uses a 4-inch

LCD that allows the user to watch the movie in color on an ample-size screen as it is being shot. Despite the high prices, ranging upwards of \$1,300, it commanded 20% of its domestic market[2].

3. Successes and failures of breakthrough products

A product breakthrough does not always mean commercial success. Why do some breakthrough products succeed but others fail? This question is addressed below.

(1) Compact camera

The 35mm compact camera dominates the mass market. It accounts for over 70% of all camera sales[15]. The key success factors are relatively low price and ease-of-use. The core concept, 'point-and-shoot' camera, was especially effective, considering that nearly 46% of compact camera owners consider themselves beginners[21].

(2) Instant camera

Although Kodak made instant cameras, Polaroid has dominated the instant camera market under the umbrella of patents. The company name, Polaroid, has been perceived as the instant camera itself in the market. The instant camera had been a big success for a while, but Polaroid failed to keep its position. At its peak in 1978, Polaroid sold

13 million instant cameras. In 1990, by which time the price of a basic Polaroid camera had dropped from \$100 in 1978 to \$30, sales barely passed 4 million[9].

The change of market share in the U.K. shows this declining trend more clearly. In 1981 instant cameras took 45% of the U.K. camera market in volume sales[17]; the proportion has declined to 3% in 1987[18].

The core benefit of compact and instant cameras are similar, but the 'point-and-shoot' compact camera has been a continuous success and the 'absolute one-step' instant camera is not. There are two main reasons. First, the usability of instant camera has not improved significantly. Research conducted by Polaroid revealed this problem which has lasted for a long time[3]:

"A few years back, market researchers at Polaroid Corp. secretly videotaped tourists using its instant cameras at Walt Disney World. What they discovered was both hilarious and troubling. As the cameras spit out print after print, the hapless tourists struggled to find places to put them. One man clamped several still-developing print in his teeth. Another put them on top of his backpack, only to have the wind blow them away."

Based on this research, Polaroid launched an ambitious new camera, Captiva, in 1993. The Captiva has been described as the most researched product in the company's history - it took five years and \$100 million in its

making. Its size is just two-thirds of the previous Onestep, and it mimics the look and features of the 35mm point-and-shoot cameras which dominated the 1990s market. It is also equipped with automatic focus, exposure, flash, and aperture control. Furthermore Captiva is the first instant camera that stores its own pictures.

A more important reason exists for the declining demand for instant camera. While Polaroid had been protected with a battery of patents, some competitors have adopted a roundabout strategy, instead of trying to overcome the high barrier to entry. Competitors have challenged the instant camera market not by attempting to enter the hardware sector, but from the service sector. The rise of the mini-lab and one-hour processing has reduced the merits of instant picture making. Since the competitors are changing the 'rules of the game,' instead of competing directly with existing core products, it is more difficult to respond to the threats.

(3) Single-use camera

The rising star in the 1990s camera market was the single-use camera. Purchases of single-use cameras were growing at 40% a year[12]. The U.K. camera market shows this emerging market distinctly: The annual growth rate of volume sales of single-use cameras continuously increased from 21.7% in 1991 to 37.5% in 1994[19]. Although

single-use cameras are now enjoying explosive demand, the path to success was not so straightforward.

When Kodak and Fuji launched single-use cameras in the U.S. market in 1987, they had little impact because of slow acceptance by American consumers. One reason for the slow acceptance was the quantity of environmental concerns about disposable products. By responding to environmental concerns, both Kodak and Fuji were able to reduce a major barrier to sales growth.

In the usability context, there is another important explanation for the success. Usability has been generally thought of as 'ease-of-use' in a physical ergonomic sense, but the design concept of the single-use camera extended the dimensions of usability to include 'psychological comfort.' Fuji has used this point as the key advertising concept. In the advertisement, Fuji showed expensive cameras being accidentally damaged and used the message: "You should have a QuickSnap." The sales generated by the single-use camera did not appreciably diminish regular film sales[21]. Thus it seems that consumers are willing to use them in places where they would not take an expensive camera, such as on the beach or on the ski slopes.

(4) Electronic still camera

No sooner had the electronic still camera, Mavica, been introduced into the

market than it was spotlighted as the first filmless camera. Canon's Xapshot and Fuji's Fujix were introduced successively. However they have failed completely from a commercial point-of-view. There are three reasons for the failure. First, the pictures are crude when compared with photographs taken with conventional film. Second, the price was too high to encourage wide use. The Mavica initially was priced at \$1,000, and playing back on TV screens required an additional \$230 adaptor.

In the usability context, the last is the most significant reason. It should be noted that computers have not eliminated paper; Sales of bonded paper, used for printouts and other things, have increased 50% since 1980[9]. People have always preferred 'hard copy' because it doesn't require any further operations or equipments in order to appreciate the picture.

Like the electronic still cameras, camcorders use semiconductor sensors and store images on videotape. Their resolution is also far inferior to ordinary film photography[9]. Nevertheless, camcorders have been a big success. When using camcorders, viewers don't really notice the low resolution of a motion picture; and they accept an inferior resolution since motion and sound are provided simultaneously.

(5) Photo CD system

As in the case of electronic still cameras,

Photo CD has so far failed to be a major commercial success. The reasons for the failure are similar: Consumers need to pay \$500 for a player that plugs into a TV, plus \$20 per disk, and people still prefer 'hard copy.' Kodak has tried to revive the Photo CD by marketing it to desktop PC users. By adding software to each photo CD platter, Kodak planed to make it easier to retrieve photos and use them in electronic documents. A personnel manager, for example, could load a photo CD with pictures of employees into a CD ROM and create an organization chart complete with photos[4].

4. Lessons from the successes and failures

So far in the paper it has been examined how usability is embedded in the development of new camera products and how it has impacted on the commercial successes and failures. The following are some lessons from the examination.

(1) Usability as a strategic competitive weapon

Although new-to-the-world products are introduced by technological breakthroughs, their commercial successes can be sustained by successive usability breakthroughs. Usability breakthroughs, of course, often require additional technological breakthroughs.

In 1888, G. Eastman created a huge commercial success by inventing the box camera and providing a film-processing service. It was the first breakthrough in usability since the invention of photography. The second breakthrough was made by E. Land in 1948. The instant-picture camera, what he called 'absolute one-step camera,' also achieved a big commercial success. The successive breakthroughs in usability such as point-and-shoot and single-use cameras have been heroes of the mass market.

It should be noted that considering usability just as a tactical feature is a big mistake. In order to succeed in the market, we must appreciate the power of usability. Our lessons start with the sound perception of usability.

(2) Dimensions of usability

What does usability really mean? Unfortunately, the answer is not so clear as the question. If usability is defined in a narrow sense such as ease-of-use, we cannot take full advantage of the concept as proposed. Since everything is designed and made for human 'use,' all kinds of product attributes responding to consumers' needs can be interpreted as 'usability.' However, such a broad definition falls into the paradox trap that aiming at everything means aiming at nothing.

Thus, in order to promote effective use of the concept of usability, it could be

analyzed and understood more clearly by considering its constituent parts. In this context, we propose six dimensions of usability, of which three are user-related and the other three are product-related: physical comfort, intellectual comfort, psychological comfort, time-saving, space-saving, maintenance-free.

The dimensions of usability are mutually interdependent. For example, the introduction of an auto-focus function in compact camera reduced the physical and intellectual demands in taking pictures, and it thus improved usability in the dimensions of physical and intellectual comforts. Furthermore, it improved usability in the dimension of time-saving by eliminating the previous manual-focusing task. In this case, user-related physical and intellectual comforts and product-related time-saving dimensions are mutually reinforcing.

Table 1 shows the contribution of the breakthrough cameras and photo CD in the dimensions of usability. This multi-dimensional representation of usability facilitates exploitation of the power of usability.

(3) Innovating usability

In order to succeed in innovating usability, the following four principles should be applied:

First, consider the entire process on the customers' point-of-view. Sticking to the existing features of a product is the most

Table 1. Breakthroughs in the dimensions of usability

Dimensions		Compact camera	Instant camera	Single-use Camera	Electronic still camera	Photo CD
User-related	Physical comfort	○				
	Intellectual comfort	◎				
	Psychological comfort			◎		
Product-related	Time-saving	○	◎		○	
	Space-saving					○
	Maintenance-free			◎		

(Legend : ◎ major contribution, ○ minor contribution)

common mistake. Since consumers do not buy a product itself but the benefits obtained from the product, it should be understood that 'what' and 'how much' they spend in order to enjoy the benefits through all the stages such as purchase, use and maintenance, keeping, and disposal after use. Mini-labs and one-hour processing services contributed nothing to the design or performance of cameras, but they innovated usability in the dimension of time-saving. Innovation must be planned and managed although the seed for the innovation is sometimes given accidentally as in the case of instant camera. The six dimensions of usability can be applied in the planning of innovation through all the stages.

Second, aim at the right target. If the specific element for the usability innovation is not valued by target customers, even the

breakthrough products fail commercially as the cases of electronic still camera and Photo CD. If a product is redesigned for the existing product and market, an emphasis must be put into the dimensions on which the existing customers are spending lots of time, efforts, space, etc.

Third, try to achieve innovation streams. In order to reign in the market continuously, innovation 'streams' are required. These streams include incremental, architectural, and discontinuous innovations[22]. In order to make innovation streams in the usability aspects, activities for both improvements and breakthroughs are required. In general, improvements are achieved through simplification of the current tasks, and breakthroughs by the elimination of some major tasks involved in the use of the product. The classical tools such as the

Therblig analysis and operator process chart, which have been used for work design, can be used for the improvement activities. Notice that the principles of work design, making work more comfortable, efficient and safe, are still valid in product design. The innovation of usability often requires technological breakthroughs as in the case of instant photography.

Fourth, don't be slaves of usability. Consumers expect excellence both from hardware and useware. Some conflicts between hardware-related performance and usability features may exist in practice. Although the primary goal is to find a solution to eliminate the conflicts, a trade-off is sometimes inevitable. Polaroid's new instant camera, Captiva, considered such a trade-off. "A small instant camera produces equally small prints" was the conflict. Polaroid favored the usability feature, and the Captiva produces almost 50% smaller than the existing snapshots. Although many retailers wondered whether consumers could warm to the new product, but Polaroid was confident that consumers would willingly accept the trade-off because it was the result of extensive testing[1]. On the other hand IBM's ThinkPad didn't sacrifice screen size for portability. General tendency in laptop computers had pursued for something smaller and lighter, but IBM found that customer wanted larger screen. In order to ensure a larger screen, ThinkPad was designed more

wider, but thinner and lighter, than competitors[5].

There are also some occasions that trade-offs within the dimensions of usability are unavoidable. In the case, since success and failure are likely to depend on the decision, we need more macroscopic point-of-view.

(4) Environmentally responsible products

Although disposable products, such as single-use cameras, disposable contact lenses, disposable diapers, etc., have many advantages in the dimensions of usability, they tend to provoke significant environmental problems. How Kodak responded to the environmental issues can be a good reference.

When environmentalists condemned the single-use camera for adding to the waste stream, Kodak responded by changing the name of its single-use camera from 'Flying' to the less-wasteful-sounding 'FunSaver'. In addition, Kodak began a recycling program to reduce worries about the environmental problem. For example, photo finishers are encouraged to return the entire camera to the manufacturer for reuse and recycling. The industry also made a concerted effort to stop referring to the cameras as disposal, using instead the terms 'one-time-use' and 'single-use' [21].

Developing environmentally responsible products is an important quality issue in the

design and development of new products. The term, DFE (design for the environment) is frequently used to describe the integration of environmental responsibility into the product design or development process. This essentially involves integration of the environmental product characteristics, and is based on the cradle-to-grave concept.

We cannot stress enough that human beings are living in the man-made world and everything is made for human use.

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