National College of Art and Design

Industrial Design Dept.

"The inter-relationship of medical products and industrial design."

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Introduction

It is important that the aims and objectives of this thesis are clearly outlined:

Objectives:

To show that there is a correlation between medical products and industrial design and to define this relationship as an identifiable pattern.

To show that the historical patterns of the medical product is similar to the conventional history of industrial design, in that medical products went through the same phases as industrial design, such as a use of ornamental decoration. (Ch 1 & 5).

To examine how current theories in design are adapted to medical products (Ch. 2-4). Not only are these theories prevelant to medical design but are adaptable to all areas of industrial design.

To examine how industrial and medical designs interact.

To explain why medical products have the opportunity to fulfil the particular requirements of design in a realistic manner and why they have been prevented from doing so (Conclusion).

A definition of medical products is required:

"Medical products means any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary, for it's proper application intended by the manufacturer to be used for human beings for the purpose of

- diagnosis, prevention, monitoring, treatment or alleviation of disease.
- diagnosis, prevention, monitoring, treatment or alleviation of, or compensation for an injury or handicap.

- investigation, replacement or modification of the anatomy or of a physiological process.
- control of conception.

and which does not achieve it's principal intended action in, or on the human body by pharmological, immunological or metabolic means, but which may be assisted in it's function by such means."
(Butler, 1993, pretext)

The purpose of this thesis is to discuss various aspects of medical design, in relation to it's effects on industrial design, and vice versa. The thesis has 5 main chapters:

* Chapter 1 discusses how the needs of surgical equipment on industrial design has diminished over a period of time. The purpose of this chapter is to illustrate the historical aspects of medical design and it can be taken as a general history of all medical design.
* Chapters 2 and 3 are interlinked. In Chapter 2 the current theories prevalent to industrial and medical design shall be examined, while Chapter 3 explains how these theories have attempted to be implemented into modern design. Two examples of good and bad implementation are given (N.N.H. and Victor Papanek).
* Chapter 4 gives two examples (the inhaler and the heart support system) of how these theories have been realised in marketable, human-conscious products.
* Finally, a case study of a company which has realistically put these theories into practice, even before the theories were established, is given in Chapter 5. A history of the company shall be given, which relates to Chapter 1 in terms of a similar pattern of development.

1

Diagram 1 - Traction Hook, 17 cm in length, *(Naples Museum)*

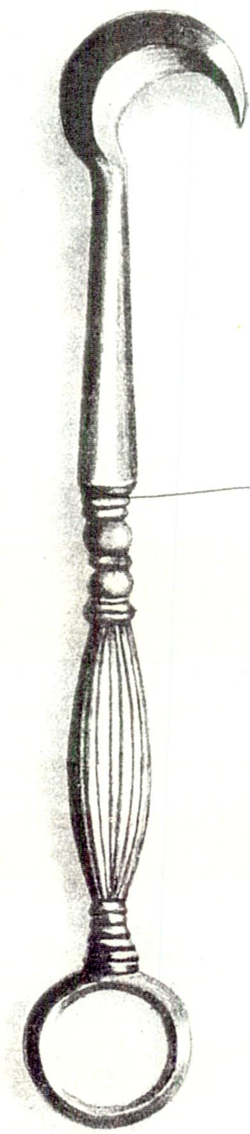

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Diagram 2 - Traction Hook, 15 cm in length, *(Vedrenes Museum)*

Chapter 1

The history of medical design - surgical instruments

In this chapter, it shall be seen how the role of industrial design in relation to medical instruments has changed throughout the ages. The past of medical design often reflects what was happening in industrial design at that particular time. Note that in earlier times, industrial design was employed only in a decorative sense. Other considerations such as function and materials were limited to the knowledge of the medical and engineering professions at that time. It must be remembered that decoration is not often a frivolous thing, and the different uses of decoration in various eras can be seen in the following examples:

Example 1: Roman traction hooks

Example 2: Victorian trepanning instruments

Example 3: Modern day sutures

Example 1

In diagrams 1 and 2, two traction hooks are shown, both from Pompeii. The function of these hooks is rather grisly in that they were used to remove an unborn child during a difficult labour. The hook literally caught onto the child in the mother's womb, either by it's ear, mouth, eye or sometimes even by it's forehead. If the mother was undilated as the child was being drawn out, serious danger to the child and the mother was inevitable. The design of the tract hook in Dia. 2 shows some precautions being taken to limit the danger. the hook is curved downwards so that as it is pushed into the womb, the hook is prevented from

tearing tissue. The grip and the ring at the end of the instrument ensure steady hand movement.

Compare this hook with that of Dia. 1, where the hook seems to be designed to stab the mother and child to death. these hooks are both made from steel, with bronze handles. Though these instruments were cleaned regularly, the materials used were potentially toxic to the patient. The ornamentation is simple, yet effective, and aids the grip of the handle (this ornamentation is typical of the period). The design of many Roman instruments has set precedents for surgical design today. For example, in order to save on cost and material, many of the equipment had two attachments at either end, giving one instrument two functions, allowing for quicker surgery. The theory behind the traction hook is still used today in a less vicious form by veterinary surgeons. Whether the designer happened upon the original theory is hard to say, but regardless of this it is still a good, sturdy design for it's time.

Example 2

In the 1700's surgical instruments were designed in roughly the same manner in that the form was often dictated by the function, but with a decoration thrown on top of the product. One particular area of 18th century medicine that stands out for it's eccentric function was the surgical method of trepanning. The trepanning operation is the oldest known operation in the history of mankind. It involves drilling a hole into the forehead in order to relieve pressure caused by the brain pushing against the skull bone. It must be remembered that, in the 18th century,

Diagram 3 - Jan Sanders van Hemessen (c. 1500-1575), "The Surgeon" (showing trepanning operation).
(Museo del Prado, Madrid)

Diagram 4a - Trepanning drill and perforator, Petit-type, c.1750, 15cm *(Museum Boerhaave, Leiden)*

Diagram 4b - Cased set of trepanning instruments, cointaining 3 trephines, elevator, raspatory, cranium forceps, ivory brush, scalpel, 3 Hey's saws, lenticular, c.1820. Weiss case, 15cm x 20 cm *(Simon Kaye Ltd., London)*

this operation was performed without anaesthetic - the patient was basically forced to drink as much alcohol as he/ she could stomach, to numb any small fraction of the excruciating pain. An 18th c. trepanning operation is shown in Diagram 3.

A " trephine" is the name given to the instrument which performs the operation (Dia. 4a). The conical crown is a circular saw, which when rotated by hand, drills out a circular piece of bone from the forehead. The saw has a slightly wider shoulder to prevent it from sinking into the brain. the handle is shaped to provide maximum grip and leverage. The instrument was basically like any other drill in that the saw could be removed in order to use a perforator (which made the initial incision into the forehead) or to use a saw of a different diameter. The trephines are typical of all medical products of that period, in that they are beautifully made and functionally well designed. Note how the spherical shape in the centre of the handle is used to turn the drill, while above and below the sphere are sturdy grips to push in or pull out the drill.

The craftsmanship shown in these instruments is obvious but note how the artistic side of the trephine accentuates the function, rather than impeding it. For example, the trepanning instrument case shown in Dia. 4b has small details of aesthetic beauty, where such beauty is allowed (the oblong central parts of the drill, the curvature of the ebony handles. Note, however, that as sterilisation became enforced, ivory and ebony handles soon became redundant. Often as an instrument advances along with medicine, the aesthetic limitations on the design of that object increase as the form is outweighed by the ever improving function. This is particularly true of surgical equipment.

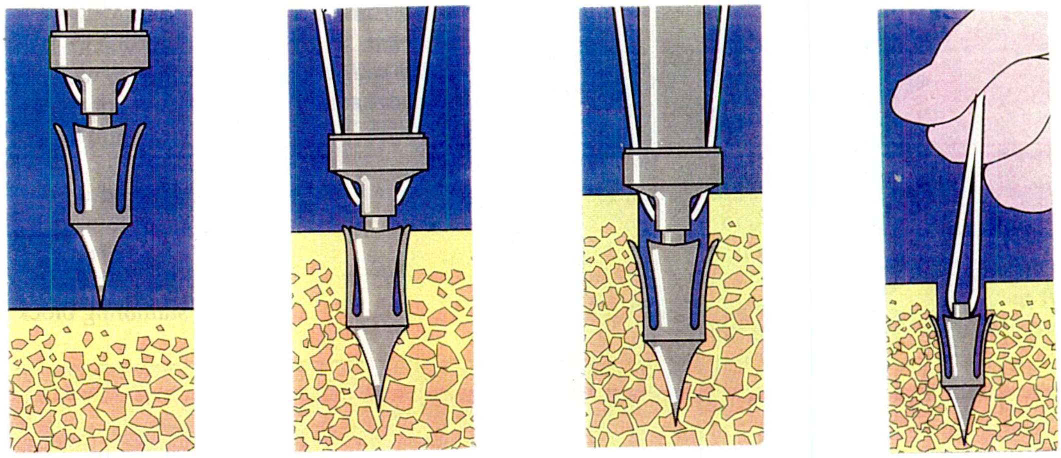
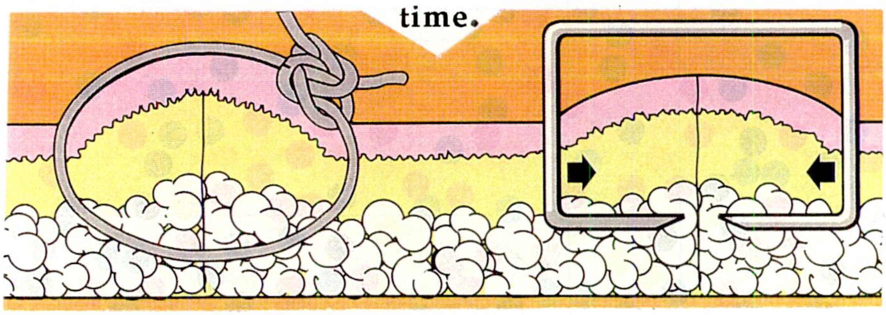


Diagram 5 - Arthrotek's Harpoon suture anchor provides surgeons a method of suturing tendons, ligaments and other soft tissues to bone. Four fins on the anchor are compressed as they are driven through the bone's dense cortical surface and then expand in the softer cancellous region to prevent it from working free or yielding under tension

Staples hold the wound closed by compressing the tissue between the staple legs, allowing the top of the staple to "float" above the skin surface. This allows room for swelling and reduces scarring. Stapling is also much faster than suturing, reducing operating room time.



Sutures are flexible and must be filled with tissue to secure the wound. Swelling that occurs naturally during healing further stretches the suture and increases scarring.

Diagram 6 - Staples V. Sutures

Example 3

Though trepanning is the oldest operation in the world, sutures, and other devices for keeping wounds closed, have been used before the "operation" even existed. In the 10th c. (B.C.), ants were placed at a wound with their jaws clutching at either side. The body of the ant was then cut off leaving the head frozen in a jaw-like grip. Other methods included the use of thorns, needles and cauterisation (the "welding" of a wound by agents such as mild acid or boiling tar).

New fasteners meant new types of surgery could be performed and thus the fastener has been constantly redesigned throughout it's history. There are various types of fasteners- suture, buttons, clips, screws and staples, just to name a few. For the purpose of this chapter, we shall look at the most effective ones and, more importantly, the most recent designs.

"Suture" is the general word used for instruments that stitch a wound together. Sutures used today are made from absorbable material so that they can break down in the body (absorbable sutures account for 40% of the global market). Sutures are either braided (softer, suppler and easier to work with, but can cause contamination) or monofilament (difficult to use, more rigid and do not break down in the body).

Arthrotek's Harpoon is an example of a new suture adapted for new surgical techniques (Dia.5), in this case for laparoscopic/ anthroscopic surgery (more commonly known as key-hole surgery). Such surgery involves the use of a wire, 0.5" in diameter, through which a video-camera, light and other microscopic surgical instruments are passed, into the body of the

Diagram 7 - Depuy's interference bone fixation screw

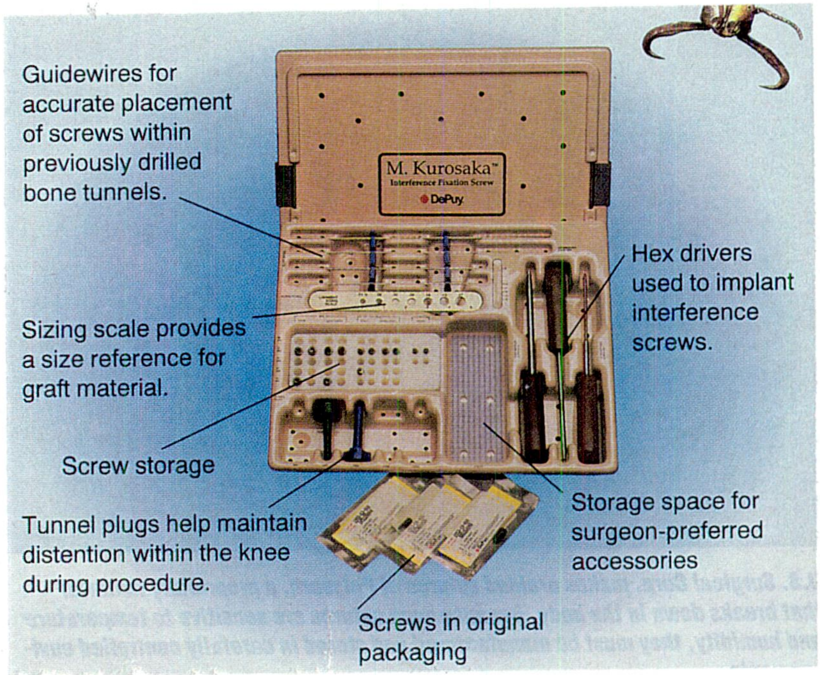


Diagram 8 - Skin staplers such as Pilling Weck's Visistat RH are replacing sutures for closing wounds and surgical incisions.

patient. The harpoon is an incredibly simple design. It is used for stitching together soft tissues (tendons, ligaments, etc.) to bone. It is pounded, through the key-hole wire, into the bone (thanks to it's stainless steel tip) and then, as it passes through the bone into the soft tissue, it expands so that it cannot be pulled out again.

However, since the tip of the harpoon has to drive through bone, designers are finding it difficult to make the tip out of an absorbable material, and thus the harpoon has to remain in the body. Unfortunately, a suture such as the harpoon is more preferable to use than other forms of fasteners (see Dia.6).

The sutures, staples and screws shown in Dias. 5-8 all encompass common elements in their design. The designs are always simple, functional and do not need to consider aesthetics, though it could be argued that the beauty of the design arises from it's function. They are good examples of medical design because they have to be- if they do not work perfectly, it could be fatal to the patient. However, they are not good examples of industrial design. Industrial design should not only consider how well the product works in the patient, but also what effects the product has on the patient psychologically.

This is why, in the area of surgical products, the role of industrial design has diminished in it's importance. This is due to the invention of two things:

1. the introduction of anaesthetic for operations in 1846
2. the development of disposable plastic instruments.

A surgical instrument has no psychological impact on a patient, if that patient is under sedation, while decorative elements are made redundant if that instrument is only going to be used once and then thrown away.

Surgical instruments have cast away their aesthetic "shrouds" and are purely designed for functional and humanic (effects on the environment, cost, market potential, etc.) purposes, and thus can no longer be termed industrial design.

Industrial design is defined by Prof. James Pirkl as a balance of three areas (Dia.9a), as shown in his lecture at N.C.A.D. on 27th Nov. 1995.

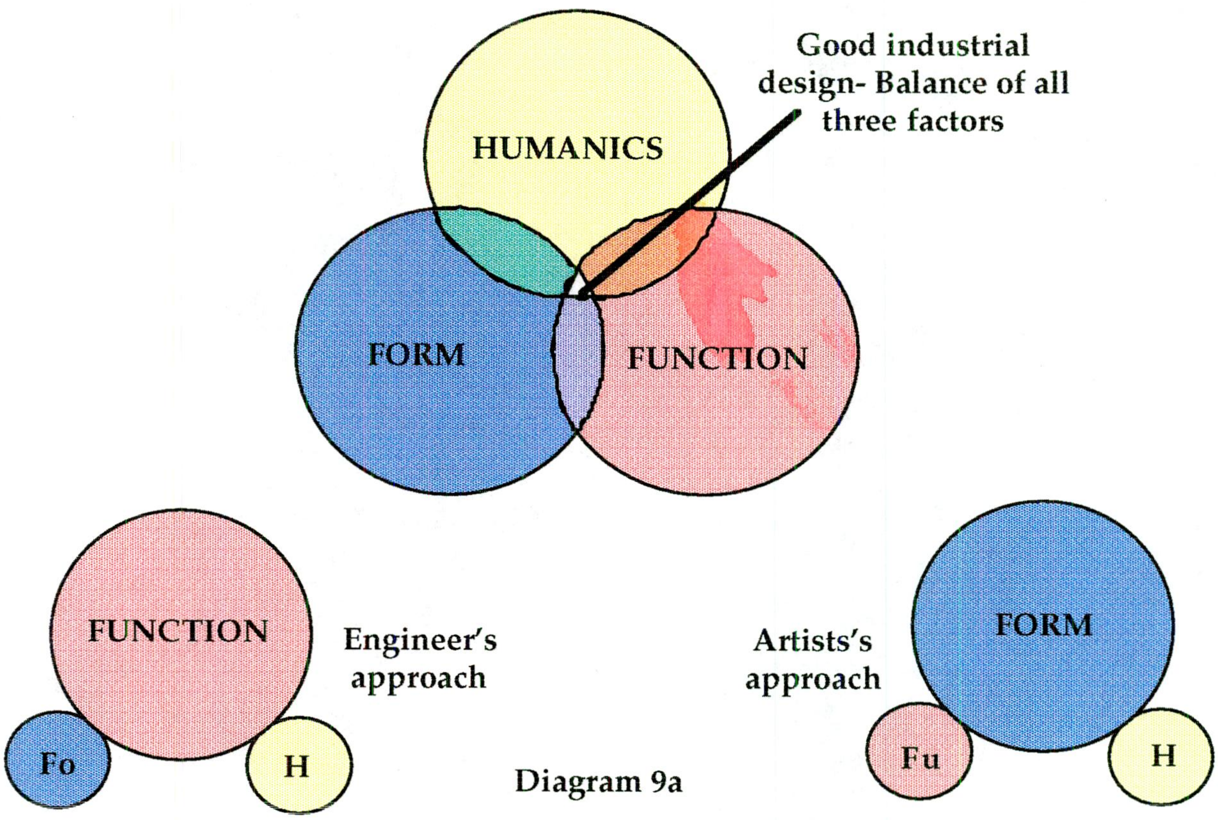


Diagram 9a

This diagram illustrates the perfect approach to industrial design, a compromise of all three factors.

Due to realistic factors, surgical equipment has changed from the industrial design approach to the engineering tactic, as illustrated in Dia.9a. It is a poignant statement, that such equipment, once rich in craftsmanship and style, now does not need, or can accommodate, such aesthetics anymore and that one of the factors in it's decline should be called "an<u>aesthetic</u>".

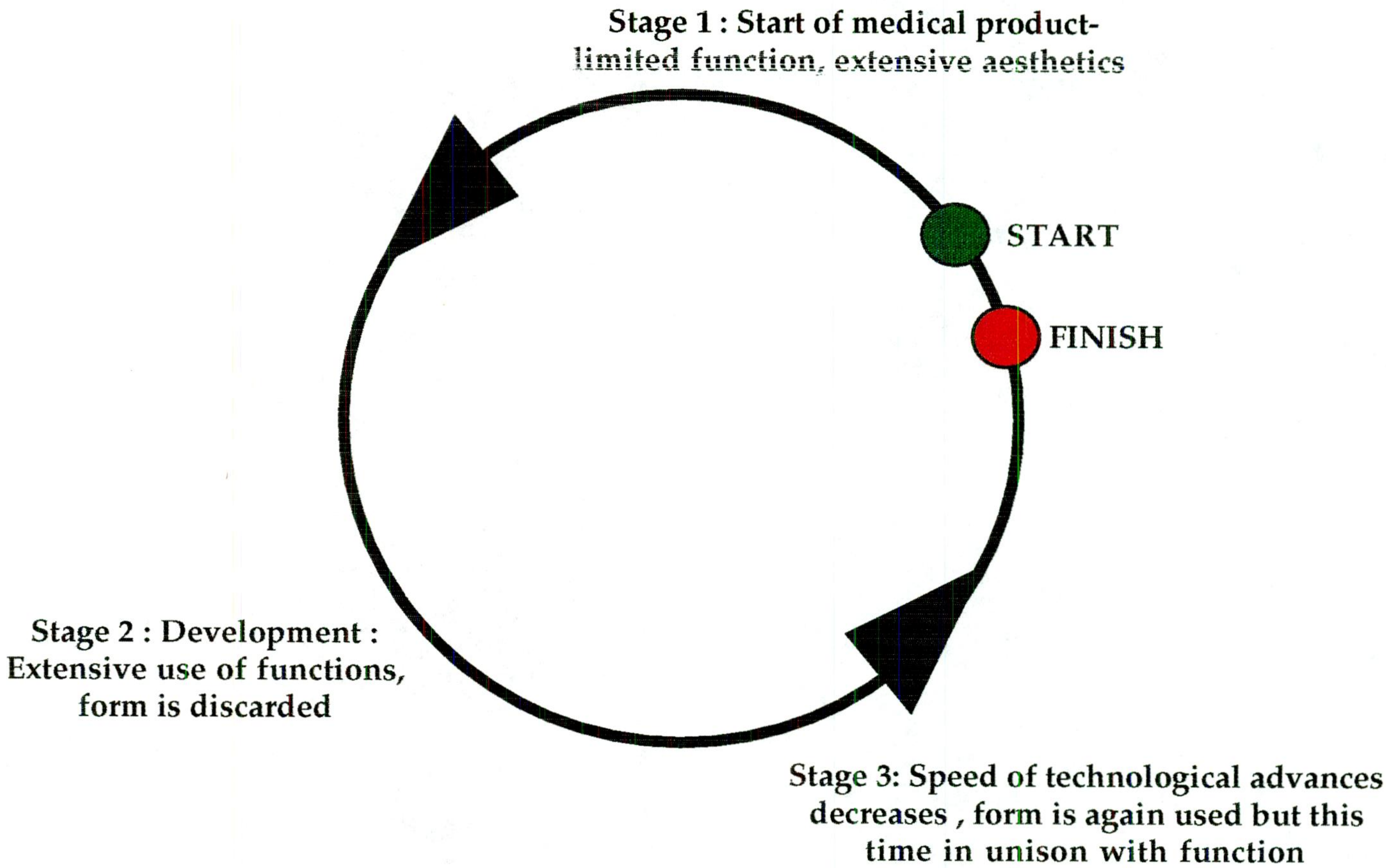
The history of surgical equipment is the general historical pattern of all medical products. The history of medical products can be split into three separate stages:

* Stage 1: An initial period of form outweighing function. This occurs early in the development of a medical product, as the technologies involved are limited.

* Stage 2: The discarding of form as the function becomes more prevalent. This stage exists as the medical concept is explored in detail and advances in technology occur rapidly. This happened for most medical products in the technological revolution of the 19th and 20th centuries.

* Stage 3: As the medical and technological advances are discovered and explored to their final detail, the medical product begins to return to form, but this time the form accentuates the function of the product, rather than merely hiding those functions (Though this stage does not apply to surgical equipment, it does apply to products where the patient is conscious of it - the three stages shall be seen in examples given in Chapters 4 and 5).

A diagram of the three stages shows how medical products have departed from and returned to aesthetics (see Dia. 9b).



Dia 9b - Development of a medical product in relation to it's form and function

Chapter 2
Current theories in medical and industrial design

The following theories and issues in design shall be explained and reviewed in this chapter:

* The issue of aesthetics
* Transgenerational design
* Barrier-free (universal) design
* D.I.Y. design

Note: Transgenerational and universal design are basically the same concept. Transgenerational design refers to the idea that
a product should allow anyone of any age to use it.
"Universal" theorises that anyone of any ability should be able to use the product.

The aesthetics agenda

Prof. Pirkl, an advocate of Transgenerational Design, states that the aesthetics of a product comes through it's function *(Pirkl, 27th Nov. 1995, lecture)* . The function is interlinked with "humanics" which refers to the product being socially conscious. However, it is in the author's opinion that Prof. Pirkl does not treat aesthetics on it's own as an important contributing factor in the overall design (as hinted when Pirkl kept referring to "form" as "fashion") .

There has always been the fundamental argument in product design about the issue of aesthetics. It is rarely seen as a function in itself, as we shall see later in Ch.4 .

"User-friendly" is a term often used today in product design, but it is an often misunderstood phrase. It is seen primarily to mean the function of the product and how easy it is for the consumer to use. It does not relate to how the consumer feels about the product. People can be "fond" of products in the same way as they are fond of other possessions, such as cars, clothes, and jewellery.

A case in point, in the area of medical products, where the power of aesthetics is not realised, is disability aids. This is not just from the aesthetic point of view of the author, but also from that of the users. In a U.S.I. (Union of Students of Ireland) conference to elect a new disability rights officer, informal discussions were conducted with several people attending the meeting. In these interviews, questions were asked referring to how they felt about the aid they used most often, e.g. a hearing aid, a wheelchair, etc., etc.

The aesthetics agenda in relation to the hearing aid

Firstly, hearing aids are the only medical products designed and made in this country. The problem with them, as the author was told, is that they define a disability in an ugly and unfriendly way. One girl suggested that it did not exactly co-ordinate with her earrings, while another man commented that it was like having a piece of chewing gum behind his ear.

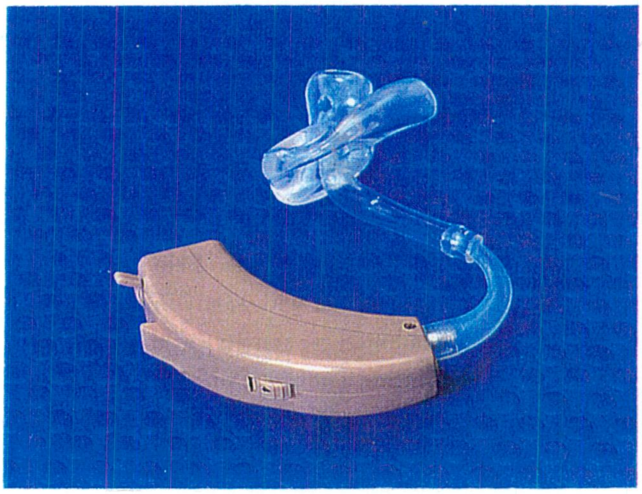


Diagram 10a -
Typical hearing aid

Diagram 10b - a group of plated Rein ear trumpets, c. 1865, length of first 7-5 cm (*Simon Kaye Ltd., London)*

The general attitude was that the product was needed but that didn't mean it necessarily had to be liked. This isn't to say that the people were dissatisfied with themselves and they were blaming any hatred they might feel towards their aid. It just means that the aid was a means to an end, but if it was aesthetically more pleasing, it would have been an " added bonus".

The attitude of doctors is entirely different to that of patients in relation to medical products/ assistive devices. A classic example as mentioned earlier is the hearing aid (Dia 10a). The users at the U.S.I. meeting were mostly unhappy with it's appearance, the aid's (all aids) biggest problem. As discussed, however, in a renowned medical magazine:

"The biggest problem with hearing aids is too much amplification of background noise"

(Sirimanna, June 1993, p. 962)

The doctors' concern with the aid is not the psychological effect on the patient but how well it performs it's intended function. This is fair enough, since a doctor's prime requirement is to repair or ease physical damage. It is the industrial designer's job to make the product acceptable to both doctor and patient, extremes of function and form, so to speak. The psychological effects of the aid is proved by the same article in the following statement:

" Even in countries such as the U.K. where the provision of hearing aids is free of charge, only about 20 -25% of those with hearing impairment seek help."

(Sirimanna, June 1993, p. 960)

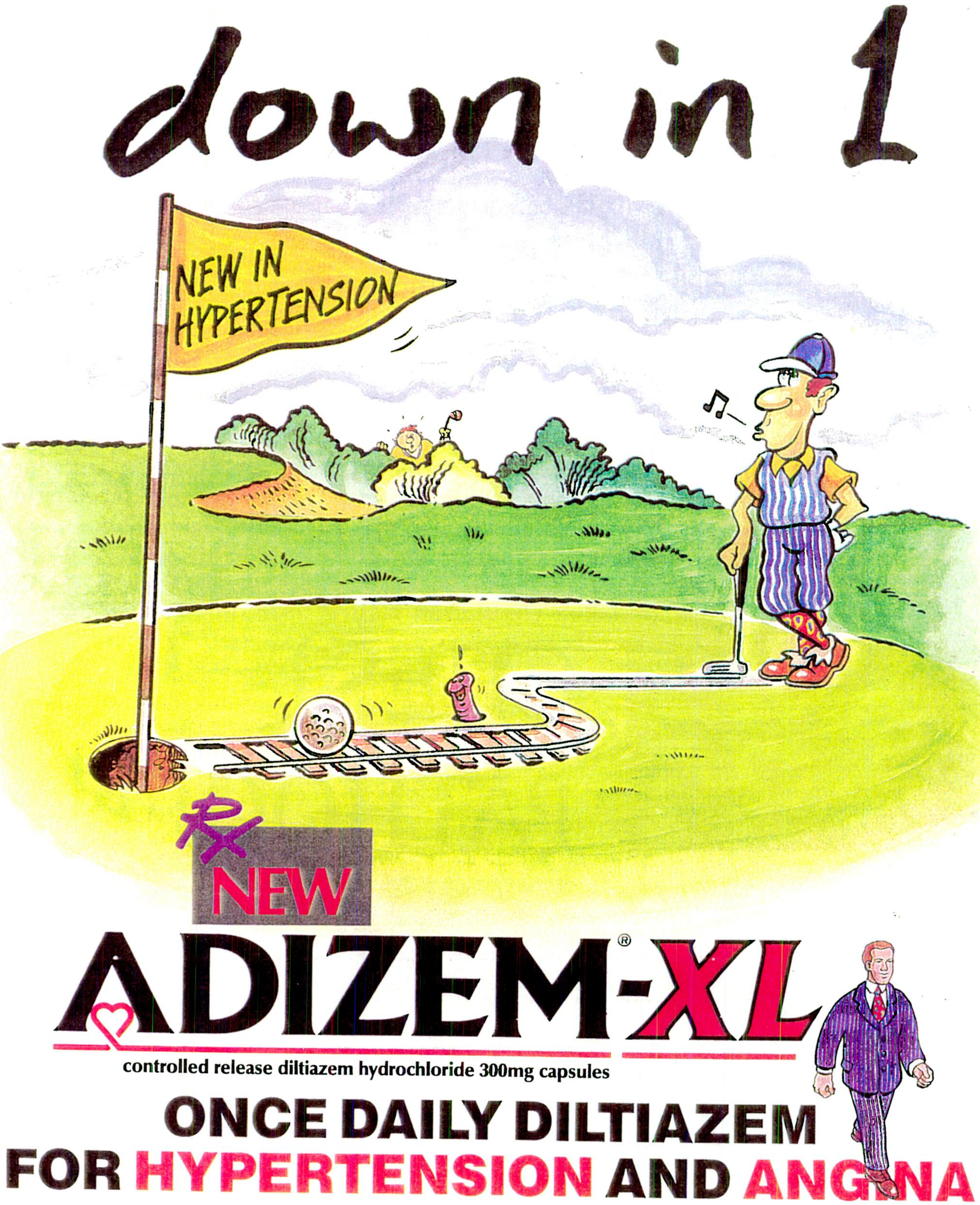


Diagram 11 - Stereotypical medical advertisement

It is important to note, however, that no matter how effective and "beautiful" the assistive device was, this figure might stay the same, as an "aid" is still considered an aid no matter how well it is dressed up. It is the attitude of a patient and society to a particular condition which can contribute to how fondly a person regards his/ her aid. Still, by making such aids "beautiful", such attitudes can be changed.

The hearing aid has been following the typical historical pattern for a medical product (see Dia. 9b). It has already completed Stages 1 and 2 (see Dia. 10a - 10b) but it has been impeded in reaching it's final stage because of the severe lack of understanding between patient and doctor, of the different requirements of each. Certainly designers only cater to the needs of doctors. This makes logical sense- companies rely on doctors to recommend their product over competitors and it is their requirements that must be met first. An extreme of this is shown by a graphic designer as seen in Dia. 11. It is obviously an exaggeration to assume that all doctors are golfers (though from the author's experience, not an entirely unwarranted view), but the point is this - when a product or drug is to be sold, it is marketed to an audience made of doctors.

Barrier free design ("Universal" design)

The problem, according to the European Institute of Design and Disability (E.I.D.D.) is a lack of common sense, on the part of designers. The E.I.D.D. believes benefits, made for people with disability should not be considered as "special" exceptions to a given rule, not just in the area of design, but in the world in general.

The organisation was set up in April 1993, to "contribute to the participation of people with disabilities through design", as stated in their leaflet. It's offices are located, ironically enough, on the second floor beside the Visual Communications department of N.C.A.D. The irony is that while E.I.D.D. insists on a barrier-free Europe, for people with disability, it's head office is located in an area inaccessible to all people.

Either this is Murphy's Law, or a prime example of a lack of common sense on the part of N.C.A.D. for putting such an office in such a place. However, N.C.A.D. cannot really be blamed for such an act as very realistic factors such as cost and space had to be considered.

Government common sense, however is severely lacking in relation to colleges and disability. As brought up in the U.S.I. meeting, N.C.A.D. is unlikely to receive any wheelchair-users as students. On further examination, the author concluded

along with the student union president (Leonie Prendergast), that the only place a person in a wheelchair could comfortably spend his/ her 4 years of study was either the in student union or in administration since all other departments could not be entered without difficulty (including the toilets, library and canteen). This however is due to the age of the college (250 yrs old in 1996) where such design considerations as wheelchair accessibility did not exist. A stair lift could be installed but there is one slight problem with this. All colleges in Ireland receive an annual grant of IR£60,000 between them to cater for people with disability - <u>one</u> stair lift costs approx. IR£80,000 to purchase and install (Note: throughout the course of this thesis, efforts have been made to rectify this situation, eg. the toilets have been made accessible) .

The E.I.D.D. believes architecture and all other areas of design should start to design so that all people may use their products, buildings, etc., so that future grants and assistive devices are not needed to fill the gap made by distinguishing one market from another- a "universal" approach. The E.I.D.D. maintains that such design will not cost any more and that it is necessary not just to criticise but to educate designers to increase their targeted market to encompass people with disability:

"Good design costs no more than bad. Placing street furniture in a rational position takes no longer than putting it where it can obstruct the unwary [e.g. visually impaired]. Forming the handle of a carving knife to facilitate the arthritis sufferer's grip uses no more material."

(Hogan, Autumn/ Winter 1994, p. 4)

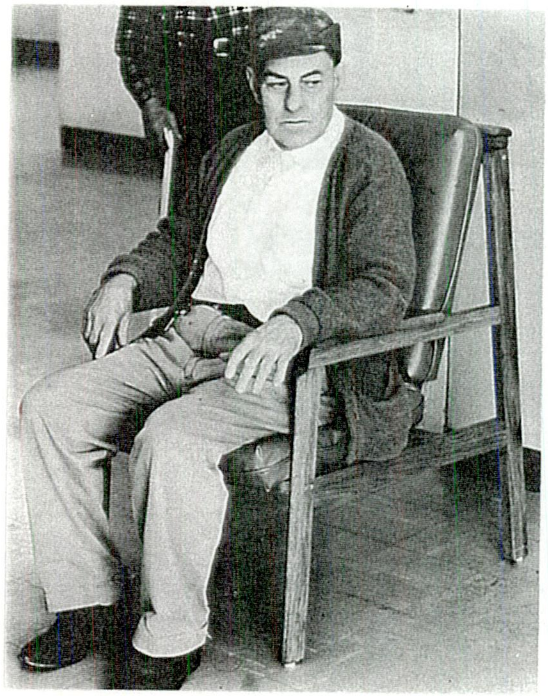


Diagram 12 - Chair to be made by elderly craftsmen in retirement homes for other elderly people on a custom basis. Designed by Blackman and others as graduate students at Purdue University.

The barrier free attitude is very much a Victor Papanek thought. In his book, Design for Human Scale, Papanek discusses what could be done on the part of designers to make this world a better place. When designing, it is the person's responsibility not just to stick to a brief with a limited range, but to remember that anybody could be using the product, and that anybody should be able to use it safely and easily. It is up to the designer to recognise the after-effects of his product, such as effects on the environment, will it ever need to be redesigned, etc., etc.

D.I.Y. design

"Less style, more substance" is the common thread in these views. Papanek believes that a designer should be extremely conscious of the world he/she lives in and in order to know a market, one must become part of that market. A case is given *(Papanek, 1983, p. 25-27)* where a chair was designed so that elderly people could use and make them (Dia.12). This not only means that the products are well made (since the craftsmen know and understand how important the chair is) but also that costs are considerably reduced, and the psychological well-being of the elderly is improved. The student who designed the chair found that the elderly in the particular home he was studying felt that their purpose in serving society was lost.

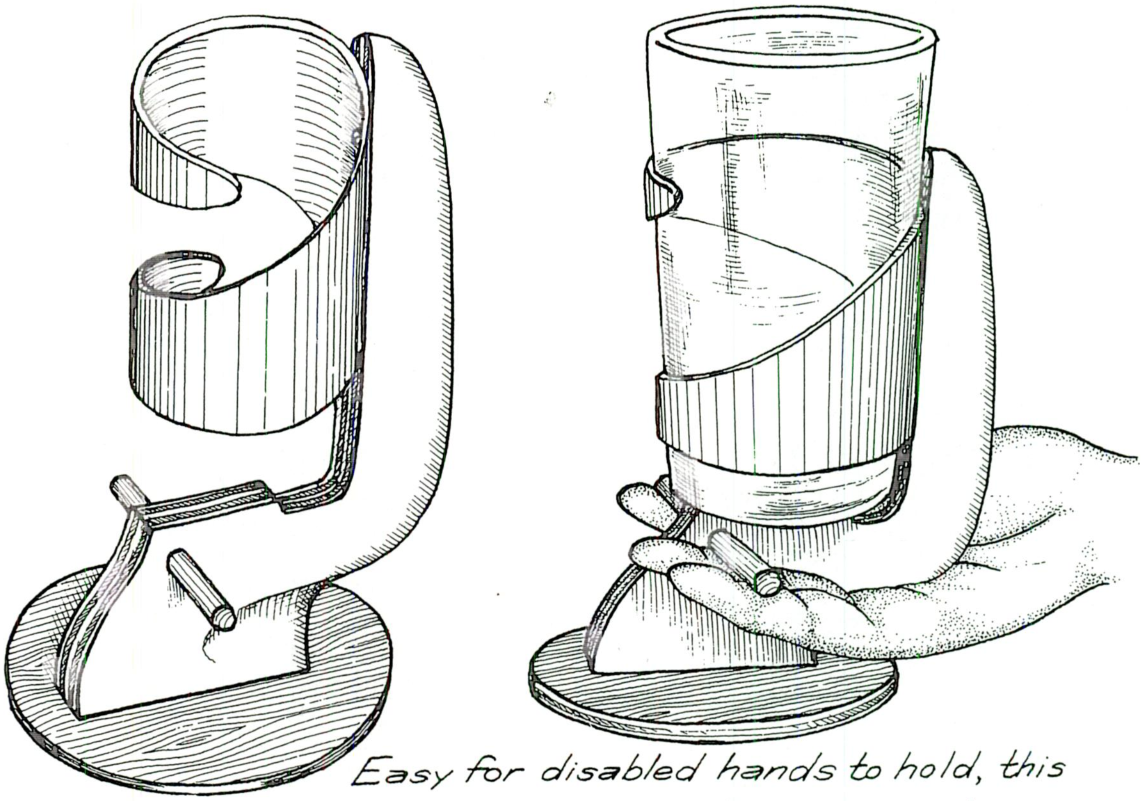
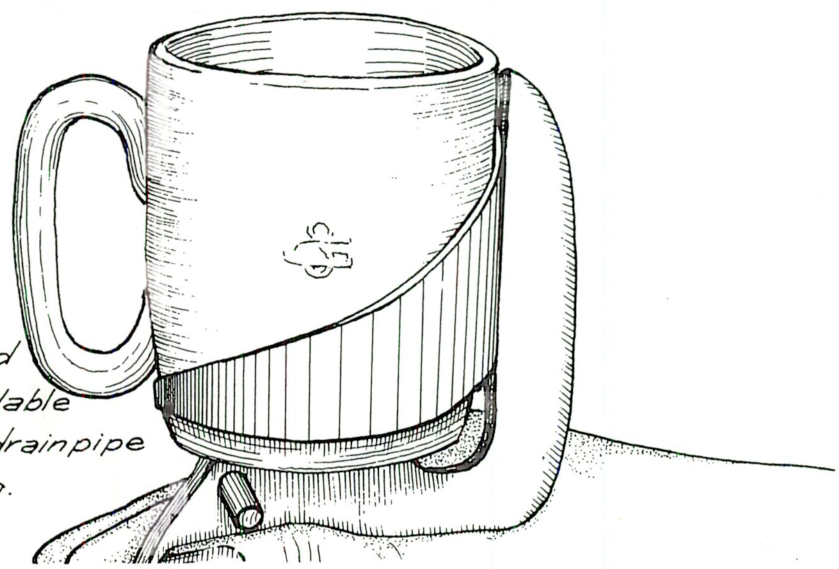


Diagram 13 - **One of the many designs in "Making Aids for Disabled Living"**



Thus, by having the chairs made by elderly craftsmen, they were serving their particular section of society. By using the chairs, the elderly were helping the craftsmen by communicating any needs for further development, and by keeping them economically stable.

This idea of "DIY designing" is given emphasis in the book Making Aids for Disabled Living where easy to understand technical drawings are given and simple constructional techniques (gluing, cutting, folding, etc.) are utilised in order to allow a person with disability to make it him/herself. Most of the designs allow for an everyday object, such as a cup, to be adapted to the needs of a person with disability (Dia.13). Not only is cost considerably reduced but the satisfaction a person gets from making his/ her own aid is undoubtable. There is no need for styling in these products because of a very basic fact - if a person makes something, he/ she loves it regardless of how ugly everyone else might think it is.

However, while the concept of "DIY designing" appears to be the ideal solution for industrial designers and their markets, it is not. Firstly, since style is not a prevalent issue in these designs, there will be fewer options and so the need for industrial designers will decrease. The designers are thus digging their own graves. Secondly, these designs rely on the assumption that all people will want to make their own products and people are not as thrift with their money as these designs would have them.

These designs also react against a universal concept as outlined by E.I.D.D. and are created to "cater for special needs" and thus segregates them from society. However, the E.I.D.D. does consent that the:

'concept of "design for all" has it's limitations and there will always be a need for design directed towards meeting special needs'.

(Phillipen, 5 Dec. 1993, p.3)

Thus "DIY" designs will essentially not be seen more often in the future because of what Papanek believes is due to a materialistic western culture which does not pride itself on it's own creations, but on obtaining what other people have.

Chapter 3

How design theories should and should not be implemented : The Nordic Committee on Disability V. Victor Papanek

In this chapter, we shall examine how the theories and issues outlined in Chapter 2 should and should not attempt to be implemented in today's society.

Firstly, we shall examine a realistic attempt at universal, barrier-free design, combined with the concept of "DIY" design. The Nordic Committee on Disability (N.N.H.) was set up by the Nordic Council of Ministers to deal with disability issues and to provide equal opportunities for the elderly and disabled. One of the main areas the N.N.H. concentrates on is telecommunications and, with the aid of the Nordic Forum of Telecommunications and Disability (N.F.T.H.), produced a publication to: "provide information on the special requirements of older and disabled citizens [as regards conventional telephones]"

(Brandt, 1995, p.2)

The book provides helpful and realistic advice in how to design a telephone to cater for the widest possible market. As discussed by Papanek, and by the E.I.D.D., there are many sectors of the community left untapped in terms of a profitable market. Papanek examines how a market of "short people" is not fully examined by manufacturers. This is due to the fact, as put by the chairman of the E.I.D.D.:

'Until very recently most products and environments were designed for an idealised consumer. This non-existent "average man" was young, enjoyed perfect health and had the physical attributes of an Olympic athlete'.

(Hogan, Autumn/ Winter 1994, p.4)

The N.N.H. proves that by expanding design specifications to encompass the widest possible market, it will enable European manufacturers to compete with American companies who are already producing telephones to fulfil these obligations as required by the Americans and Disabilities Act (A.D.A.). Not only does the N.N.H. entreat companies to follow such design practices, it gives profitable and practical reasons to do so.

"The aging population in Europe is predicted to increase from 38 million (1990), corresponding to 13.8%, to 49 million (18.1%) by the tear 2020. Disabled people constitute 11.3-15.1% of the population, corresponding to between 36 and 48 million, in the whole of Europe."

(Brandt, 1993, p.10)

The N.N.H. also recognises that certain people will never be able to use telephones and suggests designing the telephone to be adaptable to specific user requirements (such as a text reader for people with a hearing impairment). However, the book does not aim to hinder design imagination by giving solutions, instead it shows all the variable problems that could arise from the design. The range of problems covered in the guidelines is extensive, from the layout of the keypad to how the extension cord connects to the telephone. Examples include:

Guideline 4.7

" For head stick and mouth stick users and for people with other motor impairments, it may be an advantage if the keys are set into the telephone body, so that the hands can rest on the telephone"

(Brandt, 1995, p.32)

and also:

Guideline 5.1

" People with reduced muscular strength and/ or reduced movement capability in their arms and hands often need to rest their hands on the table in front of the keypad or on the front of the keypad itself. Consequently, it is important that the front of the keypad is not too high and the keypad is not too tilted. If the keypad is horizontal, however, most people find it more difficult to e.g. read the characters on the keypad."

(Brandt, 1995, p.35)

In conclusion, the book has a section entitled "basic requirements". These are the minimum needs that a telephone design should fulfil at the least. The book is extremely helpful but is not restricting on a person's sense of style or ingenuity. The guidelines are like optional design specifications, and the general tone is that of friendliness. This is written in such a way as to influence a designer to seriously consider the needs of the elderly and the disabled. The book suggests ideas rather than enforcing them.

In comparing the ideas of Papanek and N.N.H., one is turned off the idea of "designing for all" by Papanek's condescending tone. The impression one gets is that if you don't design his way, you're beneath contempt. The N.N.H., unlike Papanek, accepts the different styles of designers and suggests new concepts on which they can play with their own particular style. It is unfortunate that Papanek presents his worthy causes in a seemingly narrow-minded and unrelinquishing way. It is also unfortunate that Papanek cites one example as "beautiful" while another as "repulsive". Papanek seems to forget the fact that in designing for the benefit of mankind, one must realise that opinions on beauty vary.

For example, though all of Papanek's examples of "great design" are clever and stem from a solid viewpoint, it is in the author's opinion that the majority are unbelievably disgusting and it would be to the author's shame to have such items in his possession. Papanek shoots himself in the foot by giving us an example of how his idea of a good design is not always considered beautiful: he describes how he and his students returned to a residents' block after designing a chair for them 5 years previously, only to find none of the designed chairs were in use:

"They [the residents] told us that the chairs had been quite comfortable and had worn well, But that they did not like them. What the design students had considered beautiful, the end users had found ugly."

(Papanek,1983,p43.)

The chair is shown in Dia 14.

One half expects 3 exclamation marks and a drum-roll after this statement as it writes it in such a way as to suggest it highly unlikely. Papanek shows us exactly how not to express a view and get it accepted, by enforcing it. Adolf Hitler should have given Papanek a clue as to this. As far as this author is concerned, let Norway rule the world.

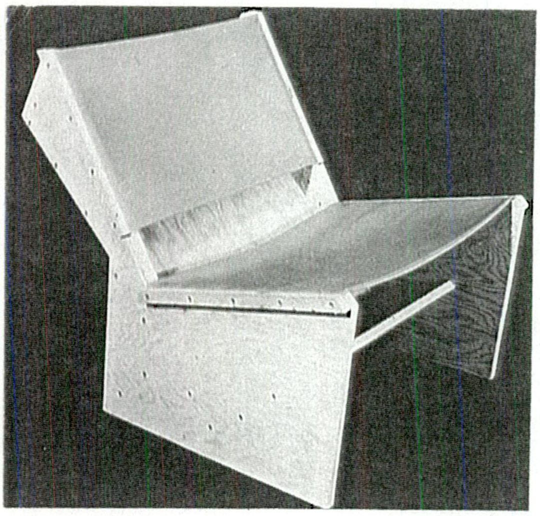
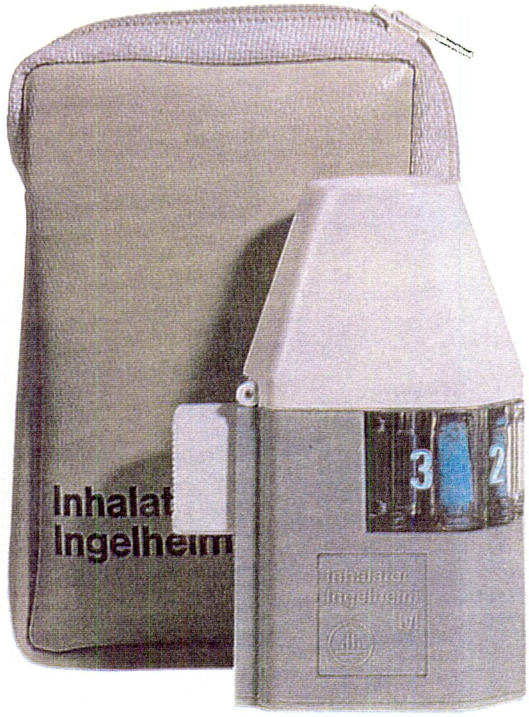
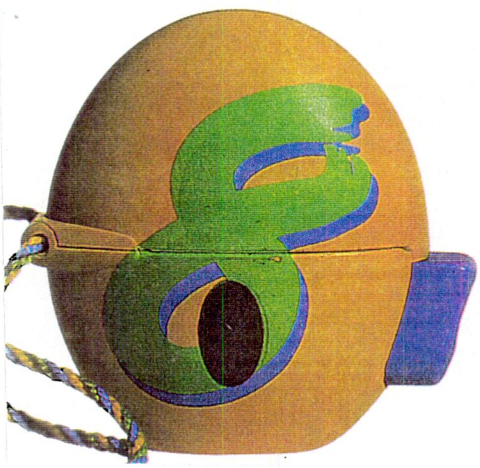
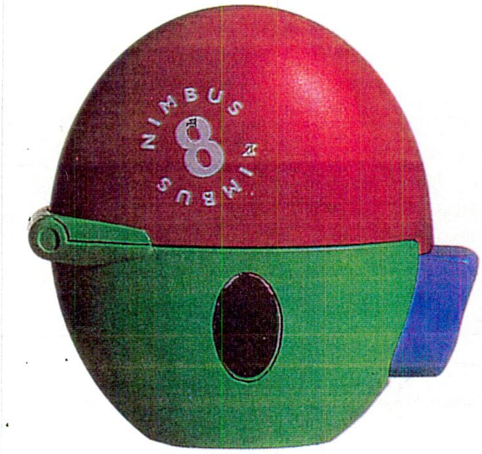


Diagram 14 - First chair developed for residents of Wayne Miner housing development. Designed by Jim Murray as a student at the Kansas City Art Institute.

The original inhaler







Various models of the Handihaler

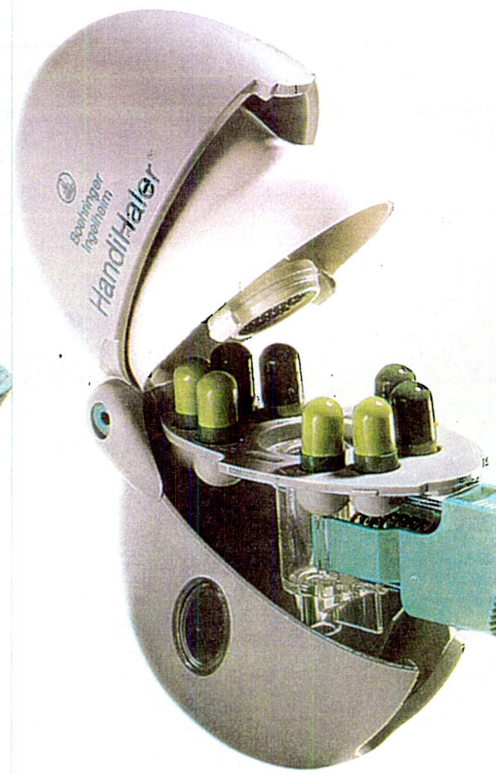


Diagram 15 - Handihaler.

Chapter 4
Examples of good medical design : Asthma Inhaler & Heart Support System

Areas such as wheelchairs, portable equipment and home medical devices are so bereft of creative thought that the user does not identify with them as products with a sense of dignity and joy, but just as products which do their job. However, it could be said that all these products are at the 2nd stage of their historical development (see Dia 9b). In this chapter, two examples of products which have reached Stage 3 shall be examined.

The Handihaler

The asthma inhaler, shown in Dia. 15, is an example of a good attempt at alleviating this problem. A common problem that asthma sufferers have with their inhalers is that they are ugly, easily lost and difficult to clean and use. Boehringer Mannheim, the company which commissioned the inhaler, produces asthma relievement drugs in capsule form which makes the operation of inhaling easier, since the capsule is first punched open and then inhaled (the aerosol inhalers have to be punched and inhaled at the same time). Since capsules only account for 10% of the asthma drugs market, the company needed to make an alternative inhaler that would boost sales.

Research was carried out in 1992 to find out what consumers would change about the inhaler, the results having focused on the aesthetics and ease of use being the main problems. The resulting inhaler is not only aesthetically pleasing, but the overall costs for Boehringer in producing their inhalers has been reduced by 50%. The success was due to the designer's approach (Ross Kinneir's):

"The German team was appreciative of Kinneir's eye for detail. 'There is one company we have worked with in Germany,' says Hochrainer, 'but they were not as excellent as Ross. What was surprising was how he identified details about use, safety and cleaning, for example, that are not self-evident to people outside the industry' ".

(Evamy, Spring 1995, p.36)

Not only does this design improve on it's original function but it also realises how important aesthetics are in psychologically affecting a person, as does the second example of good medical design.

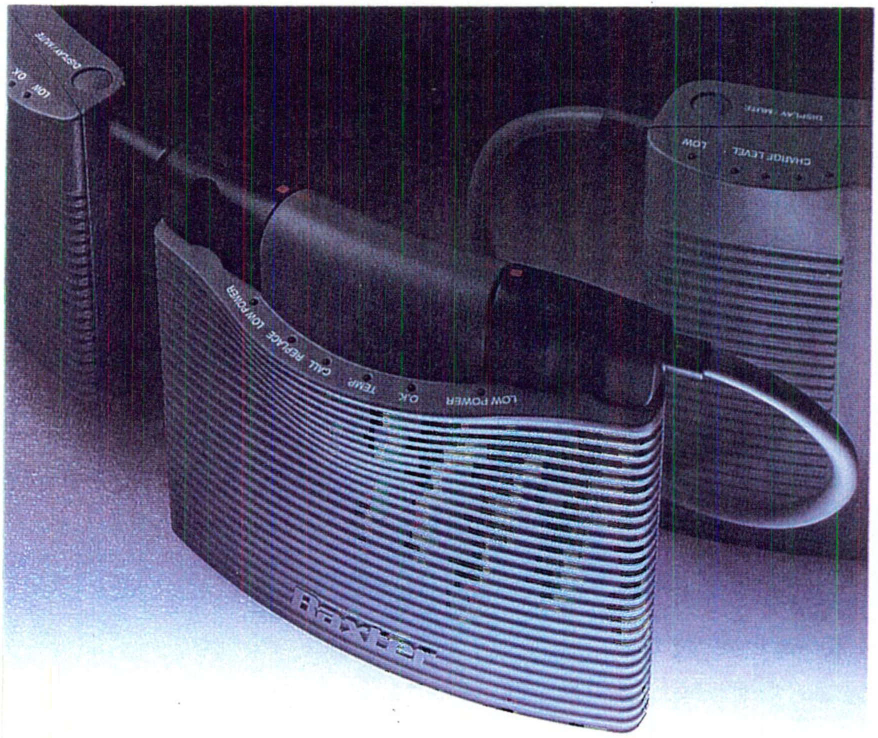
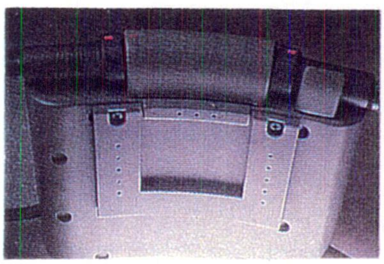
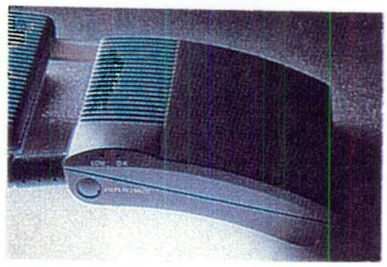


Diagram 16 - Baxter's Heart Support System.





The external microprocessor control unit and battery packs are unalarming, toso-hugging units light enough to leave the patient mobile..

Baxter's Heart Support System

The portable heart support system (Dia. 16) is for patients with a weak heart waiting for a transplant. Previously, such a system was the size of a wardrobe (which meant the patient was confined to hospital). Now it has been reduced to the size of a book.

In the U.S., 2000 donor hearts are available for transplant p.a. 70,000 lives could be saved by a support device or a transplant. Only 1,500 patients are allowed on the waiting list with a transplant available after a 6-12 month wait. Obviously, a market was there for a portable device (since hospital beds are limited) for that 6-12 month wait.

The product had to consider aesthetics because unlike sutures (see Ch.1) and other operational devices, the patient had to look at it, use it and basically be attached to it for a minimum of half a year. With the prospect of open heart surgery at the end of this wait, the product must make the patient as much as ease as possible i.e., to show the "friendly face" so to speak.

As with all medical design, function had to be of the up most quality. However, the product is one of the few medical products on the market where aesthetics also play an important function.

The product, due to it's portability, improves the patient's circulation, since he/ she is able to move around. This increases the patient's chance of surviving a transplant. The 3 battery units (each the size of a disc man) are held about the waist with

curvaceous fins to direct the generated heat away from the body. The whole outfit is surrounded in gently curved exterior which hugs nicely to the body and is intended to induce trust in the patient. The lights to indicate charge level have been simplified for easy and quick reading. The product is placed slightly above the midriff and outside the clothing to allow for natural, free body movement

In this case, aesthetics are there for more than just a psychological reason. The surface contours easily show people with low vision the product and gives it a soft, non-intimidating form.

The product provides similar qualities to that of a small walk-man in that the independence of the patient is maintained. The casing is water-proof, so that the patient can take showers. The system has an external and back-up battery, and due to a white typeface on a black background, enables the patient to easily see when the product is on low power, overheating or running perfectly.

The system is a good example of conscious design, i.e. aesthetics are not there simply to make the product pleasing to the eye, but also to serve another purpose. The psychological aspects of colour and form on patients has rarely been explored to such an extent. Uptil today's medical products, the philosophy was that if it does it's intended function and theoretically makes the patient better, then it works. Good design not only accomplishes what it sets out to do but, by

satisfying these requirements, but goes ahead to bring new objectives into play.

Medical designers are beginning to realise that function is not only limited to the physical aspects of the patient but also his/ her mental health.

Diagram 17 - Logo celebrating Picker International's 80th birthday and the centennial of the X-Ray.

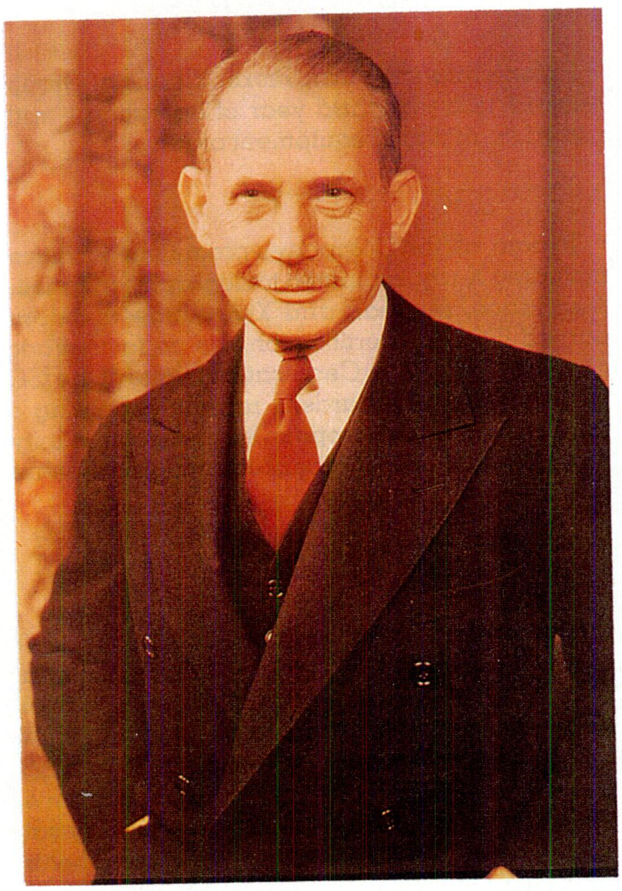


Diagram 18 - James Picker, 1882 - 1963.

Chapter 5

A case study of a design innovative company : Picker International

1995, appropriately enough, marks the 100th anniversary of Rontgen's discovery of the X-Ray, and also the 80th birthday of one of the leading manufacturers in X-Ray machines, Picker International, which has 4,600 employees worldwide (see Dia. 17). In this chapter it shall be seen how a world-conscious company invented and produced good medical design. Firstly, the beginning.

History - early beginnings to the 1960's

James Picker (Dia. 18) was a Russian emigrant who became a pharmacist in New York, and whose pharmacy was located near the Mt. Sinai hospital. After learning of a new medical technique (the X-Ray) in the Rontgen unit at the hospital, he expressed an interest in selling the glass photographic plates (which the X-Rays were developed on) , manufactured by Kodak, to the hospital. By 1915, he set up the James Picker Company for the sale and distribution of X-Ray supplies (which also included the relevant apparatus).

Such rapid success was plausible because at the turn of the century, technological advances were not accepted as quickly as they are today. Even before the accidental discovery of the "X-light" by Wilhelm Konrad von Rontgen in Germany 1895), there was evidence to suggest that electricity would play an important

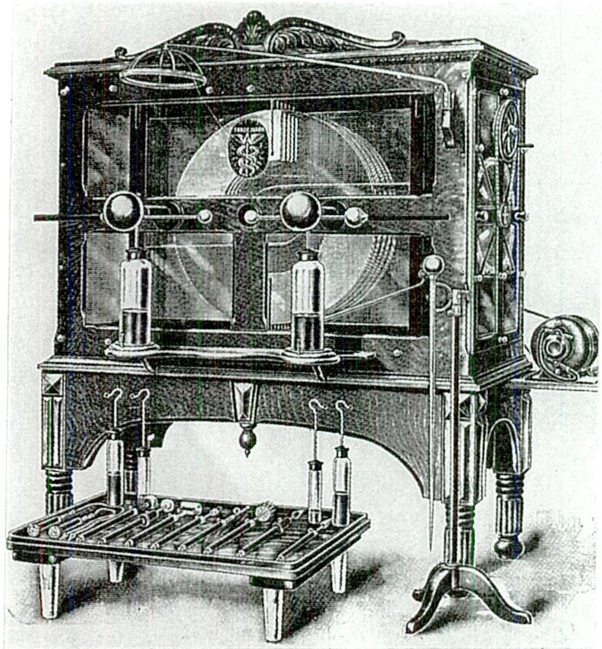


Diagram 19 - Static generator produced by Waite & Bartlett Co., long Island, New York, 1880.

Diagram 20- Mobile X-Ray unit, designed by Dr Harry Waite and used by expeditionary forces in Europe during World War I circa 1916-1918. Notice exposed high voltage wires.

role in medicine. Static electricity was the most popular since the energy needs of even a large static machine could be transmitted through a sewing machine belt (Dia. 19). However, medical products at this time were not as technical as they are today and often electricity was used in order to "blind" the patient into thinking something was actually happening.

The following quote illustrates an example of a medical product with a powerful aesthetic form (in psychologically influencing the patient) but a poor, if existent, function:

"A complex looking oak chair, resembling an electric chair, was arranged so that two sides of the chair contained eight or more tubular lamps, somewhat similar to fluorescent lamps of today. Each lamp was filled with a different gas that would produce a soft fluctuating coloured glow when excited with high voltage. Usually each lamp produced a different colour. the patient, sitting in the chair, received a treatment of the so-called beneficial light."

(Goldfield, 1955, p.105)

This is a synonymous with Stage 1 in the development of a medical product in that the form dictated the function.

The Pickers' machines, however, developed in function first, with the main objective to create protection for the patients and technicians from the harmful light. Lead rubber was considered as the most effective protection, in 1898 by a dentist in Ohio (which would be the future headquarters of Picker International). Early signs of it's development can be seen in Dia. 20. Further developments made the images clearer and the machines easier and safer to use.

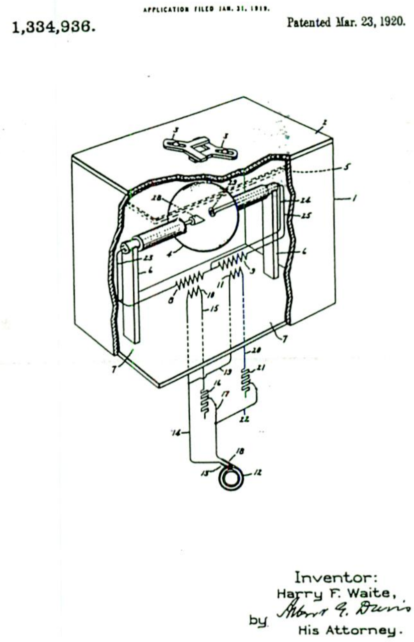


Diagram 21 - Patent issued to Harry Waite in 1920 - perhaps one of the most important ever issued in the X-Ray industry.

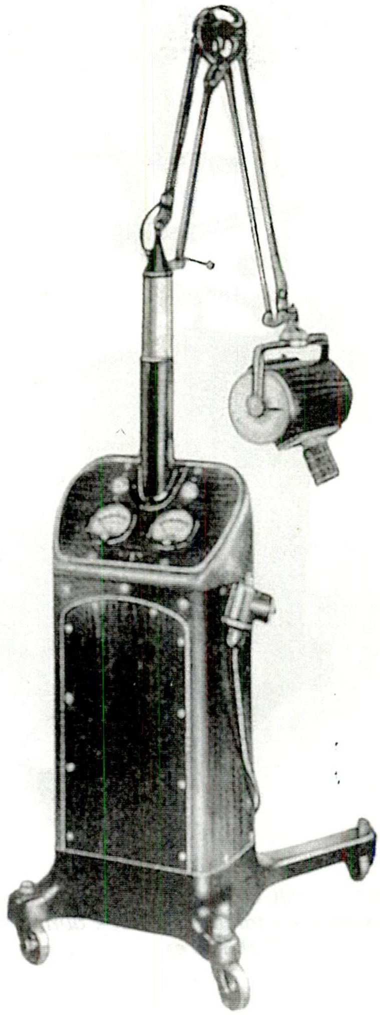
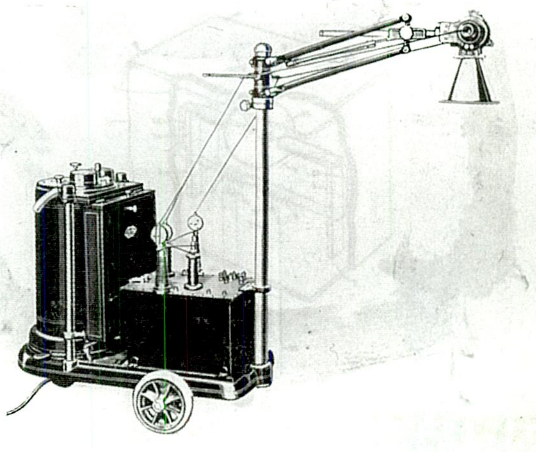


Diagram 22 - Dental unit designed by Harry Waite using his 1920 patent. This product, circa 1930, is not too dissimilar from those manufactured in 1994.

Diagram 23 - 1920 non-shockproof mobile X-ray unit which at times could electrocute personnel. Exposed voltage values could be 150,000 volts.



Prior to the invention of the cathode tube, shown in Dia. 21, fatal electric shocks to patients and servicemen were common (see Dias. 22-23). The emphasis on function first indicates stage 2 of the X-Ray's development.

The X-Ray machine is a classical example of function given form. The Waite & Bartlett co. (a sister company of Picker), concentrated on the function while Picker used an approach quite different in order to achieve new functions (a typical industrial design approach).

Picker quickly surpassed Stages 1 and 2 to move on to Stage 3 - a return to an equal emphasis on form and function (see Dia. 9b). Picker's line of equipment was the first to make use of colours, to use streamlining, chromium plating and most importantly, the first to make it simple to use and completely shockproof. The shockproof designs were completely different in that the high voltage cable equipment was shielded. The company's approach became reality and virtually overshadowed their competitors by 1936. The cam World War II. Picker, at it's own expense built the army X-Ray Field Unit to facilitate the war (see Dia. 24). The huge sales (approx. 13,000 units) marked huge profits for the company (Picker had been contracted by the government to produce the machines- the only American company to do so). James Picker, however, returned sums of $4.0 million, between 142-51, to the government. Palermo quotes Picker as saying in 1951:

"I did not want to make a profit on men dying. With our fellow Americans and allies being killed in the war, the least we could do was to see that we [Pickers] did not profit from it."

(Palermo, 1995, p.110)

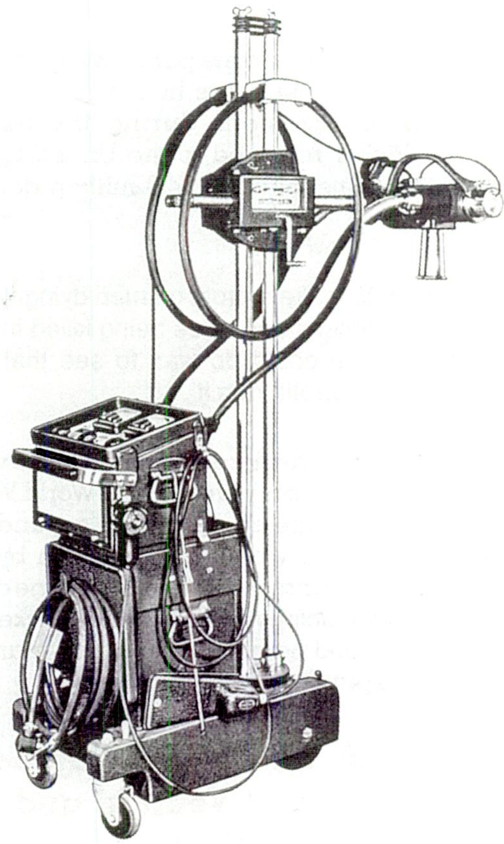


Diagram 24 - **The US army X-Ray Field Unit, used extensively during World War II. Picker produced about 13000 units during the war. The unit could be removed from three shipping chests and assembled in 5 minutes.**

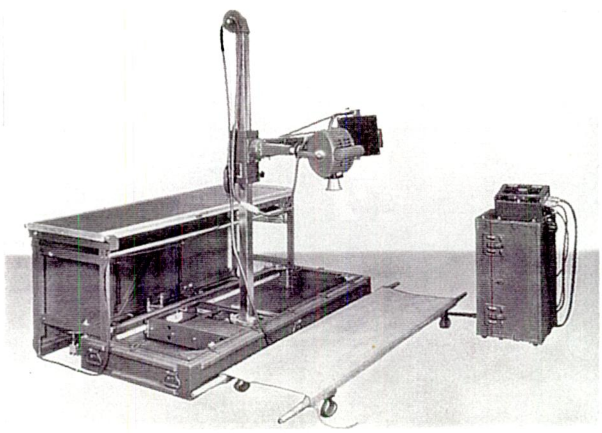
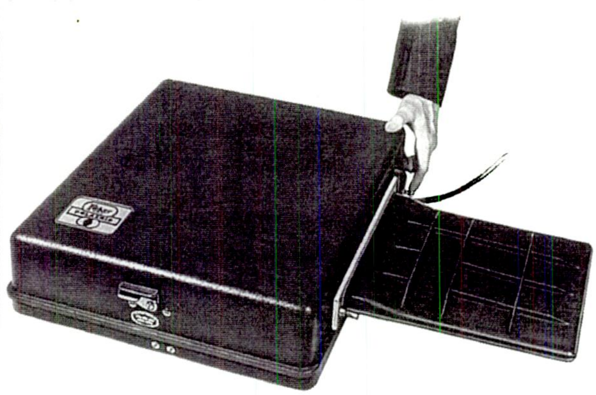


Diagram 25 - **Korean War Unit, 1950. This unit provided improved technology over it's predecessor.**

Diagram 26 - **Picker Polaroid Processing Unit, 1950. This design was an outgrowth of the Polaroid "instant picture" camera developed in 1947.**



This is a marked comment on design, in that Pickers designed equipment, not solely for profit, but for the benefit of mankind. Instead of sharing his social consciousness on paper, as Papanek does, he proves it by doing it. Picker therefore not only considered function an form, but also humanics in equal measure.

In 1950, the company redesigned the whole mobile military X-Ray unit in anticipation of a new type of warfare, as well as a high image X-Ray processor (Dias. 25-26). Both the units were completed in 1951, and were used in the Korean War. The system could be dropped at a combat zone (carried by two men) and be ready to work in 15 minutes. After further equipment developed for the Vietnam War in the 1960's, Picker maintained a foothold in the market for near-front-line combat medical diagnostic X-Ray equipment.

We shall now look at the three separate factors in Picker's designs:

Form

It must be noted that Picker's success was due to considering all aspects of it's designs, from the technology used, to the psychological effects of the product's colour. For example, Picker's always used a light green on it's products, as a corporate identity. Normally, this colour wouldn't be seen as the X-Ray room was similar to a photographic darkroom, in that no lights, besides a red light bulb, were allowed, as this would ruin the X-Ray. The "darkroom" suddenly did not exist anymore with the

invention of the "intensifier" in the early 1950's, which meant X-Rays could be taken and developed in a lighted room. Thus "Picker's green", which has a bad psychological aspect in terms of hospitals (along with yellows and blues), was changed to a neutral, off-white earth-tone in 1977. The colour is still the most preferred colour of hospital equipment today. A dedication to form is also seen in their New Preference Mammography System, which :

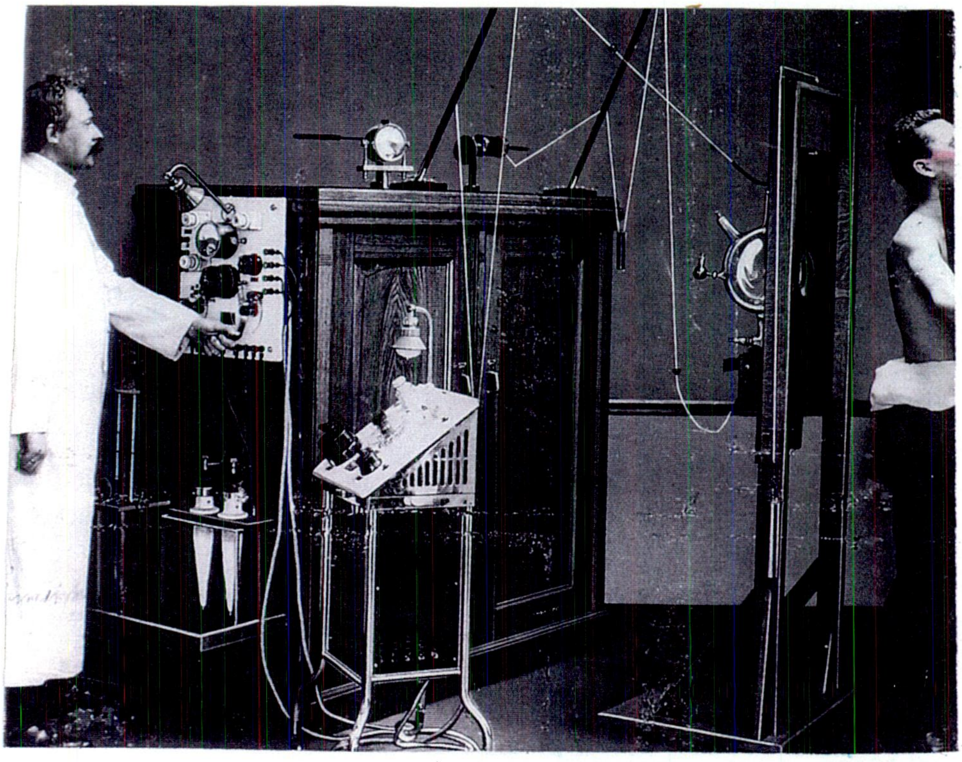
"breaks new ground in patient-friendly design with soft edges and rounded corners that increase patient comfort and ease-of-mind."

(Anon., 1995, p.0)

Function

Though the company slumped between the 60's and 80's, it was due to the company's willingness to accept new technologies that made it return as a success after the 80's and through to the 90's. Listed below are some of it's achievements:

* In March 1978, Picker produced a new scanner, the CAT scan (Computed Axial Tomography- invented in 1967 by Nobel peace prize winner Godfrey Hounsfield). The scanner won many awards for brilliance in Industrial Design.



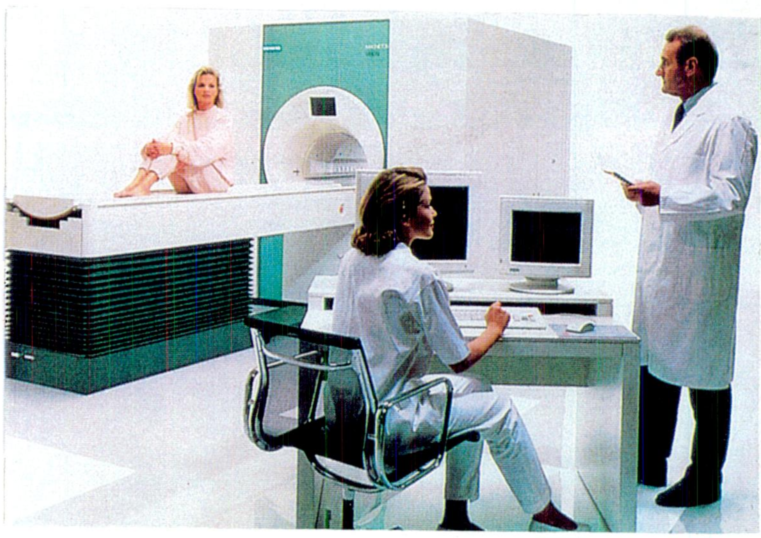


Diagram 30 - Two of Siemen's X-Ray machines showing Stages 1 and 3 of development.

Humanics

All of Picker's products are based on a modular system to allow for adaptability, and to save time and money with installation. Picker provides a management system which assists hospitals in complying with the American Occupational Safety and Health Act, and the Environment Protection Agency. It also encourages less chemical usage and more silver recovery, when dealing with it's products. Finally, Picker provides parts of more than 40,000 different types, through it's Picker International Parts Operation (P.I.P.O.), and as quickly as possible, to provide it's customers with a quick turnaround.

The company has maintained it's success by putting into practice some fundamental industrial design theories, but yet realistically keeping abreast of the current market and adapting to it:

"We believe innovation a key strategy. Last year, we increased R&D [Research and Development] spending, and introduced products across all modalities to address our customers' changing needs. But technology alone does not complete the picture. Equipment service has also undergone significant change."

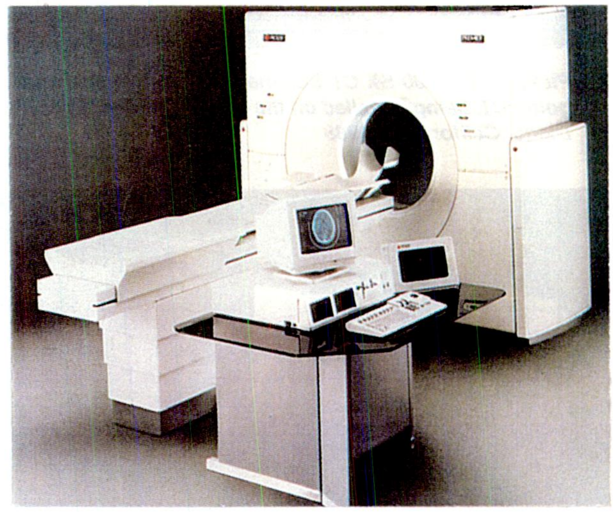
(Nolan [Pres. & Chief Executive Officer] , 1995, p.1)

Picker's designs have developed from Stage 1 into the ultimate balance of function, form and humanics, Prof. Pirkl's assessment of the perfect industrial design, as illustrated in Dia. 30 (see also Dia 9a-9b).

* At the Radiological Society of North America conference in 1988, Picker launched the "I.Q." scanner. This scanner (Dia. 27) was the first to use slip-ring technology (whereby a person is passed through a high-frequency X-Ray generator) and was produced at a reduced cost for the lower-cost market sector.
* in 1989, two of Picker's scanners (the 1,200 SX CTs) were built into two U.S. Navy hospital ships, a feat previously considered impossible (Dia 28).
* Their "MEDCAT" scanner was used in "Desert Storm" in Saudi Arabia (in an evacuation of a hospital 200 miles from Kuwait). The "MEDCAT" was also used in the Somalia Relief Effort in 1992.
* Picker's "VISTA HPQ" (Dia. 29) led to the diagnosis of AIDS and Alzheimer's disease.
* In 1991, the "VISTAR" was introduced. The physician could now look at a 3-D rendered image, rather than a conventional 2-D black and white. It also allows him/her to "see" through segments and to block out obstructing objects. Thus the chances of a good diagnosis are greatly improved.
* Also in 1991, the fastest real-time scans were produced by Picker's products. That is, the time it takes between performing a scan and the final image appearing on the computer screen.

Note that these medical innovations were used by Pickers, as part of the form/ function/ humanics equation to evolve into design innovations.

Diagram 27 - IQ Premier Computed Tomography (CT) Scanner, 1988.



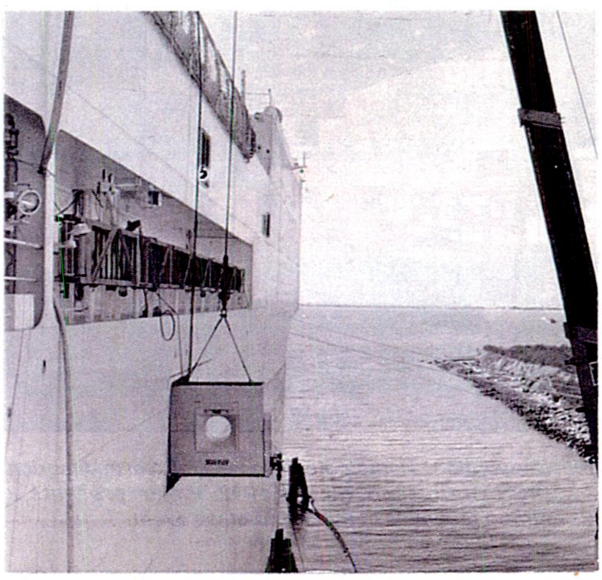


Diagram 28 - Picker CAT 1200 SX CT Scanner , the world's first sea going CT, being installed on the USNS "Comfort" in San Diego, California, 1988.

Diagram 29 - A Vista Magnetic Resonance Unit undergoing final assembly.

Conclusion

The previous chapters (3-5) have shown companies, products and theories which have all accomplished Stage 3 of their development (see Dia. 9b) i.e. they have passed the "finish line". However, the standard of design excellence of the examples previously discussed is not common in the area of medical products (particularly disability aids). The majority of medical design is still stuck at Stage 2. What, therefore, is preventing the final stage from occurring?

A medical product is a complicated thing, and has a wider range of considerations than most other products.Apart from the normal factors such as cost, market, etc. there are the needs of the user, doctors and manufacturers to be assessed. It is the manufacturers' needs which have the ability to impede the development of a product. To gauge these needs, a questionnaire was sent out to 100 manufacturers of medical products. The questionnaire, with results, is shown on Page 57.

Note: Picker International answered the questionnaire as follows:

Q.1 : YES

Q.2 : YES

Q.3: Form : 8 — Colour: 9

Feel of the product: 7 — How well it functions: 10

Cost of manufacturing: 8 — Cost to consumer: 10

Materials used in manufacture:10

Size of the available market: 7

Q.1 Do you employ industrial designers? Yes **29** No **71**

Q.2 Industrial Design is often seen as given an artistic, individual style to everyday products, such as a chair or a kettle. In your opinion, does this design method realistically apply to your products?

Yes	12
No	57
Sometimes	31

Q.3 On a rating scale of 1 to 10 (10 being the highest), how important do you rate the following factors in the overall design of your products?
Note: figures are an average of all 100 results.

Form/ Shape	3.1
Colour	2.7
Feel of the product ie. is it warm, smooth, etc.?	1.8
How well it functions	8.3
Usability	7.6
Cost of manufacturing	7.8
Cost to consumer	7.1
Materials used in manufacture	4.9
Size of the available market	8.5

Little attention was paid to the more theoretical aspects of design, such as the psychological effects of colour and form on the consumer, while there was a concentration on more practical matters, such as function and cost. Therefore it can be seen that there is an imbalance in terms of function, form and humanics. Thus, for a product to achieve ultimate industrial design, it depends on the manufacturers to realise the importance of maintaining that balance.

It would be arrogant and naive to say that medical products are the answer to all of industrial design's prayers. It would also be naive to say that medical products give a blueprint for great design.

Great design happens- as Einstein said, genius is 10% inspiration and 90% perspiration. The author, however, does believe that medical design has the most chance of producing great design because all other areas of design have become overworked and saturated, while medical design has been left relatively untouched and thus gives it room to grow. Great design is based on that 10% inspiration and medicine is an area where constant new ideas are essential for a world changing too quickly in needs and demands.

Industrial design involves the following factors in order for it to be successful in today's world:

- The product must be marketable
- cheap to produce
- environmentally friendly
- ergonomically sound
- new and individual in style
- universal, i.e. the product should be easily used by anyone of any age, size, ability (mentally and physically).

Craft areas of design have always been seen as the epitome of product design. However, craft design, which originated with the

Bauhaus, did not realistically achieve the enlightened views of the Bauhaus. Medical design can achieve the goals of the Bauhaus. Medical equipment, once medicine became a popular science, obtained little from design, and yet ironically has come to symbolise the best qualities of design. In the past 5 years it has become the largest field of industrial design, second only to computer and technological hardware. This is reflected in Fitch design company, Oklahoma, the largest I.D. company in the world. Within 2 years, medical products have become the 2nd biggest employer of the company's workers. Previously, medical design had not been seen as real industrial design because of it's often terrible lack in aesthetics and too much emphasis on technology. Now, thanks to the efforts of companies such as Picker and Baxter, it is beginning to redefine the term "Industrial Design".

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