

PRODUCT INDUCED HOME ACCIDENTS: A SEARCH FOR SAFER DESIGNS¹

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INTRODUCTION

Designers usually begin the design process with some presumptions about the potential users or the consumers which aid them in making predictions about the final product's interaction with its user. Such presumptions may finally turn out to mismatch the actual usage.

In specific usage environments, as in the home, where the user is untrained, the evidence of the outcome of mismatch is often readily observable. Accidents can be thought of as examples of such mismatches. Causes of an accident may indicate to a designer where and how his predictions fail to match the actual usage of a product.

'Human factors' or sometimes referred as 'ergonomics' is one of the disciplines which is regarded as providing direct input to the design process concerning safety. It is nevertheless the case that product usage in the domestic environment is largely ignored by 'human factors' studies. One possible reason for this is identified by Ward (1970) who points out that there has been little political or commercial pressure to increase performance and productivity in the home. According to Galer and Page (1991), there is less control over product usage, accidents and injury in and around the home, than is usually the case in working situations. In a work situation the safety of a product is to some extent assured,

Received : 1. 11. 1993

Keywords: Industrial Design, Consumer Protection, Home Accidents, Product Safety.

1. I would like to express my special thanks to Prof. Vacit İmamoğlu and Prof. Engin Sungur who both helped me in the conduct and analysis of this research for my MSc thesis in 1988.

in that the product is carefully selected to serve its purpose and is used by people who have been trained in its operation. The employer is also required by law to provide a safe working environment. At home, the user is untrained and there are numerous other factors influencing the user in the selection (*i.e.* purchase) of the product. Vanity or cost for instance is sometimes more dominant than the functionality or safety of the product.

This study aims to draw guidelines for product designers in considering the safest usage of household products. This is done by drawing their attention to the existing failures of product usage which have resulted in accidents and to their apparent and predictable causes. A field survey was carried out in 1988 as part of the author's Master's degree study (Hasdoğan, 1988) to elicit the causes of home accidents which occurred in Turkish urban life. In this article the results of that study are being presented in a manner which highlights the most problematic areas of product design in terms of safety. Initially, causal components of an accident and the nature of their interaction will be discussed. Later the results of the study will be presented.

ACCIDENTS AND INTERACTION OF THEIR CAUSES

One of the most common approaches to accident systems which is known as the epidemiological approach, considers that accidents result from the interaction of products, people and their environment (Wilson, 1983). It states that only certain characteristics of each factor are proved to be causative. According to this approach the relevant characteristics of the product can be its type, age, size etc; that of the person being age, sex, physical or psychological state; and that of the environment being physical and social state.

In view of this, an accident is defined as a sudden unexpected mismatch between people and the environment as a result of interacting causes with an outcome of fear, injury or death.

The scope of these two main sets of elements which constitute an accident can be defined as follows:

Environment: The environment which is home, including its all permanent and temporary situations can be counted as the universe of this study.

Person: The person who is involved in the accident, can be anyone sustaining an injury or contributing to the events either directly or indirectly.

It is assumed that the problems and their causes existed before the accident happened. An accident is a momentary output which validates the problems within a sequence events, where the problems and their causes interact. The factors which generate the causes of accidents within the above elements are described below.

A. ENVIRONMENTAL FACTORS

Accident causes which are related to environmental factors are grouped as the ones originating from the designed elements of the environment and temporary environmental conditions.



Figure 1.

1. Designed environment

The word 'designed' does not necessarily refer to the efforts of a skilled designer but to any person's permanent or temporary organisation of the products and their features within an environment. This is the area of architects and industrial designers. The factors belonging to the designed environment can be listed as follows:

a. Product design defects:

Judging whether a product is defective or not is a matter considered by many countries in the process of preparing their laws of "Product Liability". According to the Consumer Protection Act of 1987 in the UK, there is a defect in a product if

... the safety of the product is not such as persons generally are entitled to expect; ... (To determine what persons are entitled to expect) ... all the circumstances shall be taken into account, including ... what might reasonably be expected to be done with or in relation to the product... (Consumer Protection Act, 1987).

The concept of reasonable expectation of use involves a knowledge of how people actually use a product rather than how the designer may think it ought to be used (Galer and Page, 1991) and the consideration of all the circumstances of use (Figure 1).

Some products are inherently hazardous and a person using the product should know this. But if the designer conceals the hazard from the consumer and does not take adequate precautions the design will be defective. The Uniform Product Liability Act in the US (1979) asserts this statement by the term 'unreasonably unsafe' product. The law provides more rights to the claimant such as:

Product seller cannot be shielded from liability for an unreasonably unsafe product simply by indicating that the product may be hazardous. (Additionally,) if an alternatively designed product which would have prevented the harm while preserving its usefulness, could have been produced with a slight increase in cost, it is likely that the product is unreasonably unsafe (cited from Abbott, 1980).

For the purposes of this study the defectiveness of a product can be determined in reference to the following outline:

1. If safer examples of the product exist even if with a slightly higher cost;
2. if designing a safer product is conceivable;
3. if any foreseeable manner of use or contact either by the end-user of the product or somebody else, was not considered;
4. if potential safety-devices were not applied; the product can be assumed to be defective.

b. Architectural design defects:

Architectural design concerns both with the features of the building such as windows, doors, roofs, floors, their dimensioning, material selection *etc.*, and their composition within the space. Assessment of design defects in architectural elements is similar to that of the product design defects. A safer building design can be maintained by using additional safety devices such as balconies which are completely enclosed by railings that children cannot squeeze through *etc.*; or by an appropriate material and component selection such as a non-slippery floor covering *etc.*, or by a careful composition of building components such as keeping hazardous components (*e.g.* doors and stairs) apart *etc.* (Sinnott, 1985). In

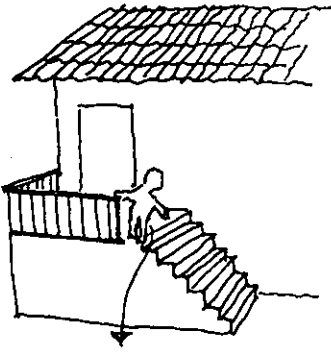


Figure 2.

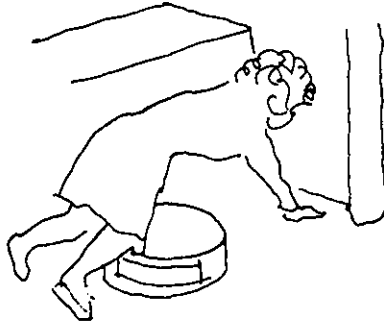


Figure 3.

comparison to most of the consumer products architectural features are used by a larger domain of people including high risk age groups such as children and elderly. Therefore the defect is effective to a greater extent (Figure 2).

c. Space organisation defects:

For the purposes of this study, the term space organisation refers to the composition of consumer goods and furniture which are not mobile in everyday use, such as the positioning of the stove, seating elements, closets within rooms, *etc.* 'The designers' in this context are usually the occupants of the house, themselves (Figure 3).

d. Production defects - construction defects:

The definition of a production or a construction defect made by the US Uniform product liability act (1979) is convenient within the framework of this study: "A product is held to be unreasonably unsafe in construction if, at the time it left the manufacturer's control, it differed in some material way from the manufacturer's design specifications or performance standards, or it differed from otherwise identical units from the same production line." (cited from Abbott, 1980). It is difficult to detect a production defect without having a detailed information about the background of the product during an overall study of accident research. Production defects can be detected by detailed case studies.

2. Temporary environmental conditions

Temporary environmental conditions include physical conditions within the accident situation, such as light, temperature, messiness, dust, dirt, ageing, wear out, proximity of animals around etc. They may lead to a stress situation on human capabilities and consequently cause errors and accidents. The environment of use is important for the designer's concern that he should consider the extreme conditions of the environment in which the product will be used.

B. PERSONAL FACTORS

As previously stated, accident is a system where the environment fails to match to people where the person or people constitutes another set of elements and contributory factors. According to the Consumer Safety Unit of Department of Trade and Industry in the U. K. (1980), there usually is a tendency to dismiss the accidents with recognised personal factors as beyond the scope of conventional accident prevention programs. This point of view can result from too simple an approach to accident causation. Personal factors play an important role in the evaluation of accident causes and cannot be omitted from design consideration.

1. Personal physical factors, physical incapability:

Physical incapability refers to not being able to do something intended, owing to exhaustion, inadequate body dimensions, lack of agility etc. This fact must be considered within distinct categories according to inherent or developmental capabilities of people, such as children, adults, elderly and disabled.

It is obvious that capabilities of children are quite different from adults. They are not small replicas of adults. The proportions of their bodies, their speed and nature of actions differ considerably at different ages. Elderly are effected by the loss of acuity and range in their senses, as they are rather slow to recover after being thrown off balance, also effected with poor posture, usually suffer from falling accidents.



Figure 4.

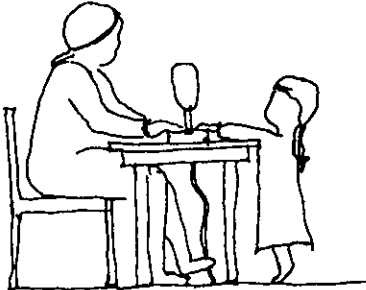


Figure 5.

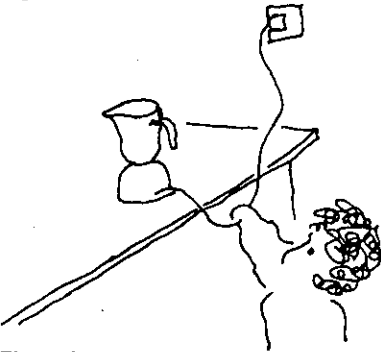


Figure 6.

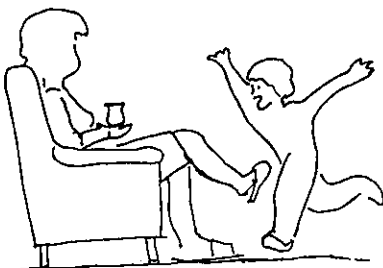


Figure 7.

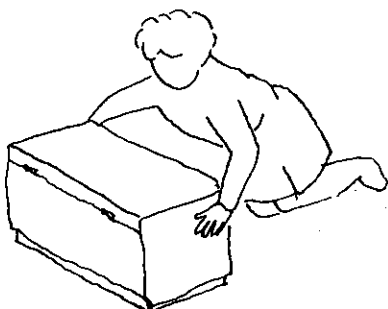


Figure 8.

Disability may bring quite different consequences to the usage of environment, and possible mismatch (Figure 4). Besides the inherent characteristics of people there are other causes of physical incapability such as, the incapability resulting from extraordinary physical conditions like illnesses or dizziness; incapacibilities which are usually consequences of excess, or long term efforts like tiredness or absentmindedness; and the incapability owing to drugs and alcohol etc.

2. Personal sensory behavioural factors

Personal sensory and behavioural factors are those which effect such accident causes as attitudes and behaviours of people which are the results of their psychological state, personality or age.

a. Carelessness, negligence:

Home is a place where things are used in the most relaxed manner. Most of the activities overlap with each other while unlimited variety of other factors are influencing the situation. There are various types of manner which can be called negligence or carelessness such as inadequate supervision of children, thoughtlessness, indifference or shortcuts etc. (Figure 5).

On the other hand, character of such manners show a great difference between different age groups. In this study, carelessness or negligence on the side of children is distinguished from that of the adults, since their carelessness to a great extent is what normally is expected from them.

b. Child behaviour:

Besides their different capabilities, children use their environment differently than the adults do. They run rather than walk and use the elements of their environment as play equipments (Figure 6). Toddlers have the largest number of home accidents of any age group. They are incapable of appreciating danger and are physically immature and yet at the same time are exploring their environment; they are thus regarded as being at greatest risk of accidents (Jackson, 1985).

Yet, neither children for their inquisitive behaviour, nor parents for not taking sufficient care can be directly blamed (Figure 7). Some of the accidents are considered to be fruitful since they are incurring a slight injury which may teach them what is dangerous. Every child learns that a stove is dangerous after an initial touch. However the outcome does not worth learning every time. It is the designer's responsibility to create a safe environment for children.

c. Poor judgement:

Poor judgement includes any failure both in perceiving the phenomena, and deciding what to do. With individuals of any age the influence of strain or absent-mindedness may disrupt rational thinking and decision making. For example decision of lifting a heavy object may end with an accident (Figure 8). Children are excluded from this definition, as their behaviour is considered discretely as indicated above.

d. Anxiety, excitement:

Forms of suffering stressful conditions owing to anxiety or excitement can also be categorised as behavioural and sensory factors on the part of adults. Long term stresses may be effective on the behaviour and physical capabilities of people. Also in this category can be included a sudden panic attack following a poor judgement.

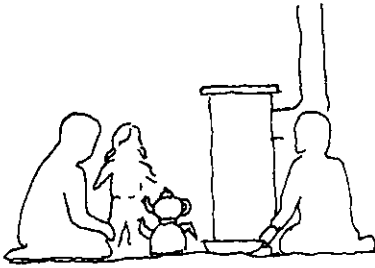


Figure 9.



Figure 10.

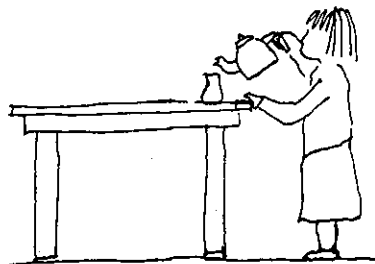


Figure 11.

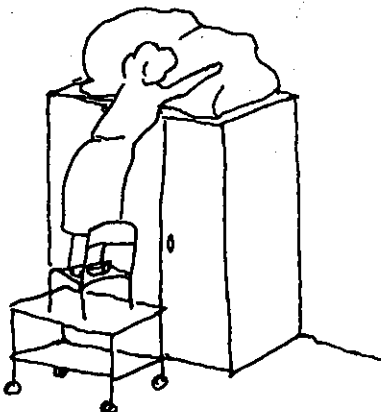


Figure 12.

3. Social and cultural factors

In addition to individual characteristics, groups of people who belong to different socio-economic status groups may also present varying characteristics. These in turn, create the following additional set of factors which affect accidents.

a. Life styles:

People with identical life styles have similar routine activities and similar manner of using the objects at home. For example, in rural areas of Turkey, people spend most of their time in a single room where they eat and sleep on the floor and use a stove for cooking as well as heating (Figure 9). Such a way of living effects the manner of using utensils and determines the form of accidents which may happen in their homes. Undoubtedly, people possessing life styles different than that of the designer's understanding cannot be blamed. Nevertheless, the mismatch of environment with the living style creates an accident and in turn, relevant information input for the design process of future similar items.

b. Lack of knowledge:

Lack of knowledge is one of the essential factors which influence accidents (Figure 10). It must be considered in the design process of products where functioning and handling require intensive learning at the beginning by the user. Written warnings and instructions do not make sense to illiterate people. The potential end user of the product may not have the common sense that the designer expects.

c. Acquired roles within age group: Acquired roles in children significantly differ within socio-economic status groups. In most of the rural areas for example, people burden their children with hard duties and consequently their incapability to do work may cause accidents (Figure 11).

4. Factors belonging to the manner and circumstances of use

Factors belonging to the manner and circumstances of use may be influenced from the overall interaction between the environment and its user. Misuse is an example for such a factor which in many cases is considered to be a design concern. According to the 'product liability laws' both in USA and UK, a designer can be regarded to be legally responsible from an accident or a product failure which is the consequence of a foreseeable misuse. Abuse, inexperienced use, assemblage, maintenance or repairing of products are other examples for such factors.

a. Misuse, abuse:

A 'misuse' is any usage of a product other than its functional recommended usage; (Figure 12) and an 'abuse' is any unrecommended usage behaviour which is harmful to the product (Hasdoğan, 1993). Misuse is usually a consequence of both environmental and personal factors. It may be intended and carried out frequently by everyone such as using chairs for reaching high surfaces instead of ladders. Also, it may be unintended because of the user's lack of knowledge or poor judgement. A full understanding of the range of ways in which the product is likely to be used is an important point in the design of any product. It is a widely accepted opinion that if specific patterns of misuse occur repeatedly it is legitimate to expect the design to reflect such demands (Warne, 1982).

b. Inexperienced use:

In some cases misuse may be a consequence of being unfamiliar to the phenomenon or to the product. Sometimes it may be combined with lack of knowledge or carelessness and ultimately cause an accident. Again it is the

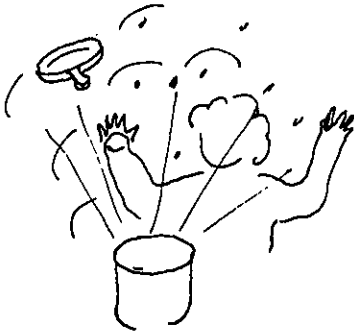


Figure 13.

designer's responsibility to consider his product's initial usage. For example most people in their initial usage, cannot guess the pressure cooker would pop up if opened before removing the expanded gas in it (Figure 13).

e. Assemblage, maintenance and repairing defects:

Defects may arise during the usage of a product after it is bought by the user. These defects may emerge from its assemblage, during its maintenance or repairing. Usually it is the assembler, maintenance person or the repairman who are then mainly liable, but the designer should also consider the way his product will be assembled, maintained or repaired.

FIELD WORK

A field study was carried out in order to find out the significance of product induced home accidents in Turkey. For this purpose 300 accident cases were received, each hundred being from three different socio-economic residential areas of Ankara. To achieve this, the total occupants of 186 dwellings were interviewed.

Three socio-economic levels were identified as those of low, middle and high income levels. The heating system of the house is usually dependent on the socio-economic level of the family. It is assumed to be a typical feature which influences their life style. The type of house is also another feature which represents the socio-economic status and effects the life style of the residents. These factors were therefore also considered in determining the regions of the study. The regions were:

- a. A squatter housing area in Akdere
- b. A series of flats in Öncebeci
- c. A modern residential quarter in Gaziosmanpaşa

Squatter housing areas are generally considered to be the transitional state between rural and urban life. They still reflect the characteristics of rural life styles, such as eating and sleeping on the floor, using a stove for heating and living in a single-room *etc.* The inhabitants are considered to belong to the lower socio-economic-status group.

The flats in Öncebeci are considered to belong to the middle socio-economic-status group. This residential area was chosen because the proportion of using a stove for heating was approximately equal to that of using a central heating system. Therefore the lifestyle patterns in this area had similar characteristics to both those of the lower and upper socio-economic status groups.

The third group at Gaziosmanpaşa are of high income families residing in private houses or flats, represent a modern style of living as they use contemporary household equipment, use a central heating system *etc.* They are considered to belong the upper socioeconomic-status group.

DATA ANALYSIS

Although accidents are absolute outputs from reality, to reach definite results in evaluating their causes is difficult, since they have quite complicated structures of causal interaction. For the validation of the results of accident causes, opinions of more than one expert were needed for the assessment. Experts were chosen from the staff of the Industrial Design Department of the Middle East Technical University.

Figure 14. Critical Cause Network for the lower socio-economic status group.

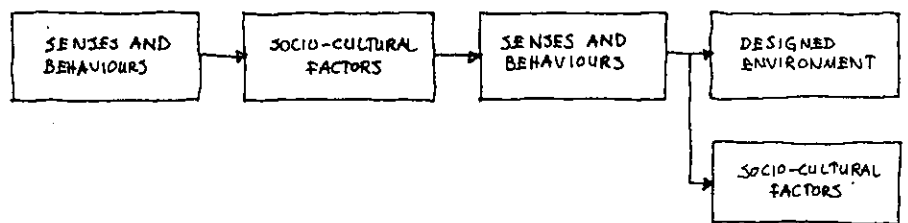
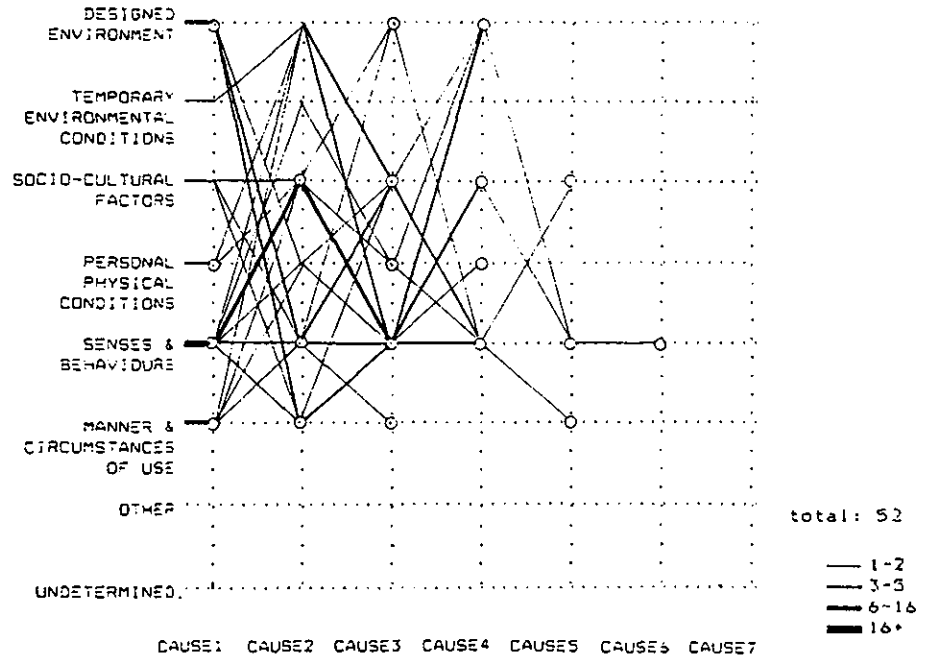


Figure 15. Critical Cause Path for the lower socio-economic status group.

In order to find out the most important chain of causes which create an accident the most frequent paths were searched within the cause network of expert opinions.

It was assumed that critical cause paths of certain type of accidents provided the most important clues in identifying the reasons for the diverse forms of mismatch between the people and environment. In order to find out the cause structure of accidents which occur in certain forms and conditions the significant relationships were looked for between the expert opinions and independent variables such as accident type, age and sex of the casualty, socio-economic level *etc.* By using log-linear analysis, the results indicated that every expert had a certain thought structure when evaluating the accident causes. Their opinions were mostly effected by the independent variables of accident type, age and socio-economic level of the casualty.

FINDINGS

After finding out the critical accident cause paths for socioeconomic-status groups, it was concluded that, in the upper socio-economic status group the most important cause origin of accidents other than the slight effect of designed environment were the factors of human senses and behaviours. However in the middle group, as people use rather cheap goods designed environment gains dominance as a cause origin of accidents. In the lower group, where people live in highly deprived conditions this affects their life-styles in almost all of the items and life-styles and senses and behaviours appear to be the most important causes of accidents (Figures 14, 15).

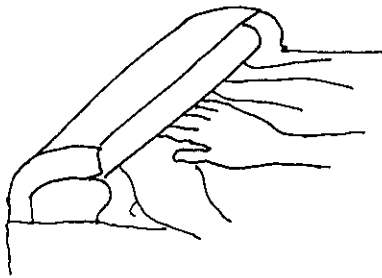


Figure 16.

Analysis of critical cause paths for the levels of age groups indicated that in child age groups and especially in the pre-kindergarten children, human senses and behaviour are the most important cause origin of accidents. In adults various causes effect accidents, especially temporary environmental conditions and manner and circumstances of use gain importance in comparison to other age groups. Physical incapability appears to be mostly effective in the accidents to elderly people.

Defective products:

A more detailed analysis was carried out for different types of accidents and typical (most frequently involved) objects. Several conclusions can be derived from the results:

Roller type washing machine:

In the accidents which resulted in getting caught by machines, washing machines with rollers were found to be defective in design (Figure 16). This type of washing machine is a typical hazardous product which is mainly used by the middle socio-economic status group. Since this type of product constitutes a lower price range in the Turkish market, upper socio-economic status group prefer to use automatic and spinning type washing machines whereas the lower socio-economic status group never own any type of washing machine. The high incidence of such accidents brings out the fact that roller type washing machines are inherently hazardous. Since safer systems of removing water from clothes do exist the production of roller type machines should be abandoned as already it has been in many countries. This type of washing machine was involved in 5.6 percent of the accidents reported.

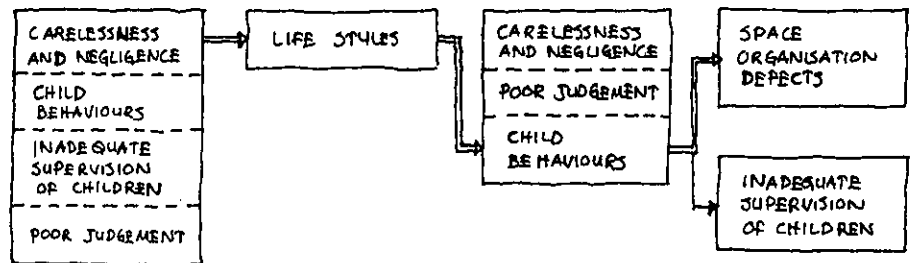


Figure 17. Detailed Cause Path for Turkish Teapot.

Turkish teapot and portable bottled gas:

In sealding accidents the most effective cause was carelessness, and inadequate supervision of children. The living style had been a significant factor and product design defects and space organisation defects effected these accidents to a slight degree (Figure 17).

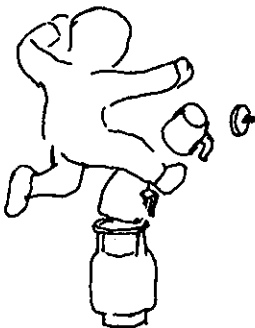


Figure 18.

The scenario for the majority of these accidents was the same (Figure 18). In a squatter type house (which belongs to the lower socio-economic status group) the mother makes tea with a Turkish type teapot on a portable bottled gas unit. However, while the child is playing around he knocks the teapot and tips it over. The combination of Turkish teapot and portable bottled gas unit causes the accident. These features occupy a place in the main room all day long by being occasionally supervised by the mother. Turkish tea requires a long process to be made, is drunk continuously at any time of the day, and bring warmth and a soft humidity to the room. It is therefore an integral part of the environment and culture and is an unchangeable element of life in those houses. The main room is the most commonly used room by everybody in the house obviously by being the most favourite play-room for the children.



Figure 19.

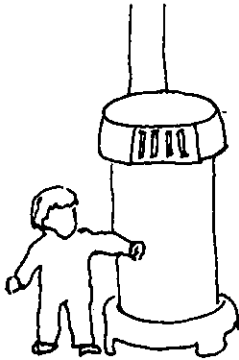


Figure 20.

In most of the cases the teapot and the bottled gas unit can be regarded as being defective in design, since their frequent combined use was never considered as a design problem. The teapot is already dangerous by its nature since it contains two hot containers on top of each other and in most of the cases having a slim and unstable form with a narrow base (Figure 19). When it is placed on another hot and unstable container, such as the bottled gas unit one should not be surprised to have a high incidence of accidents. The Turkish teapot was the most frequently accident causing object. It was involved in 11.6 percent of all accidents reported. Portable bottled gas units were involved in 4.3 percent of all reported accidents.

Stove:

In the accidents which resulted in burning from touching a stove; space organisation defects had an important dominance, and child behaviour appeared to be a secondary factor. In the houses which do not have a central heating system, the stove is usually the central element of the house. There is usually only one stove in the house which is placed in the main room where nearly all the activities have to take place in the winter time including eating and sleeping. The stove being a central element for people to gather around, in order to get warmth, and its inherent danger which require it to be kept apart from the main activity areas create a conflict in the environment and cause it to be placed inappropriately in the house. As a result, the first factor of warming people is given highest priority in deciding how it will be positioned. Stove causes more accidents by having too much prominence in the room while successfully performing its warming function.

The victims of stove are usually children who learn that it is dangerous after their first experience of touching it (Figure 20). The result is usually a minor injury which is often ignored by the parents and probably the producers too. However sometimes the consequences are not that simple and it is worth considering the redesign of the product or the design of child-proof stove barriers. The stove was the second most frequent accident causing object in the home and was involved in 10.6 percent of all the accidents reported.

Medicine packages:

In the accidents which resulted in swallowing substances, hierarchical order of causes differed within expert opinions. According to most of the experts, product design defects of medicine packages were the initiating cause of accidents, however according to a contrary opinion child behaviour and inadequate supervision of children were the primary causes. Despite this contrary opinion, medicine packages which do not involve a childproof lock can be regarded as to be defective, since packages with childproof locks do exist with a low cost in the market. Medicine packages were involved in 3.3 percent of all reported accidents. It is interesting to note that typical victims of this type of accidents were two to four year old children (Figure 21).

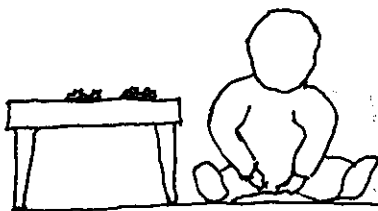


Figure 21.

Pressure cooker:

In the accidents which resulted in explosion of pressure cookers the primary causes of the accidents differed according to the expert opinions. Product design defects, and warning and instruction defects appeared to be important in some of the judgements. However dominance of maintenance defects was observable in another expert's opinions. It is important to note that inexperienced use and maintenance defects appeared to be dominant causes only in pressure cooker explosion accidents.

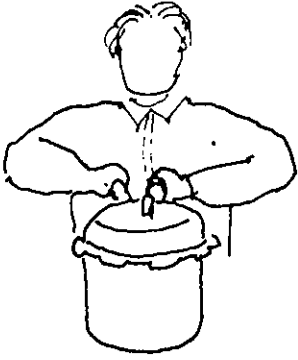


Figure 22.

In the majority of this type of accidents, the accident happened when the victim was using the product for the first time. The victim did not know that the pressure cooker should not be opened before the inside pressure was released. This is mostly because warnings about the usage of the product were written in an instruction booklet which was not read by the user, because it was already lost when a second user was using it for the first time. Also because by its design the pressure cooker allowed the user to open the lid when there was pressure inside it (Figure 22). All these factors would render such a design defective since the pressure cooker could have contained warnings and instructions on it and it might not have allowed its lid to be opened when there was pressure inside. Pressure cookers were involved in 6.6 percent of all the accidents reported.

CONCLUSION

The findings of this study reveal the fact in general that design defects of products contributed significantly in a considerable proportion of recorded accidents. This brings out the hypothesis that in some cases there is a serious mismatch between the designer's predictions of usage and actual usage.

The resulting data relating to accident scenarios highlight the most problematic areas of product design safety and the most critical problems of some target age and social users groups. If, as a further study, such typical scenarios are presented in the form of storyboards for each defective product, a useful source-book of guidelines can be published for product designers.

ENDÜSTRİ ÜRÜNLERİNİN NEDEN OLDUĞU EV KAZALARI: GÜVENLİ TASARIMLAR İÇİN BİR ARAŞTIRMA

ÖZET

Bu çalışma, Endüstri Ürünleri Tasarımında bir ürünün güvenli kullanımını sağlamaya yönelik, tasarımcıyı kullanıcının ürünle gerçek yaşamdaki ilişkisinden doğan kazalar ve bunların görünen ve tahmin edilen nedenleri konusunda aydınlatan bir rehber oluşturma amacını taşımaktadır. Bu nedenle, 1988 yılında yazarın Yüksek Lisans tezi çerçevesinde Türkiye'de kentsel ev yaşamında olagelen kazaların nedenlerini araştıran bir alan çalışması yapılmıştır. Sonuçlar tasarım hatalarının ev kazalarının oluşumunda önemli ölçüde rol oynadığını ortaya çıkardı. Örneğin, merdaneli çamaşır makinesi, çaydanlık, piknik tüpü, soba, ilaç kutuları ve düdüklü tencere gibi ürünlerin tasarım hatalarından da kaynaklanan nedenlerle kazalarda sıklıkla rol oynadıkları saptandı. Bu gibi sonuçlar bu ürünlerin üretici ve tasarımcılarının ürünlerinin kullanıcıyla olan ilişkisi konusundaki varsayımlarının gerçek yaşamdaki kullanımına uyuşmadığı hipotezini doğruladı. Bu gibi vakalarda özellikle ev ortamında ürünle ilişkide bulunan kişilerin yaş faktörü ve sosyal konumlarından kaynaklanan yaşam stili farklılıklarının gözde alınmadığı ortaya çıkarıldı.

Alan çalışmasının sonucunda elde edilen veriler kaza senaryoları biçiminde olup, güvenlik faktörü göz önünde tutulduğunda ürün tasarımının en problemli alanlarını ve hedef tüketicinin en kritik yaş ve sosyal statü gruplarını belirlemektedir.

Alındı : 1.11.1993.
Anahtar Sözcükler : Endüstri Ürünleri Tasarımı, Tüketicinin Korunması, Ev Kazaları, Ürün Güvenliği.

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