Developing a Model for Consumer Product Safety Evaluation

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"Acquire new knowledge whilst thinking over the old, and you may become a teacher of others"

Confucius (551-479BC)[1]

[1] Giles, Lionel, Sayings of Confucius: A New Translation of the Greater Part of the Confucian Analects (1993)

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Safety enforcement practitioners within Europe and marketers, designers or manufacturers of consumer products need to determine compliance with the legal test of "reasonable safety" for consumer goods, to reduce the "risks" of injury to the minimum. To enable freedom of movement of products, a method for safety appraisal is required for use as an "expert" system of hazard analysis by non-experts in safety testing of consumer goods for implementation consistently throughout Europe. Safety testing approaches and the concepts of risk assessment and hazard analysis are reviewed in developing a model for appraising consumer product safety which seeks to integrate the human factors contribution of risk assessment, hazard perception, and information processing. The model develops a system of hazard identification, hazard analysis and risk assessment which can be applied to a wide range of consumer products through use of a series of systematic checklists and matrices and applies alternative numerical and graphical methods for calculating a final product safety risk assessment score. It is then applied in its pilot form by selected "volunteer" Trading Standards Departments to a sample of consumer products. A series of questionnaires is used to select participating Trading Standards Departments, to explore the contribution of potential subjective influences, to establish views regarding the usability and reliability of the model and any preferences for the risk assessment scoring system used. The outcome of the two stage hazard analysis and risk assessment process is considered to determine consistency in results of hazard analysis, final decisions regarding the safety of the sample product and to determine any correlation in the decisions made using the model and alternative scoring methods of risk assessment. The research also identifies a number of opportunities for future work, and indicates a number of areas where further work has already begun.

Consumer

Safety

Appraisal

Hazard

Risk

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Chapter 1 : Consumer Product Safety - How Safe?

1.1 Safety expectations

The safety of consumer products is an emotive topic. Should consumers expect that all products are totally safe? Indeed, is the concept of "total safety" realistically achievable? What price would they be prepared to pay for safety?

Many familiar household products such as the sharp kitchen knife can become lethal if they are used improperly, or by children unsupervised. Recent legislation to control use of knives which might be used as weapons wrestled with this conundrum in defining the scope of the legislation. From the author's experience, certain magistrates have ruled that supermarket shopping trolleys should be "childproof", a concept which was never envisaged through consumer safety legislation. Potentially dangerous products such as glass-topped tables have been misinterpreted by consumers as affording the same strength and durability as wooden tables, and subsequent misuse has resulted in injury and death.

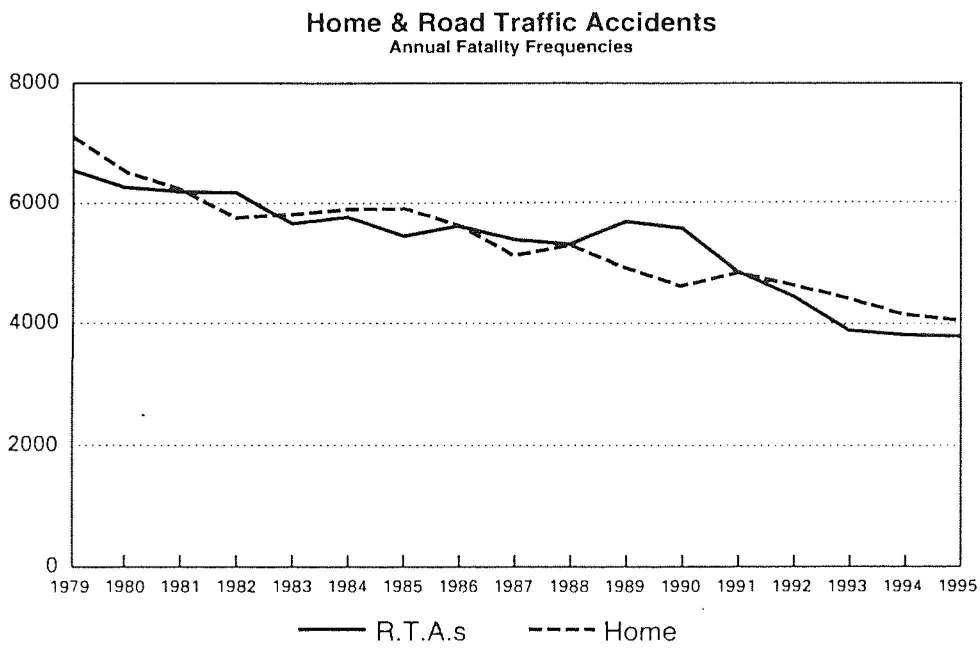
The media play an important role in influencing public expectation of safety, and media exposure can have major impact on the reputation of major producers of products which are seen to cause death or injury. Although consumer experience is that most products are safe for most of the time, product safety scares are newsworthy, and national product recalls may introduce bias in safety perceptions.

Combs and Slovic (1979) and Slovic, Fischhoff and Lichtenstein (1980) reported that catastrophic causes of death had greater media coverage than more frequent causes of death. This was to be positively correlated with people's perceptions about the probability of death through "unnatural" causes. The correlation may equally be due to the media reflecting public perception as well as influencing their perception.

Public perceptions and expectations about the safety of consumer products are closely associated with certain biases based on past experience in using such products, and the whole range of subjective factors to be discussed in Chapter 4. Safety may also be seen as a body counting exercise, where legal measures are introduced only when accident statistics reach a given bench mark.

Since the introduction of the Home Accident Surveillance System (HASS) in 1976, fatalities resulting from home accidents have reduced from almost 6000 per year to 4055 in 1995. This downward trend in home accident fatalities is represented graphically, together with road traffic fatalities, which are of the same order in Graph 1.0.

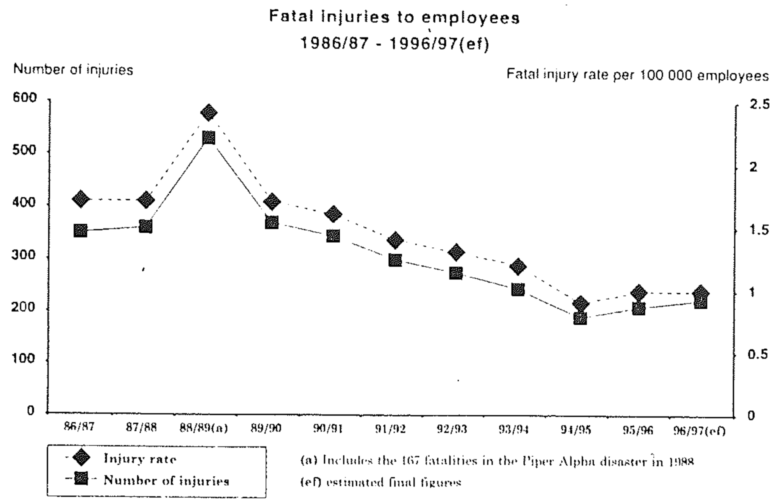
Graph 1.0 : Home and road accident fatalities



Source: Home and Leisure Accident Research
19th Annual Report 1995 data : January 1997

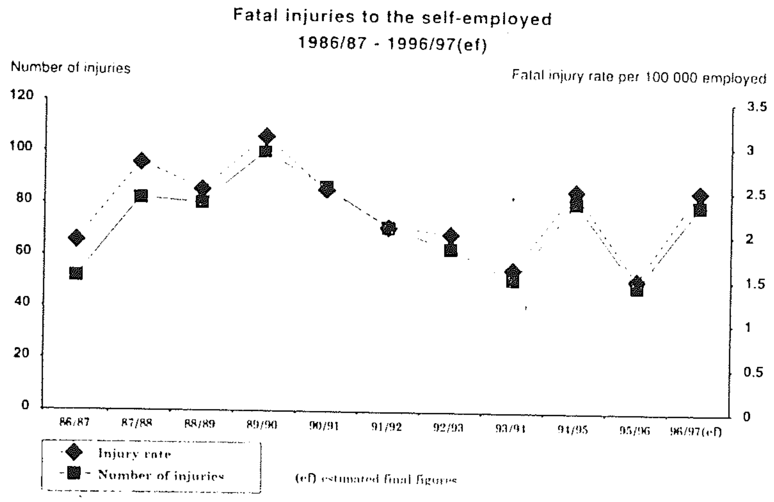
The trends in occupational fatalities to employees reported by the Health and Safety Executive (1997) also show a general downward trend in fatalities reported, since requirements were established to record serious occupational injuries and fatalities in 1995, as illustrated in Graphs 2A and 2B. The final number of fatal injuries to workers in 1996/97 was 302 (219 employees and 83 self -employed).

Graph 2A : Fatal Injuries to Employees



Source Safety Statistics Bulletin 1996/97 Prepared by the Governmental Statistics Service : Health & Safety Executive July 1997

Graph 2B : Fatal Injuries to the Self -Employed



Source Safety Statistics Bulletin 1996/97 Prepared by the Governmental Statistics Service : Health & Safety Executive July 1997

Table 1 shows the causes of death in the population of England and Wales in 1986, as derived from Office of National Statistics survey data (1998) from the General Household Survey for England and Wales. As the table shows, the majority of deaths in the UK are due to natural causes, and accidental deaths due to external causes of injury and poisoning represent a mere 2.88% of the total.

Table 1 : Causes of death of Population of England and Wales 1996

Cause of death	Number	%
Disease of circulating system	237669	42.63
Malignant neoplasms (cancers)	137459	24.66
Diseases of respiratory system	88630	15.90
Diseases of digestive system	19946	3.58
External causes of injury & poisoning	16061	2.88
Signs, symptoms and ill-defined conditions	10772	1.93
Disease of nervous system	9772	1.75
Mental disorders	9296	1.67
Endocrine, nutritional, metabolic, immunity	7502	1.35
Diseases of genito-urinary system	6752	1.21
Infectious and parasitic diseases	3636	0.65
Diseases of musculoskeletal system	3517	0.63
Congenital abnormalities	1227	0.22
Diseases of the skin and subcutaneous tissue	1075	0.19
Conditions of perinatal period	149	0.03
Complications of pregnancy and birth	41	0.01
	553504	100.00

Source: Office for National Statistics (1998)
Mortality Statistics Cause, England and Wales, Series DH2 no 23 London TSO

Table 2 shows statistics for medically treated home and leisure accidents from 1987 to 1995 where accident data are taken from the HASS (Home Accident Surveillance System) and LASS (Leisure Accident Surveillance System).

Home accidents account for almost 40% of all fatal accidents and a more than a third of medically treated accidents. One fifth of the 14 million people treated in Accident and Emergency Units in the UK are treated for home accidents.

Table 2 : Statistics for all medically treated Home and Leisure Accidents from 1985 to 1996

Accidents	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th
Home	- 34%	- 32%	3.2m 34%	3.1m 33%	3.3m 32%	3.3m 35%	- 38%	- 34%	- 34%	2.7m 37%	2.7m 33%
Work	- 19%	- 20%	2.2m 23%	2.0m 21%	2.0m 21%	2.0m 21%	- 20%	- 23%	- 23%	1.5m 21%	2.1m 26%
Other	- 25%	- 18%	3.6m 38%	2.0m 21%	1.6m 22%	1.8m 19%	- 18%	- 19%	- 20%	1.5m 20%	1.6m 19%
Sport	- 11%	- 15%	-	1.6m 17%	1.2m 16%	1.6m 17%	- 18%	- 13%	- 14%	0.3m 12%	0.9m 11%
Road	- 5%	- 5%	0.6m 6%	0.7m 7%	0.6m 8%	0.7m 7%	- 6%	- 9%	- 9%	0.7m 9%	0.9m 11%
School	6%	11%	-	-	-	-	-	-		-	-

Source: Home and Leisure Accident Research, 10th-20th Annual Reports 1986-1996

In setting these UK home and leisure accident rates in context of European statistics of more than 75,000 deaths, where 40 million consumers received hospital attention for injuries due to home or leisure accidents each year in the twelve EC Member States, Parliamentary Under Secretary Edward Leigh (1992) of the Department of Trade & Industry commented that they are among the lowest in the world.

In commenting on the range of household products associated with injury, Parliamentary Under Secretary John Taylor (1995) of the Department of Trade & Industry remarked that there were always products associated in the public mind with injury and fatality as cutting tools, medicines and combustion waste products. However, there were also a number of individual household articles not usually perceived to be hazardous which have the potential to injure. Taken together, these "less hazardous" household items account for a large proportion of the injuries receiving hospital treatment.

By direct comparison, the accident data shown in Table 2 demonstrate that significantly more accidents occur at home than at work, which would appear to support Kay's (1971) contention that the public perception that the workplace is intrinsically more dangerous than the home is erroneous.

However, any comparison of the relative danger of the home and workplace at this level fails to consider the more complex issues of ongoing exposure levels and accident rates inherent in the workplace, and the fact that such exposure may be intrinsic to the nature of work.

Feldman (1980) cites the views of a past Chairman of the National Committee on Product Safety in America which provide an idiosyncratic summary of public perception:-

> "Problems of safety do not have great public appeal. One condones with product safety problems and is concerned with them at the moment, but after the heat of discussion is over, and the smoke has cleared away, everyone feels protected psychologically by their concept that it will happen to someone else, and not to them and that risk taking is part of everyday life"
>
> A. Elkind

In relation to the consumer's risk assessment of consumer products, Elkind argues that "familiarity breeds contempt". This concept of familiarity and how it affects consumer perception is to be explored further in Chapter 4.

Chapter 2 describes the various legal measures and published standards for the safety of consumer products, which provide a wealth of information for manufacturers, suppliers, and enforcement agencies to consider in reaching a decision on whether a product meets legal safety requirements. This process may be informal, or formal, as part of a design brief for designers, manufacturers, retailers or their agents, or typically involving a testing regime during product development and launch, and subsequently by enforcement authorities or their agents.

Inevitably, this regime can be expected to include one or more of the elements of an appraisal of the product and any instructions and warnings provided with it: an observation of the product in use: analysis of reported data concerning how customers have used/misused the product; and a test of the product in use, or simulated use.

Thus, there is a need for developing a framework for safety testing of consumer products in context of the legal requirements set out in Chapter 2. Such a model would be of interest to all parties in the chain of supply, as well as to enforcement authorities. In practice these parties will often commission "expert" test houses to conduct such a safety appraisal, and it is specifically in context of developing an "expert" safety appraisal and testing approach that this research is concerned.

Failure to meet their legal responsibilities can result in prosecution of parties in the supply chain and a fine of up to £5000 per offence and/or imprisonment, as well as civil action for unlimited financial damages. Suppliers of unsafe products can further expect media exposure, posing a serious threat to the image of the "unsafe" product, their own corporate identity and probably other products supplied.

Thus, a retailer may find sales of unrelated products fall, and manufacturers may find other products - even dissimilar products - are no longer seen as attractive by prospective customers. There may also be a need for a costly product recall, with potentially devastating financial penalty. In summary then, there are also sound commercial reasons for suppliers of product to submit their products for safety testing.

1.2 Provision of information

In setting the scene, it is important to identify the role of consumer protection legislation, not only as a means of setting standards and regulating suppliers, but also as a means of putting buyers (the consumer) and sellers (the manufacturers, importers, distributors and retailers) on a more equal footing. Buyers are considered to have limited product knowledge based on their expectations of use with similar products, and from the product features highlighted in marketing. The law expects retailers and distributors to have greater product knowledge based on their expertise gained through previous sales of these products. Full product knowledge is considered to be possessed by the manufacturer or importer who has designed the product or set specifications for it.

In general terms, current consumer protection legislation which is described in more detail in Chapter 2, emphasises the provision of information to the buyer about the product, its quality, its description and fitness for purpose, its price and its safety to enable an "informed" decision to be made before purchase. In addition, safety legislation sets out standards of safety which must be met. In the last 10 years there has been a move away from prescriptive consumer protection legislation setting out detailed minimum standards to be met for specific consumer products, towards placing general rather than specific responsibilities relating to all types of consumer goods on their suppliers. This has placed a general and more sweeping burden on the seller, but has also placed greater emphasis on the buyer to have regard to the information supplied.

The provision of information, then, is a central concept to enable the customer to select the right product for its intended purpose. How this information is provided is subject to scrutiny by enforcement agencies, and is also a central feature of a safety evaluation of the product to determine compliance with the law.

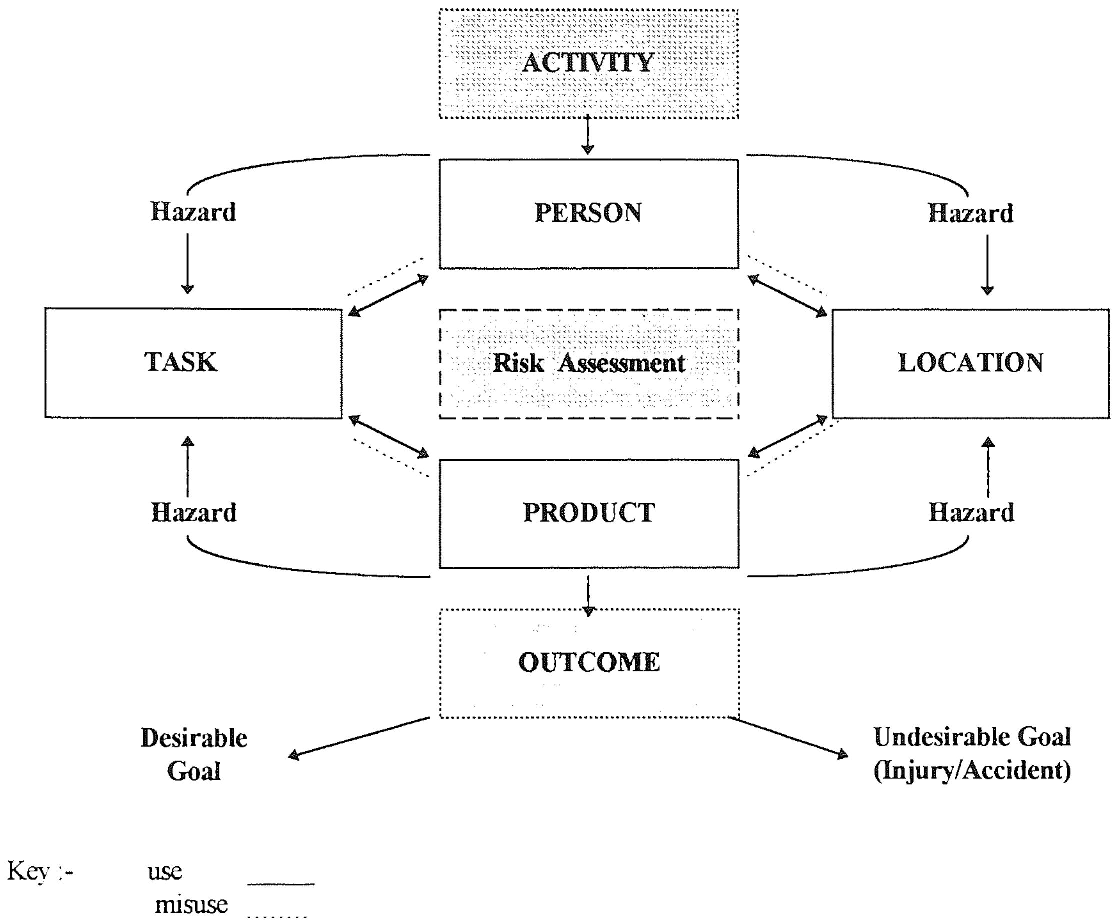
1.3 Definitions

For the purposes of this study it is important to set out certain working definitions of the terminology in use. A systems approach can be used as a model of activities which occur when a consumer product is used, including four interacting components within the system: the user; the product; the task or activity; and the context or location where the activity takes place.

There are hazards associated with each system component and their interaction which may give rise to desirable or undesirable outcomes, contingent on the way in which information about hazards is processed, through risk assessment. The outcome of the activity can result in an accident or injury in certain circumstances.

Figure 1 illustrates how these components interact. It is precisely these circumstances, and the complex interaction of system components that a product safety appraisal endeavours to predict.

Figure 1 : A systems model of interacting components



To understand the elements of the system the following definitions are proposed, drawn from the literature and based on the legal requirements set out later. The definitions have been developed from Hale and Glendon (1987) who use a systems framework to describe how users perform tasks based upon a combination of knowledge, skill and rule based behaviours to avoid danger, based upon their perceptions of the environment.

Product - An object intended for private use or consumption with which the user interacts. Products may be familiar everyday objects, or unfamiliar products of varying degrees of complexity.

Use - The interaction between a person and a product, including keeping, consuming, assembling it in ways intended by the manufacturer or designer and in ways which might be reasonably foreseeable.

Misuse - The product/ person interaction including keeping, consuming and assembling it in ways which were not intended by its manufacturer, in ways for which the product was not designed, and which might not be reasonably foreseeable.
Note: The test of foreseeability in user/misuser definitions refers to whether the use/misuse was reasonably foreseeable, and is relevant to the activity rather than the person.

User - the person or persons who use, or who are intended to use the product. Persons may be male, female, young or old, with differing levels of previous experience and skills of interacting with products.

Misuser - The person or persons who use the product in a way which was not intended by the manufacturer or for which the product was not designed.

Location - The context in which the product is used by the user. Early Home and Leisure Accident Research cited 16 location categories, however, since 1994, HASS reports analyse accident data based on the following 24 locations in the home:

- Kitchen
- Bathroom/toilet
- Living/dining areas
- Bedroom
- Stairs inside
- Hall/lobby
- Landing
- Loft/attic
- Cellars/basements
- Storeroom /cupboard
- Balcony
- Porch /threshold
- Conservatory
- Other indoors/home
- Unspecified indoors (home)
- Unspecified (home in/outdoors)
- Garden/grassed areas
- Yards/driveway/path
- Stairs/steps - outdoor
- Garage
- Greenhouse
- Shed etc.
- Other outdoors (home)

Task - the operation or activity carried out by the user in interacting with a product. This may be a simple operation as a combination of sub-tasks, and is a goal directed activity.

Goal - The completion of the activity or task. This goal may be desirable or undesirable. Drury & Brill (1983) suggest that the product involved may be peripheral to the goal, where the goal is undesirable. An example would be beating a window with the fist in rage causing the window to break and personal injury. In this instance, clearly the window is incidental in venting anger. However, the fact that a window was beaten, rather that the window frame, is material to the injury outcome.

Foreseeable - What the reasonable person would expect to be the outcome of the activity, given access to the current state of knowledge at the time of making the decision.

Unsafe - Where risks of death or personal injury or damage to property in using a product have not been reduced to a minimum.

Risk - The potential for injury to a person or property. This potential culminates from the combination of interacting components within the system and the associated hazards. As such it is intangible. The concept of risk is an area which has been the subject of extensive research, and there are many definitions attempting to describe the process of risk assessment in consumer and occupational safety. This research is reviewed in Chapter 3, and the related concepts of danger, hazard and harm are also explored in further detail.

Hazard - A specified agent which in defined circumstances would cause injury to a person or property. In contrast with "risk", a hazard is tangible.

Hazard Pattern - A scenario involving the interaction of a user a product and a task in a given set of circumstances (the environment) which has been shown to result in harm. Drury & Brill (1983) have used this concept to classify accidents.

Accident - The process or occurrence of unintended harm where exposure to the hazard results immediately in harm. The definition includes unintentional injury or suspected injury but excludes deliberately self-inflicted injuries, and excludes injuries resulting from physical attacks by other persons.

Injury - The outcome of an interaction between the user and a product where exposure to a hazard results in immediate or delayed unintended harm. Early Home and Leisure Accident Research cited 18 injury types for classifying injuries in addition to undiagnosed injury and other injury.

- Cuts/ lacerations
- Puncture wounds
- Splinters including foreign bodies under the skin
- Abrasions/ grazes
- Other external open wounds e.g. amputation, accidental loss of limbs, bleeding in absence of cut/puncture
- Dislocation
- Fracture
- Sprain/ strain
- Bruise/ contusion
- Tenderness/ swelling
- Burns caused by exposure to flame/ hot object
- Scald caused by exposure to hot liquid/ vapour
- Poisoning/ suspected poisoning through swallowing or inhalation
- Foreign body in orifice/ eye/ throat
- Ingestion of substance (not potentially poisonous) which doesn't obstruct breathing e.g. marble
- Suffocation including smoke inhalation
- Concussion/ head injuries where no wound or fracture
- Other internal injury

Source: Home and Leisure Accident Research : 16th Annual Report 1992 data : May 1994

Following a change in the content and presentation of data, with the introduction during 1992-3 of computerised entry of accident information, the number of injury categories has been reduced to 12 generic categories in reports published from 1994.

- Superficial injury
- Open wound
- Burn
- Bruise/ contusion
- Concussion
- Other soft tissue injury
- Bone injury
- Joint/tendon injury
- Chemical injury
- Systemic injury
- Non-injurious foreign body
- No diagnosed injury
- Unspecified injury

Source: Home and Leisure Accident Research : 19th Annual Report 1995 data : Jan 1997

Harm - Damage or injury to a person or to property preventing its function and requires repair, rehabilitation or treatment.

Danger - A situation which has foreseeable potential for unintended harm to persons or property.

Hale and Glendon (1987) argue that the way the user perceives and processes information is critical for avoidance of danger. In simple terms, users process the available information, and base their perception of the situation and their previous experience of similar tasks to make a risk decision in order to be able to complete the task safely, avoiding injury to themselves or their property. If their mental model of how to use the product is ill-founded, or they have made a poor risk assessment, users may not anticipate or avoid potential danger, which may result in injury to themselves or their property.

1.4 How information is provided

Fundamental to decision making, then, is processing of available information. Product information is typically provided by the external packaging of a consumer product on display in retail outlets, and its associated marketing information such as displays at the point of sale, adverts, and instructional videos or leaflets supplied with the goods. These visual characteristics, or the "get up" of the product are largely a function of packaging design and marketing influence. Thus, consumers are advised of features which the marketeer feels they "need to know" to set their product at an advantage over a competitor's product, and to stimulate or satisfy a need in consumers to buy.

The product itself can also provide valuable information by its physical appearance when it is displayed without external packaging, when it is unpacked, or before use. This visual information provides certain "clues" to the product's intended use which may be based on the user's previous experience with similar products. Norman (1988) describes this experience as a combination of "knowledge in the head" or memory, and "knowledge in the world". Clues are provided by the natural constraints evident in the product, i.e. the order in which parts can go together, the way it can be moved, picked up or otherwise manipulated, and cultural constraints, i.e. those artificial conventions which govern acceptable behaviour and which are learned. However, the previously mentioned instances of injuries associated with glass topped coffee tables resulting from children standing on them, demonstrate how clues can be misread by naive users.

As will be discussed in Chapter 4, these "clues" are given by the product's "affordances", or the perceived and actual properties which determine how it could possibly be used. This relies upon the product's "visibility", or the clues provided perhaps by its controls, which offer alternatives for action, showing what can be done and how the actions can be performed. The "mapping" of these controls and their movements are also important so that user can determine the relationship between actions and results. These factors combine to give the user a good conceptual model, or mental simulation of the operation of the object in use. The product must also provide feedback to the user, preferably immediately and obviously, of what action has been done and what result has been accomplished.

Norman (1988) concludes that these physical and mental characteristics associated with the product, and product usage, have been shown to be largely a function of design. Where the design process has addressed the relationship of users and products, these factors will have been addressed to maximise the natural "clues" provided to the user and to increase the visibility of those necessary to ensure the product is used as intended. That children might stand on glass topped tables is arguably foreseeable by prudent designers, necessitating use of toughened or plate glass - or sufficient supports to improve surface strength.

In theory, the information provided with the product, such as product labelling, instructions for use, assembly and operating manuals, and warnings to prevent misuse is an important factor in risk assessment, and is considered to be of great importance within the statutory framework governing consumer product safety. There has been an abundance of research within occupational safety and consumer safety concerning the presentation of instructions and warnings, and how this may or may not influence the way in which users interact with the product in use.

Regardless of whether appropriate warnings and safety instructions deter unsafe behaviour and increase the likelihood that a product is used as intended, as discussed in Chapter 2, there is clearly a strong expectation through the courts that such information is provided.

1.5 Safety Test

Ideally, consumer product safety appraisal will assess all of the interacting components in the system, and include an appraisal of the product, its packaging, and any safety risks in use. Inevitably, testing will often depend on simulations of how the product may be used, based on a subjective or "expert" assessment of the user, the environment within which the product is expected to be used, and the way in which it is expected to be used. It is not always commercially feasible to undergo extensive user trials of consumer products, and care must be taken not to expose testing personnel to safety risks.

However, as will be discussed in Chapter 3, there has been increasing interest in usability studies. In the instances of drugs, household chemicals and cosmetics products, there has often been the need to rely on animal testing in product development. However, in the latter two instances, legislative pressures are moving away from animal testing in preference to the use of theoretical models.

It is important to use every effort to apply realistic simulations of usage and user behaviour in the product appraisal. Historical accident data is useful in devising a suitable test schedule, addressing known risks in the interacting system components of user, product, task and location. As we shall see later, objectivity is introduced through reference to published standards which may specify anthropometric data and appropriate testing conditions as the basis of a "General Safety Test".

Dirken (1990) argues that as consumer durables diversify, multiply and become more complex in modern society, the need for "user friendliness", i.e. maximising the clues to the intended use of the product, particularly for naive users becomes paramount.

The 16th Annual Report of the Home Accident Surveillance System (HASS) published by the Consumer Safety Unit (1992) commented:

> " There is little doubt that over the years since HASS first began collecting data, consumer products have increased in both numbers and complexity. More products, especially those aimed at the gardening and DIY market and for use in the kitchen, are powered and so the potential to inflict injury is undoubtedly increased. ...However, to address many of the hazards associated with these new machines, the scope and range of British Standards have also broadened in the last 15 years.... p 14 - 15
>
> However, the development of new products and their constantly changing range and variety do require a concomitant effort to identify the seriousness of new hazards to their users..." p 17

Dirken advocates that manufacturers and designers should consider ergonomics quality in terms of ease of understanding, learning and handling, and that ergonomics can contribute to the development of relevant methods and standards. Ergonomists working in product testing laboratories play an important role as specialists in the assessment of user product interaction. This may also lead to the methodology for assessing comfort, efficiency and safety developing and progressing to the point of assessing product usefulness.

In deriving a consumer product safety appraisal, the relevant legal requirements must also be addressed. The legal definition of "reasonable safety" from the Consumer Protection Act 1987 sets out various circumstances which are relevant in determining whether safety risks have been reduced to the minimum. These include:-

- the purpose for which the product is marketed and its manner of marketing
- instructions and warnings
- published safety standards
- existence of reasonable means to make a product safer

The 1994 General Product Safety Regulations, which implement Council Directive 92/59/EEC on general product safety, impose a slightly different definition of "safe" product.

The regulations are more specific about the relevant particulars to be taken into consideration, including:

◊ the characteristics of the product including its composition, packaging, instructions for assembly and maintenance
◊ the effect on other products, where it is reasonably foreseeable that it will be used with other products
◊ the presentation of the product, the labelling, any instructions for its use and disposal and any other indication or information provided by the producer
◊ the categories of consumers at serious risk when using the product, in particular children

The availability of other products which present a lesser degree of risk does not automatically mean that the product is unsafe, as regard must also be given to the safety which consumers may reasonably expect, and legal rules for health and safety requirements, or in their absence:

◊ voluntary UK standards
◊ community technical specifications or UK standards
◊ codes of good practice on health and safety for that product sector
◊ state of the art technology

1.6 Importance of historical accident data

Published accident statistics are a useful source of data to identify consumer products and the typical uses which have been shown to be involved in accidents. These data can then be used as a basis for risk assessment to pinpoint high risk users, tasks, locations and products, within the system framework introduced earlier.

Insurance is used domestically and commercially to underwrite potential risks and risk managers carry out an expert analysis of all operations, past incidents and claims history to arrive at a careful balance between controlling, reducing or eliminating losses and methods of risk transfer through insurance. Insurance companies also rely heavily on previous product safety insurance claims as an indication of the level of premium, and therefore the risk, to be covered. The basic premise behind these approaches is that historical accident data can be used as a fairly reliable predictor of future behaviour, and as a starting point for preventive action.

1.7 Home Accident Surveillance System (HASS) & Leisure Accident Surveillance System (LASS)

UK accident statistics related to consumer products are collated and published annually by the Consumer Safety Unit (CSU) of the Department of Trade and Industry (DTI) for home accidents (Home Accident Surveillance System - HASS) and for leisure accidents (Leisure Accident Surveillance System - LASS). Historically, these accident data have been analysed and published retrospectively 3 years later, i.e. 1989 data are published in 1992. With the advent of computerisation, the delay in publishing accident data has reduced, realising the benefits of instant error correction and rapid transmission of records to database since 1994, such that 1995 data are published in 1997.

UK home accident statistics are currently generated through casualty statistics from a sample of 18 hospitals. Although all of these hospitals also monitor leisure accidents, the annual report of UK data to the European Home and Leisure Surveillance System (EHLASS) is taken from 11 hospitals, to reflect proportional population sizes. EHLASS reports are also based on a different classification system common to all E.U. countries to permit inter-country comparison.

Hospitals are selected based on the operation of a 24-hour casualty service treating at least 10,000 cases per year, taking ambulance cases. National statistics are extrapolated from reported injuries, but various adjustments are made to provide a meaningful national estimate. Annual variations are more likely to demonstrate the imprecision of this technique, than actual accident fluctuations. However, the recent introduction of information technology following an overhaul of HASS from 1990 to 1993, means that published reports are more up to date and more details about products and their involvement in the accident are included in descriptive free text.

Home Accident interviewers working with reception staff in Accident and Emergency in the participating hospitals record detailed accounts of accident information from patients in casualty and transmit it to the central HASS database. Road Traffic Accident details are now also recorded on behalf of the Transport and Road Transport Laboratory of the Department of Transport.

Table 3 shows the general categories of home accident by mechanism of activity, their incidence reported by UK participating hospitals, and the national extrapolated estimates from 1995 data.

Table 3 : UK Home Accident Data 1995 - Mechanism of Activity

Source: Home and Leisure Accident Research : 19th Annual Report 1995 data : Jan 1997

The quality of reported data is dependent upon the time available and expertise of casualty staff completing the questions, and the level of co-operation of the injured and their families. Additional part-time HASS clerks specially trained in the work of interviewing and coding are funded by the Department of Trade and Industry to cover busy periods such as evenings and weekends. The level of reporting has been shown to be at its lowest when only nursing staff are on duty, improves when a receptionist is present, and is at its highest when the home accident clerk is present.

By restricting the number of hospitals participating to 18, the means and quality of data collection has been standardised, but inevitably these data are susceptible to human bias. This reflects a willingness or reluctance to attribute blame, distorted perceptions of what occurred, and incorrect diagnosis of the cause of the accident.

1.8 The European Home and Leisure Surveillance System (EHLASS)

The European Home and Leisure Surveillance System (EHLASS) is aimed at creating a HASS style database of accidents requiring medical treatment to cover the whole of the European Community, and effectively runs alongside HASS and LASS. Since 1987, data from Scotland and N. Ireland has been added to the reported England and Wales HASS and LASS data to give full UK coverage. Data for EHLASS combines and re-codes HASS and LASS data from 11 of the 18 UK hospitals, to follow a common sense system of classification for all EC countries so that inter-community comparisons can be made.

Council Directive 93/683/EEC requires that basic data must include information on :

- ◊ the place where an accident occurred
- ◊ the date of the accident
- ◊ the place of treatment
- ◊ the activity of the victim at the time of the accident
- ◊ the type of accident
- ◊ the type of product involved in the accident
- ◊ the age of the victim
- ◊ the sex of the victim
- ◊ the type of injury
- ◊ the parts of the body injured
- ◊ the treatment of the injury
- ◊ hospitalisation
- ◊ brief description of the accident, its causes, and where possible the main features and identifying details of the product involved

All Member States participate in EHLASS and may opt to collect accident data either via hospital surveys, or through household surveys. The latter method generally offers lower quality and less detailed information at a lower cost. For administrative and technical reasons Germany has always used household surveys. Spain and Luxembourg converted from household surveys to hospital surveys in 1993. The three newest Member States, Austria, Finland and Sweden have all opted for hospital surveys.

Community funding for hospitals towards 80% of the cost of data collection was extended until the end of 1997. Subject to continuing funding, it is proposed to extend EHLASS from 1998 to 2001, introducing World Health Organisation (WHO) world standardised injury classifications. The UK has the most hospitals participating in data collection with 11 of the 18 of the hospitals participating in HASS also contributing to EHLASS. France is the next major contributor where 8 hospitals contribute, Italy and Netherlands have 7 contributing hospitals, Portugal has 6, Denmark has 5, Greece and Belgium have 4 and Ireland has 2 participating hospitals.

1.9 Home Accident Deaths Database (HADD) and Leisure Accident Deaths Database (LADD)

Home Accident Deaths Database (HADD) and Leisure Accident Deaths Database (LADD) are also prepared using statistics from Office of Population Censuses and Surveys (OPCS) and the General Register Office (Scotland) and (N. Ireland) and published by the Consumer Safety Unit as part of Home and Leisure Accident Research.

1.10 Human Factors

Many reported accident statistics in product safety seem to attribute human behaviour as the key factor in more than 80% of accidents (Ferry 1978, Heinrich, Peterson and Roos 1980). Feldman (1980) reported that in almost half of the cases in an American accident study the user accepted personal blame, and attributed more than half of the injuries to slips, trips, falls and bumps, rather than being specifically product related. Feldman reported the general view expressed by the trade in the USA that improvements in product packaging or design would only reduce accident statistics by 4-7%, as the user was considered largely to be to blame.

Adams, Barlow and Middlestone (1981) also report that occupational safety accident investigation is also prone to diagnose "operator error" as a prime cause of the accident with there often being no further effort to examine human behaviour in accidents in further depth.

That there is evidence from both areas of accident investigation of researchers attributing accidents to "human error", however, cannot be taken as a valid conclusion that accidents are wholly user rather than product related, due to the absence of data also addressing sufficiently the design features of the product/ equipment in use at the time. Feldman (1980) and Drury and Brill (1983) report that traditional methods of accident investigation lack detailed data on actual human performance and predicted human capabilities, and should ideally employ an independent observer trained in objective accident investigation.

Similarly, Davis (1979) reports that occupational accident statistics are similarly unreliable, as data from different sources may be combined resulting in double counting, or omission, and there is the additional problem of under reporting. Kay (1971) has commented that all accidents share in common too much data being presented in too short a time. Thus caution must be exercised in drawing conclusions from accident data.

Kanis and Weegels (1990) and Dejoy (1987) identify certain judgemental heuristics, or rules in decision making and risk perception, which tend to colour the recollection of retrospective data. These are the rules that people use in judging complex situations to help perception, structuring and processing of events:-

◊ **availability:** estimating the likelihood of an event by considering how readily it can be imagined or recalled

◊ **suppression:** selectively ignoring information which conflicts with an existing interpretation of events

◊ **anchoring:** sticking to the most recent information or the information first presented

◊ **overconfidence:** having excessive confidence in the existing interpretation of an event

◊ **hindsight:** exaggerating what others should have been able to anticipate based on hindsight of what happened.

◊ **causality:** where factors which are attributed as causes of an event have a bearing on judgements of the likelihood of an event

Such psychological biases are important in the perception of third parties or "experts" judging events, as well as in the recollections of the participants themselves. Dejoy (1987) considers it likely that consultants, juries and judges in product liability cases would exaggerate what was foreseeable and what could have been anticipated and prevented by the manufacturer.

Kanis and Weegels (1990) caution that repeatedly recounting the factors leading up to an accident results in reconstructing the events coloured by interpretations of why it happened. This can result in false accounts being reported in all honesty. The way in which leading questions may have been used can also greatly influence people's experiences (Loftus & Wells 1984, Smyth et al 1987).

1.11 Intervention strategies based on accident statistics

As well as publishing accident statistics, the Consumer Safety Unit plays an important role in promoting consumer safety education, underpinned by their role in prompting and drafting consumer safety legislation to Parliament. The CSU commissions detailed research into product safety following up accident statistics, with the majority being commissioned and carried out by the Institute of Consumer Ergonomics (ICE) at Loughborough. More recently research has been widened to include the Furniture Industry Research Association, Laboratory of Government Chemist, Centre for Policy on Ageing, University of East Anglia Environmental Risk Assessment Unit, and Institute for Occupational Ergonomics at the University of Nottingham.

Studies carried out by ICE typically take on the role of the independent observer, analysing the CSU published accident data retrospectively, where possible using in-depth interviews with selected consumers. The approach concentrates on classification on the cases as a means of simplifying the accident data, to attempt to predict the hazards involved, and to identify possible intervention strategies.

ICE do not appear specifically to apply taxonomies of task analysis which, for example were developed by Miller (1953), and modified by Meister (1971) and Singleton (1978) in relation to occupational accidents. Rather, ICE tend to group accidents, behaviours, users and injuries into research project general patterns in a similar way to that proposed by Drury and Brill (1983) in their use of hazard patterns.

Using these patterns of past behaviour as a predictor of future patterns of behaviour, ICE try to develop strategies for reducing risk by recommending:-

- ◊ improved product or modification
- ◊ better instructions for use
- ◊ improvement to published standards for products
- ◊ drawing up of new standards
- ◊ improved manufacturing practices
- ◊ better consumer awareness of safety hazards.

Having identified such characteristics, the intention is to address risk reduction and to develop intervention strategies, or take such other preventive action as is possible to reduce the likelihood of repetition of this type of accident. It is interesting that Government accident and fatality statistics identify age as a major factor governing accident risk. The youngest members of the population have the highest rate of home accidents, while the elderly run the greatest risk of having a fatal accident.

Ongoing research work sponsored by the CSU endeavours to explore what intervention strategies and consumer information campaigns can be used to reduce these types of accident in the target groups.

1.12 Epidemiological Models

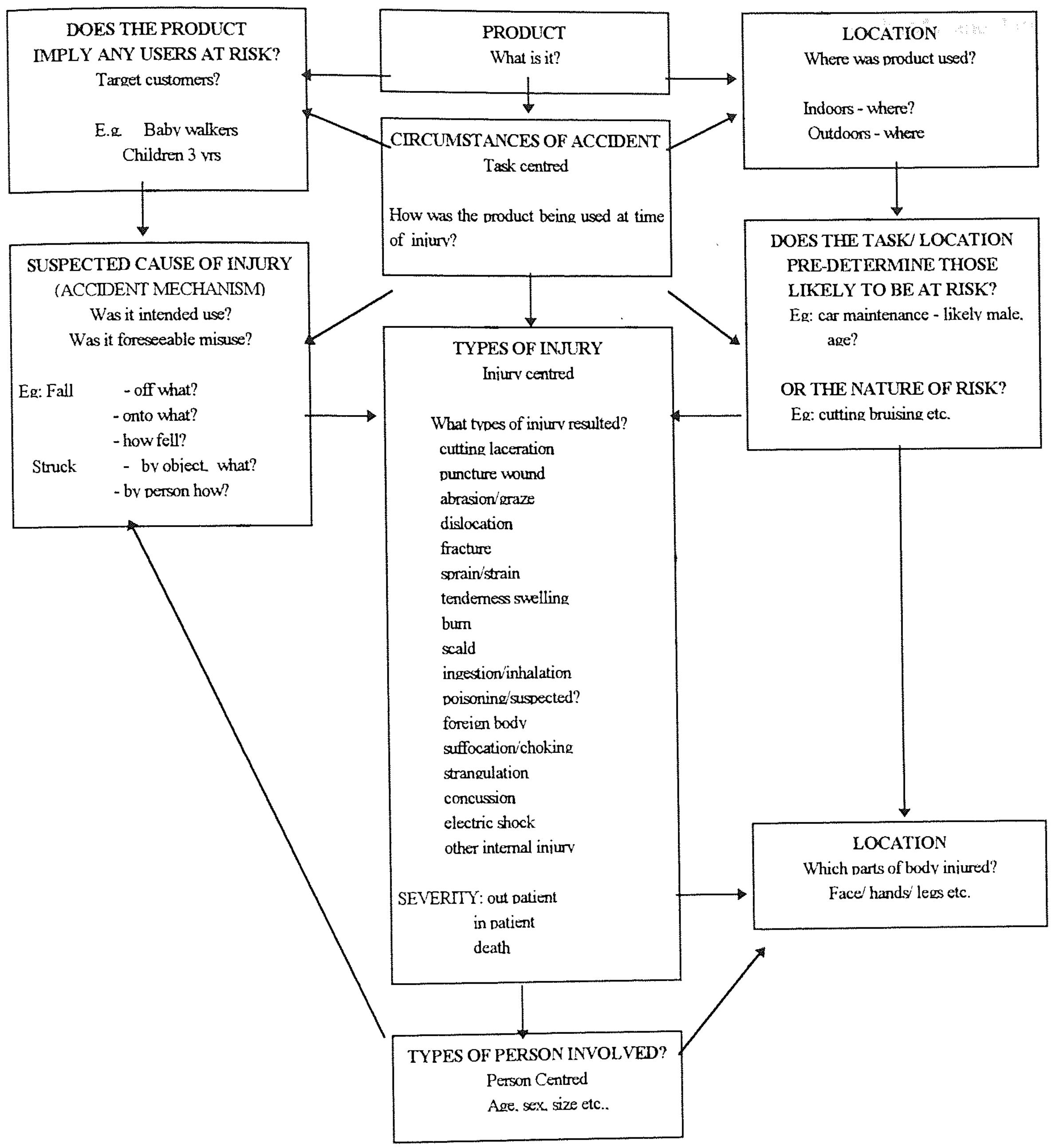
The author has developed a basic model for product safety appraisal which applies this epidemiological approach is proposed as shown in Figure 2. The model identifies characteristics associated with the product, information provided with it, how the product was used, the person who used it, the location or environment where it was used, and the types of injury, their location and severity which contributed to the product being used in an unsafe manner.

Drury and Brill (1983) have taken this approach further and have identified hazard patterns, or certain patterns of circumstances where injury has occurred. Their approach is illustrated in Figure 3.

They suggest that a useful scenario should describe more than 90% of accidents with a given product by a maximum of six hazard patterns. Each scenario should pose a feasible and effective intervention strategy, should be mutually exclusive of other scenarios, and should have human factors as a major description parameter.

They applied the model to a range of 22 products including tools, toys, sports equipment, furniture and architectural features. In each case, the accident investigators worked through a standard approach through a personal interview, and a multiple choice questionnaire addressing the victim, the task or action, the environment, and the product.

Figure 2 : Retrospective Analysis of Accident Statistics



Source of Approach : Based on Approach in HASS, LASS & HADD Reports

SOURCE DRURY & BRILL : HUMAN FACTORS 1983 25(3), 329-342

Their concept focuses the hazard analysis around the product to generate no more than 6 hazard scenarios by investigating:-

The victim
- ✧ physical descriptions, age, sex, height, weight, right/left handed, body part injured, type of injury
- ✧ clothing worn
- ✧ mental and physical conditions such as familiarity with the product, distraction, supervision, safety instructions, training.

The task
- ✧ conditions and intended action immediately before the accident
- ✧ at the moment that the task could be completed what went wrong with the intentions?
- ✧ what corrective action was taken and why didn't it work?
- ✧ how was energy transferred at the moment of injury?

The environment
- ✧ Location: indoors, outdoors, other persons at site of accident and relationship to them, details of floor, ground, wall, ceiling materials and conditions, details of environment Eg lighting visibility, temperature, familiarity descriptions;

The product
- ✧ Type, make, weight, size, shape, colour, materials, presence of any safety features, visibility and contrast with surroundings, condition descriptions such as age, modifications, malfunctions, maintenance and hazard history, broken loose or missing parts, manufacturer's labelling and information

Godfrey, Fontenelle, Brems, Brelsford and Laughery (1986) applied this model to ingestion accidents reported to the Texas state poison centre, and generated two scenarios to describe the majority of accidents. They found that despite legal requirements for fitting child proof closures on certain dangerous substances to act as a safety barrier, 57% of children were reported to have opened the closure. Their preliminary conclusion was that parents had left the product out and/or had left the closure off, or had not properly secured it. They recommended a warning to remind adults to replace tops carefully and check they are correctly closed, and an instruction to store dangerous substances out of children's reach.

Woodcock and Webb (1986) suggested an alternative approach towards accident analysis based on a self-reporting questionnaire addressing sensory factors, attention, knowledge, posture, reach, force, manipulation, energy, environment and psychosocial factors. They focused on the task being done at the time of the accident as a basis for information about the person-task-environment system, as a basis for developing intervention strategies.

Kanis and Weegels (1990) collected accident data retrospectively as a basis for re-design of consumer products. They video recorded retrospective simulations of the way the product was used at the time of the accident by the victim, asking the victim to think aloud, and they also conducted measurements of the product, the scene and the victim's anthropometrics. However, they reported that the sample size for participation in the experiment was limited by low response rate from victims who minimised the severity of injury or blamed their own "carelessness" or "stupidity".

Schoone-Harmsen's (1990) product safety matrix as shown in Figure 4 can be used as an analytical tool to make consistent descriptions of known product-related accidents, in the way outlined by Kanis and Weegels, and may also serve as a predictive tool of possible situations occurring during use. The method firstly requires identification of product features, actions of the user, and environmental conditions; secondly requires highlighting those features of the product, of user actions, and environmental conditions which are critical; and then through synthesis to explore possible solutions.

She then identifies the relevant factors connected with the product, the actions of user, and with situation of use for each phase of use as detailed in the product safety matrix in Figure 5.

Schoone-Harmsen stresses that familiarity with the method is essential for it to be applied successfully, and specifically knowledge of human behaviours, cognition and risk perception to complete the analysis stage, and design skills for generating and developing solutions to complete the synthesis stage.

Figure 4 : Schoone - Harmsen's Product Safety Method

Aston University

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Figure 5 : Schoone-Harmsen's Product Safety Matrix

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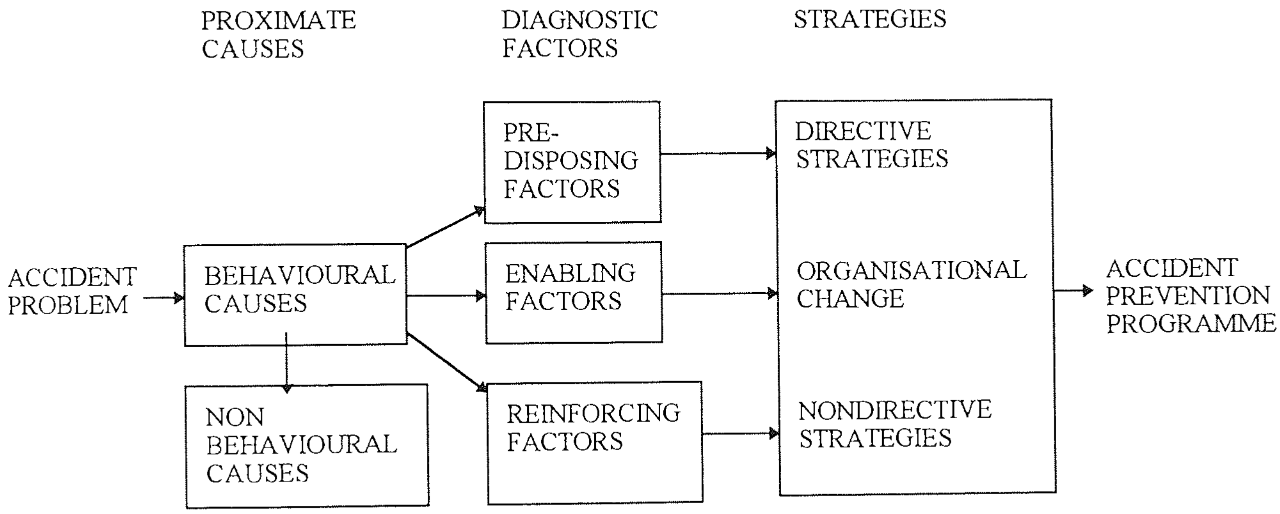
Within the field of occupational safety, Dejoy (1986) proposes a behavioural diagnostic model to be used alongside models of hazard analysis as a basis for education in safe working practices. He applies the PRECEDE framework developed by Green, Kreuter, Deeds and Partridge (1980). The model begins by identifying proximate causes of the safety or accident problem. Then three categories of diagnostic factors are examined, i.e. predisposing, enabling, and reinforcing factors.

Once they have been analysed, accident prevention strategies are developed, as shown in Figure 6.

Figure 6 : Dejoy's Behavioural Diagnostic Model Based on the PRECEDE Framework



Hazard analysis is at the crux of these techniques of retrospective analysis of accidents, and the resulting predictive estimates of safety behaviour, and accident prevention programmes. As such, it is a pivotal component of a consumer product safety test programme which is forward looking and not purely reliant on retrospective accident data, i.e. addressing how safe/unsafe might this product be rather than how unsafe it was.

1.13 Research Objective

A number of inter-related concepts have been introduced in this Chapter, which demonstrate the complexity of the issues contributing to the research problem, and which are to be explored in greater detail.

At a time of increasing complexity in the consumer products marketed it is clear that the level of understanding of the associated hazards has not increased concomitantly. Although there has been a general decline in home accident fatalities, the epidemiological data examined demonstrate that injuries in the home continue to exceed injuries in the workplace - both sources of injury apparently resisting legislative intervention in the fields of consumer safety and health and safety in the workplace.

In order to predict the human factors which contribute towards safe behaviours, or even unsafe behaviours, and to provide a basis for product safety appraisal the framework of interacting components has been identified. Detailed definitions provide the basis of themes developed in subsequent chapters, culminating in the development of a model for product safety appraisal. This research draws together various different disciplines to attempt to solve a practical problem for safety enforcement practitioners, and for those who market, design or manufacture consumer products, that is to develop and apply a robust model for appraising the safety of consumer products.

The survey of accident research in the fields of consumer safety and occupational safety described in this chapter provides an analysis of scenarios of use and misuse of products which lead to injury or death. As will be shown in Chapter 2, the legal test of "reasonable safety" for consumer goods is defined in consumer protection legislation, requiring that the "risks" of injury must be reduced to the minimum.

In chapters 3 to 5 the ergonomics contribution to accident research, current approaches towards safety testing and the concepts of risk assessment and hazard analysis are reviewed, to gain an insight into the interface between people and products, and enable the human factors contribution of risk assessment, hazard perception, and information processing to be considered. The focus of the research is to develop a system of hazard analysis which can be applied to a wide range of consumer products, by drawing upon the various disciplines and perspectives presented in the literature survey.

From the review of existing approaches to hazard analysis, a series of systematic checklists and structures for hazard analysis is developed as the basis of the empirical stages of research for appraising the safety of consumer products. The model has been designed for use in its pilot form by selected "volunteer" Trading Standards Departments, but it could be equally used by product designers and manufacturers.

Considerable interest has been shown in the possibility of the wider use of the proposed model by UK safety enforcement colleagues and their European equivalent, who are seeking to apply a method for safety appraisal which can be used as an "expert" system of hazard analysis by non-experts under supervision in safety testing of consumer goods.

The empirical work, described in Chapter 6 to 8, seeks to develop and evaluate a pilot system of hazard analysis through participating Trading Standards Departments. This work includes questionnaires used at different stages in the research to assist in selection of "volunteer" local authorities, and to identify in some detail the contribution of human factors to the process and outcome of the safety appraisal carried out.

A preliminary questionnaire is used to establish the level of experience in risk assessment/hazard analytical techniques from Trading Standards Departments responding throughout the country, to select a small number of volunteer Trading Standards Departments to participate in the research.

The six Trading Standards Departments selected to participate in the evaluation process of using the hazard analysis protocol and risk assessment model, represented three authorities who expressed little experience in using objective measures for determining product safety, and three expressing some experience in objective techniques in their responses to the preliminary questionnaire.

Subsequent questionnaires completed before and after the application of the model for safety appraisal have been developed to try to determine the contribution of potential subjective influences as described in Chapter 4, including product familiarity, uncertainty and establish views regarding the usability and reliability of the model and any preferences for a numerical or graphical method for calculating a final risk assessment.

A number of portable consumer products chosen to represent combinations of product familiarity / seriousness of potential safety hazard / obviousness or uncertainty in safety hazards were provided for each participating authority to form the basis of the process of hazard analysis and risk assessment using the model. Appropriate documentation accompanied the samples to provide instructions and to record the process of safety appraisal using the model.

The outcome of the two stage hazard analysis and risk assessment process carried out by each Trading Standards Department is compared in Chapters 7 and 8 to determine consistency in results of hazard analysis and final decisions regarding the safety of the sample product and to determine any correlation in the decisions made using the model and alternative methods of risk assessment.

Chapter 9 provides an overview of the empirical results and draws preliminary conclusions based on the information provided. It also identifies a number of opportunities for future work, and indicates a number of areas where further work has already begun.

Chapter 2 : The Legal Framework

2.1 Introducing the Basic Concepts of Criminal and Civil Law

It is important to set out the basic concepts of criminal and civil law in order to have some understanding of the UK legal framework of criminal and civil safety legal requirements, which form the primary rationale for carrying out safety testing of consumer products.

The current civil law framework for Product Liability as implemented via the Consumer Protection Act 1987, flows from European legislation, but its principles can be traced through early case law of actions in contract and tort. A number of American civil cases are discussed in order to understand the responsibilities of suppliers of consumer goods and the key principles of Product Liability to supplement UK civil case law.

The principal criminal framework for product safety now also flows from European legislation, as implemented in the UK via the Consumer Protection Act 1987, and a number of Statutory instruments (Orders and Regulations), and safety standards.

2.2 Civil Law

Civil law is concerned with a person's individual rights and responsibilities, and sets out the circumstances where damages can be claimed if these rights have been breached. Where there is a cause of action, this is taken through the civil courts and results in a penalty imposed by the court to award the injured party monetary damages, rather than fining or imprisoning the culprit as in the case of the criminal courts.

Individuals have certain common law civil rights of individuals which are relevant to product safety. Common law does not require a statute to define these rights, as they have been established over history and through interpretation by the courts. The manufacturer's duty of care under the principle of **tort** to provide a safe product for users is an example of a common law civil right. A civil action can be taken through the courts seeking to prove negligence by the manufacturer.

In general, tort law is based on the concept of the defendant being at fault, where there has been a breach of a duty of care owed to a person or persons who suffer damage in consequence. The damage must be reasonably foreseeable and not too remote.

Buyers also have civil rights set out via statute against, for example, the retailer of goods under sale of goods law. A retailer has a contractual duty to supply goods which are fit for their purpose, are of satisfactory quality and which satisfy any requirements imposed by the buyer concerning description via the Sale of Goods Act 1979, as amended by the Sale and Supply of Goods Act 1994.

Where there are legal requirements set out in statutes (Acts of Parliament) or Statutory instruments (Orders and Regulations), the supplier of products has a statutory duty to meet these requirements, and the buyer can seek damages for breach of statutory duty if the supplier fails to meet the requirements.

Before the introduction of the Consumer Protection Act 1987, a difficulty existed in taking civil action for a defective product which resulted in the injury of the user, as the appropriate cause of civil action depended upon whether the injured party had purchased the goods. Actions under the Sale of Goods Act 1979 or the Supply of Goods and Services Act 1982 may only be taken by a party to the contract for sale or supply of goods or services, due to the doctrine of **privity of contract**. In other words, buyers injured by unsafe goods would have a better chance of seeking compensation for the cost of goods bought where there was a contract of sale with the retailer, than where the goods were supplied as a gift, or where there was no contract for sale. If the injured party had not bought the goods, the only civil cause of action would be to prove that the manufacturer had not taken sufficient care, which is a greater burden of proof than merely demonstrating that the product was defective.

A key principle which established a cause of action against the manufacturer was laid down in *Donague v Stevenson (1932)* . A bottle of ginger beer purchased from a cafe was consumed by a friend. Having drunk most of the ginger beer the friend discovered the remains of a decomposed snail in the drink. As there was no contract between the friend/plaintiff and the cafe owner, an action was taken against the manufacturer. In holding that the plaintiff was entitled to recover damages from the manufacturer, Lord Atkin expounded a fundamental principle in product liability law:

> "..a manufacturer of products, which he sells in such a form as to show that he intends them to reach the ultimate consumer in the form in which they left him with no reasonable possibility of intermediate examination, and with the knowledge that the absence of reasonable care in the preparation or putting up of the products will result in an injury to the consumer's life or property, owes a duty to the consumer to take that reasonable care."

Although early product liability negligence cases were mainly concerned with manufacturers, actions in tort have also been brought against importers and distributors e.g. *Watson v Buckley Osborne Garrett & Co Ltd (1940),* when an imported Spanish hair dye caused dermatitis and the distributors were held liable for failing to test the product and for advertising it as safe and harmless. Another case involving a retailer *Kubach v Holland (1937)* held that a chemist was liable for the supply of a product described as manganese chloride which included some antimony sulphide and injured a schoolgirl during an experiment.

Actions have also been taken against designers, testing agencies, repairers and installers. In *Roe v Minister of Health (1954)* Lord Denning cautioned "we must not look at the 1947 accident with 1954 spectacles" against using hindsight which permitted current "state of the art" evidence about standards and industrial practice. However, it was held in *Vacwell Engineering Co Ltd v BDH Chemicals Ltd (1969) that* a manufacturer must conduct research into the safety of his products and monitor reactions to them.

There is an abundance of more recent American judgements in product liability cases which provide an appreciation of how their courts have interpreted:

- ◊ defective products
- ◊ consumer expectation
- ◊ unreasonable danger
- ◊ foreseeable misuse
- ◊ "open" danger
- ◊ the value of warnings
- ◊ the role of voluntary and governmental standards.

Weinstein, Twerski, Piehler and Donaher (1978) evaluate the American experience of litigation to provide a guide for manufacturing, design and marketing on the reasonably safe product. Whilst the structure and format of American legislation is quite different from the UK, the spirit of the law is very similar. Consideration of some of these American cases provides a useful backdrop to understanding the key issues in litigation.

The case law considers three types of defects in consumer products:

- ◊ a **production defect** which arises when a product fails to meet the standard of the majority of products, i.e. it does not reach the consumer in its intended form ;

- ◊ a **design defect** which exists in all products of that make or kind and may therefore result in multiple rather than isolated injuries ;

- ◊ a **marketing** defect which consists of a failure to provide adequate warnings or instructions to avoid a concealed hazard or where the product is inherently hazardous to health.

For example in *Fisher v Harrods (1966)* the defendants sold a bottle of jewellery cleaner containing isopropyl alcohol and ammonium oleate supplied in a plastic bottle with a plastic bung and screw cap. As the plaintiff was squeezing the bottle the bung shot out and fluid splashed and damaged her eye. It was held that Harrods were at fault for making insufficient enquiries before putting the product onto the market and without requiring an adequate warning of danger, e.g. to keep the products away from the eyes.

Part I of the Consumer Protection Act 1987 establishes mandatory Product Liability responsibilities which longer require the injured party to prove fault in relation to a defective product. Product Liability extends to consumer and non consumer products (e.g. those used at work). The user (who need not be the purchaser) can sue for damages exceeding £275 as a result of injury, death, or damage to property. An action must be brought within three years of the date of injury and cannot be started more than ten years from when the defective product was supplied by the producer.

This final and all embracing cause of action resulted from momentum within the European Community, to ensure that injured parties could seek damages, regardless of whether they actually purchased the goods (giving rise to an action in contract law), or whether the manufacturer was negligent (giving rise to a common law action in tort). All the user must prove to show a cause of action is that the product was defective. An action in product liability does not preclude actions in contract and tort in appropriate circumstances. However, liability can be affected by contributory negligence on the part of the person injured, i.e. where an element of "misuse" can be demonstrated.

Hall (1996) comments that Part I of the Act was intended to make it easier for people to win compensation from the manufacturers of unsafe goods. Coupled with the criminal provisions in Part II establishing a general safety requirement and the provisions of the Sale of Goods Act, she felt that manufacturers should be discouraged from cutting corners which may result in goods not being as safe as can be expected, to recompense consumers who are injured. Equally, an efficient system of civil redress would encourage manufacturers to develop proper procedures to make sure that goods they produce are safe.

However, Hall reports a survey commissioned by the National Consumer Council sampling 2000 people, who were asked whether they or members of their families had been injured in any way by an unsafe or faulty product in the last three years. 3% reported an injury. Hall extrapolates this to roughly 1.8 million injuries nationally during the three year period, which she felt was consistent with the fairly high level of complaints reported to Trading Standards Departments, and home & leisure accident statistics recorded at hospitals, which were discussed in Chapter 1.

To ascertain the number of people claiming compensation, members of the Association of Personal Injury Lawyers were asked to report instances where the Part I of the Act had been used, and requests were also advertised in legal journals. Only 30 responses were received, demonstrating the tiny number of persons injured using the provisions of the Act. Hall reports the wide variety of products which had caused injury and for which compensation had been claimed. Many were food products, but there were also claims for exploding bottles, surgical scissors, inadequate truck wing mirrors, lap seat belts, a heart pacemaker, a fan belt, the aircraft in the M1 air crash, fireworks, luggage clips, supermarket trolleys, ladders, and numerous kitchen appliances.

She proposes various hypotheses to explain the low level of use of the civil remedies provided by the Act. Injured parties may have made claims under the Sale of Goods Act 1979. Others may have considered their injuries to be too insignificant to claim, or thought themselves to blame. Hall also criticises the Act itself, which requires consumers to show that the product was defective, and that it caused the injury. She suggests that the Act might be amended to include a presumption that a product must have been unsafe unless the manufacturer can show it was not, where it has failed and it appears self evident from the failure that it must have been unsafe. Additionally, she identifies the difficulty of proving causation when the product has disappeared, for example in food poisoning or drugs cases. She concludes that the 1987 Act is a useful tool, although there are clear difficulties in consumers taking cases, and urges greater encouragement of consumers to take action to give greater incentive to manufacturers to improve the safety of their products.

2.3 Product Liability Actions Under Part I of the Consumer Protection Act

In context of Part 1 of the Consumer Protection Act 1987, a **defective** product is one which does not provide the level of safety which persons **generally** are entitled to expect. Although the definition is based on the expected safety of the product, it should not fluctuate according to individual allergies and susceptibilities.

All relevant circumstances must be taken into account when deciding whether or not a product is defective, including:

- ◊ the manner in which it is marketed;
- ◊ any instructions or warnings provided;
- ◊ what may reasonably be expected to be done with it;
- ◊ the time the producer supplied the product.

Anyone injured by a defective product can sue the producer, importer or own brander where:

- ◊ **Producer** usually the manufacturer, also includes a processor where his action caused the defect;

- ◊ **Importer** who brings the product into the European Community, and includes persons bringing product into the UK from another EC country who did so from outside the EC;

- ◊ **Own-Brander** who puts his own name on products supplied, giving the impression that he is the producer.

2.4 Defences against a Product Liability Action

To escape liability the defendant must prove that:

- ◊ he did not supply the product; or
- ◊ the state of knowledge at the time he supplied the product was not such that a producer of similar products might be expected to have discovered the defect; or
- ◊ the defect was the inevitable cause of having to comply with the law; or
- ◊ the defect was not present at the time the product was supplied; or
- ◊ the supplier is not in business; or
- ◊ a component manufacturer is not liable if he can show that the defect was due to the design of the product or to faulty specifications given to him by the producer of the finished product.

It is not always easy to distinguish between the types of production, design and marketing defect as previously described. If a significant proportion of a product demonstrates the same defect, this may be the result of a production error or a design flaw in using that production technique to make the product.

In considering the American production defect cases, Weinstein et al (1978) identify that the plaintiff (injured party) need merely compare the defective with "good" product, for example by reference to the manufacturer's internal quality standard. In the design defect case, by contrast, the product by definition meets the manufacturer's internal standard, and an external standard must be identified to establish a defect in design. They suggest it may be necessary to attempt a balancing exercise between the risks against important functions the product performs, and the cost of providing greater safety.

Weinstein et al cite *McCormack v Hankcroft Company (1967)* to demonstrate how this trade-off between product risk versus the utility of the product was used to determine the standard of reasonableness. A manufacturer of steam vapourisers marketed an inexpensive model with a lift-off cap. The principle of operation, rather like a kettle, was to provide a continuous emission of steam. In the case in question the vapouriser was used in a child's bedroom, placed on a stool. In the night the child got up, tripped over the supply lead and was scalded by boiling water when the vapouriser overturned.

Weinstein et al suggest that the utility of a vapouriser is generally unquestioned, and they examine whether or not the design of the unit with a lift-off cap caused it to be unreasonably dangerous. It is foreseeable that units will be used in darkened bedrooms, overnight in close proximity to children, and it is common practice to direct the steam towards the child in bed, necessitating placing the unit on a stool or chair near to the bed.

Thus, there is a strong chance that the unit might tip up, as in the circumstances described. A screw on cap with a small vent hole could have been utilised to prevent pressure build up, to enable easy filling, and substantially to reduce the risk of scalding water egress if the unit were overturned. The court held that the product with a lift off cap was defective. The consumer expectation test, then, does not just ask what customers expect, but also what customers are entitled to expect.

Under UK law, the test would be to consider how the product was marketed, and what instructions and warnings were provided on safe use and siting of the un-attended product, in context of what might reasonably be expected to be done. It is difficult to see how the circumstances outlined might have availed the manufacturer any defence, as it is clear that the safety of the unit did not meet the level persons generally are entitled to expect.

None of the UK cases for consumer goods examined by Hall (1966) addressed the adequacy of warnings, although warnings played a major part in some medical cases. There were two instances of claims arising from inadequate instructions, one arising from inadequate assembly instructions for a clothes drier, and another involved a hair steamer where there were no instructions at all, and the injury occurred when the claimant tried to work out how to put the product together. In both cases successful claims were made.

Weinstein et al cite Wade (1965) identified seven explicit indicators of whether a product is unreasonably dangerous:

- ◊ usefulness and desirability
- ◊ availability of other and safer products to meet the same needs
- ◊ likelihood of injury and its probable severity
- ◊ obviousness of the danger
- ◊ common knowledge and normal public expectation of the danger (particularly for established products)
- ◊ avoidability of injury by care in use of the product (including the effect of instructions or warnings)
- ◊ the ability to eliminate the danger without seriously impairing its usefulness, or making it unduly expensive.

Source : Wade (1965) as cited by Weinstein et al (1978) p 47

They also address factors of product misuse in product liability actions, and discuss the case of *Ritter v The Narrangsett Electric Company (1971)* where a 4 year-old girl was injured when using the drop down door of an oven as a step stool to look into a pot on top of the stove. The stove tipped forward. Evidence was given showing the stove tipped with 30 lbs weight on the door. It is arguable that the stove may have tipped by a housewife placing a heavy roasting pan on the door, as this type of door may be intended to be used as a shelf for checking food during cooking. However, this was not at issue in the circumstances under consideration. The court felt the crux was whether the use of the door by the child was misuse, and held that it was foreseeable that a door of this type could be used by a child as a step stool. The case was therefore proved against the manufacturer. Based on these findings, the instances of injury of children previously cited from standing on glass-topped tables would be reasonably foreseeable, and a successful action could be taken in product liability.

Weinstein et al cite a similar decision by the US Appeal Courts in *Magic Chef v Sibley (1977)* when a child was injured when standing on a chair leaning over the top of a stove, by inadvertently turning on one of the hotplates. The Court said:-

> "It has been held by our Supreme Court that foreseeability is significant in product liability cases when the product is what it is intended and known to be, but injury is suffered because the product is misused....(citation omitted). A product is not "misused" merely because the manufacturer intended that it be used in a different manner; the manufacturer must show that the use which caused the injury was not reasonably foreseeable."

Weinstein et al identify a clear trend from the judgements in American case law, that manufacturers should design for foreseeable misuse of their products. It is therefore arguable that manufacturers must also design against dangers which occur only when the product is used abnormally, provided that the abnormal use is within the range of foreseeability.

The American approach to "open danger" is worthy of consideration in this context, and Weinstein et al cite the findings of a landmark case *Campo v Scofield (1950)*. This concerned a plaintiff feeding onions into an onion-topping machine, whose hands were badly injured after being caught in its revolving steel rollers. The plaintiff asserted that the machine was inadequately guarded. The court held that the manufacturer was only responsible for latent defects and concealed dangers, the user was aware of the danger in the unguarded machine and the manufacturer was not liable.

The decision was to remain unchallenged until the case of *Micallef v Miehle* (1976), when the New York Court of Appeals held that the obviousness of danger was not the sole criterion for judging product safety. The court held that the safety of a product should be judged for its reasonableness, based on the totality of the product.

UK legislation has allowed a "State of the Art" defence to enable manufacturers to escape liability when an injury occurs associated with a product, where the hazard causing the injury was scientifically not known at the time of manufacture. In these circumstances the manufacturer must show that the product met all known voluntary or governmental standards at the time it was supplied.

Weinstein et al identify an overriding trend in American product liability law cases, the need to give adequate product safety warnings. It is a relatively inexpensive means of dealing with risks which cannot be designed out of a product without substantially adding to its cost, or otherwise affecting its utility. However, the author considers that use of appropriate warnings does not make the product safer, although it should assist the user in identifying significant hazards, and carry out an assessment of risks of injury. In Chapter 4 the complex contribution of consumer attitudes, risk perception and how information and warnings may affect behaviours are given more detailed consideration.

The US Courts appear almost always to require a warning about latent dangers. However, to be effective the warning must be selective and warn the consumer about a real and significant danger. Indiscriminate general warnings are unlikely to be effective in influencing behaviour, and are equally unlikely to provide legal protection. Weinstein et al identify that the vital question is to identify which dangers must be warned against, and which should be designed out of the product.

2.5 Criminal Law

The purpose of criminal law is to protect the general public in contrast with civil law which protects the rights of individuals. Common law, as discussed earlier, is unwritten law, and in relation to criminal law includes basic public responsibilities for example not to kill. Criminal law statutes lay down more detailed rules of society, effectively restricting individual freedoms in order to protect the general public interest. The complicated route of passage for proposed legislation through Parliament, before a Bill is made law, enables sufficient representation to be made to ensure that it is in the general public interest.

The penalty for contravening a criminal statute is prosecution through the criminal courts, and dependent upon the severity of the crime, a monetary fine and/or imprisonment. Statutes typically set out the skeleton or outline of general duties and detailed requirements are addressed via statutory instruments, or subordinate legislation such as Regulations and Orders.

Legislation to promote consumer protection has its roots in the late 19th Century which brought the availability of an increasing number and diversity of consumer goods offering consumers a wide range of purchasing choices. It gained momentum in the early 20th Century when the Depression increased consumer pressure to target spending of available financial resources as effectively as possible, and reached its height in the late 20th Century.

In particular, the boom years of the 1970s saw the enactment of price controls and the emergence of a host of legislation protecting the consumer interest in areas of price, description, quantity, quality and safety and the roots of the current legal controls on consumer safety can be traced to this era. The current trend of the 1990s is to streamline and simplify legislation considered to be over-complicated or over-burdensome to encourage business growth and competition, particularly in the wider European market.

As much of the research which considers the man/machine interface of products has been conducted in the field of occupational safety rather than consumer product safety, it is important to draw on this work in considering the human resource element. For this reason, this Chapter also considers the Health and Safety at Work etc. Act 1974 (HSWA) and there are analogies which may be drawn between analysis of occupational injuries and consumer product injuries.

2.6 Consumer Protection Act 1987- Part II

The principal statute, for the purposes of this study is the Consumer Protection Act 1987 (CPA). In addition to the civil safety responsibilities in Product Liability in Part I as previously discussed, there are also criminal safety responsibilities in Part II. The Act introduced a new **General Safety Requirement** (GSR) which is an all encompassing duty for suppliers to ensure that consumer goods are "reasonably safe". Consumer goods fail to comply with the GSR if they are not "**reasonably safe**".

The **General Safety** duty in Part II is extended by the **General Product Safety Regulations 1994** (GPS), which implement the requirements of the General Product Safety Directive. There are also various Orders and Regulations made under the Act which detail specific safety requirements for a variety of different categories of goods such as toys, nursery products etc. Failure to comply with the general duty or specific product safety requirements results in an offence being committed The GPS Regulations affect all sectors of industry, extending the general safety duty to all consumer goods.

A safe product is defined in the GPS Regulations 1994 as:

> " any product which under normal or foreseeable conditions of use, including duration, does not present any risk, or only the minimum risks compatible with the products use, considered as acceptable and consistent with a high level of protection for the safety and health of persons, taking into account in particular:
>
> ◊ the characteristics of the product including its composition, packaging, instructions for assembly and maintenance
>
> ◊ the effect on other products, where it is reasonably foreseeable that it will be used with other products
>
> ◊ the presentation of the product, the labelling, any instructions for its use and disposal
>
> ◊ and any other indication or information provided by the producer
>
> ◊ the categories of consumers at serious risk when using the product, in particular children
>
> and the fact that higher levels of safety may be obtained or other products presenting a lesser degree of risk may be available shall not of itself cause the product to be considered other than a safe product"

There is a clear similarity between these circumstances and the relevant factors to be considered in deciding whether a product is **defective** in context of Product Liability, as discussed earlier. Thus, a defective product giving rise to a civil action in product liability may also prompt action through the criminal courts, although there is a difference in the time limits for taking legal action.

A product is "unsafe" if there is a risk of personal injury or death posed by the goods. Thus, there need not be an actual injury, merely the risk of injury may make a product "unsafe" and expose the supplier to prosecution. However, the number of product safety prosecutions in UK courts which have provided an opportunity to provide interpretation on the level of risk which contravenes is limited. These prosecutions have shown that evidence of an injured consumer has tended to be required to provide a reliable indication that a product was "unsafe".

The burden of proof which the prosecution has to satisfy is that the goods were not reasonably safe *beyond all reasonable doubt*. In practice the courts have shown a reluctance to impose a guilty verdict and fine unless actual injury has occurred. Indeed enforcement officers have been subjected to cross-examination on their opinion of the relative safety of items where no injury has occurred, where items fail to meet prescriptive safety standards.

There is a difference in the time limits for taking legal action in product liability and enforcement action through the criminal courts. A criminal action is only possible up to 6 months from a complaint being registered with the local authority, or from the date of supply, unless the product is covered by safety regulations permitting a 12 month time limit. By contrast, civil actions can be taken up to 3 years from the date of injury, and delay is often encouraged by solicitors to allow the full effect of injuries to be determined, prior to making a claim. Local enforcement authorities have a duty to investigate potential "unsafe" consumer products, and have to progress matters quickly if legal proceedings are to be instituted. This may be a contributory factor in the fact that Product Liability actions are not as common-place in the UK as in the USA.

2.7 Occupational Safety

The emergence of occupational safety legislation has paralleled the development of consumer protection legislation. In the late 19th Century there was a move away from criminal sanctions concerning workplace safety, due to the increase of civil actions brought in breach of statutory duty triggered by *Groves v Lord Withborne (1898)*, and the increase in cases brought in common law due to negligence triggered by *Priestley v Fowler (1837)*. There was a vast array of legislation which was not prosecuted through the criminal courts, and it was left to individual employees to seek civil damages for contravention of these requirements. By 1969, when it become compulsory for employers to take insurance against such claims, neither civil or criminal action proved to be a major deterrent.

In the early 1970s a movement began to consolidate the morass of detailed and complex occupational safety requirements into a single statute underpinned by Regulations, Orders and Codes of Practice. This implemented the recommendations made in the Robens Report (1972) with the intention that prosecution should not always be the first resort, placing greater reliance on safe systems of work rather than technical standards, involving workers in procedures for accident prevention and ensuring that occupational safety should also protect visitors and the general public. It is interesting that the resultant Health and Safety at Work etc. Act 1974 (HSAW) has proved to be a model for much of recent consumer protection legislation, in its use of general duties, and in its enforcement tools.

The new Act was not a panacea, and Selwyn (1982) demonstrates by his comment that the Act is "turgid, soporific and in parts about as meaningful as medieval metaphysics", how complicated the statute can appear to the layman. However, the Act did provide a basically criminal framework, where civil actions would arise from breach of statutory duty or common law. The application of Health and Safety controls in the workplace has continued to evolve and there is increasing emphasis on risk assessment through the "six pack" of Regulations implementing the EC Framework Directive on Health and Safety at Work as detailed in the Appendix.

Mackmurdo (1993) highlights the current EC focus on safety and liability such as :

> " health and safety at work, product liability, liability for services, liability for waste, environmental protection, general product safety, VDUs, machinery, toys, construction products, chemicals and preparations, medical devices etc."

which impose sweeping obligations on British industry, commerce and public bodies to make risk assessments. In order to control risks it is necessary to identify and assess them, and the resulting risk assessment becomes an important management tool.

Mackmurdo defines the Health and Safety definitions of "risk" and "hazard" drawing upon guidance notes published by the Health and Safety Executive (HSE) on the Control of Substances Hazardous to Health Regulations 1988 and the Approved Code of Practice on the Management of Health and Safety at Work Regulations 1992, as the terms are not defined in any health and safety legislation:

HAZARD	- a source of possible harm (i.e. damage to a person's skin, organs, bones etc. with the adverse consequences to breathing, circulation, hearing or their offspring, including ill health or injury)
RISK	- the likelihood of that harm being realised
RISK ASSESSMENT	- qualitative or quantitative evaluation of the chance that a hazard will cause harm, identifying and taking into account all of the significant factors which can affect the chance and extent of harm, and which reaches a conclusion on whether and how management of such factors needs to be improved or eliminated or lessen that chance.

His definitions of risk and risk assessment and hazard accord broadly with the definition of risk in Chapter 1, although they all rely on an implicit definition of "harm". Ideally any lack of precision in use of terminology should be identified to reduce the likelihood of any lack of clarity in understanding of the distinction between the different concepts.

2.8 The Impact of the EC General Product Safety Directive

The General Product Safety Directive introduced the concept of monitoring of products to assess risks on an ongoing basis for the expected life cycle of the product. This inevitably places an even greater responsibility upon suppliers to build safety into all products, to design out safety problems, or effectively guard against them. A safety testing programme at design and finished product stages, which also addresses the endurance of the product is very important. There must also be a system for closely monitoring consumer incidents involving each product, to ensure users are adequately informed of potential risks.

The enforcement provisions of the directive are further strengthened by the establishment of a community - wide information exchange - (Community System for the Rapid Exchange of Information on Dangers Arising from the use of Consumer Products), known as RAPEX. This system was established under Council Decision 84/133/EEC in March 1984 to relay information to Member States on dangers arising from the use of a product in Member States which could cause a serious and immediate danger to consumers. Enforcement agencies in the UK are required to notify the Government's Consumer Safety Unit (CSU) with information concerning a hazardous consumer product which is likely to be supplied elsewhere in the EC or which has originated from another Member State. Where appropriate, the details will then be relayed to other Member States by the CSU without delay.

A RAPEX notification serves a different purpose from the requirement to notify an unsafe product which is governed by Directives dealing with e.g. low voltage electrical equipment, toys, electromagnetic compatibility etc., where the product bears a CE mark. The CE mark conveys that the product satisfies relevant essential safety requirements and is entitled to free circulation throughout the Community. Once marked in this manner, products need not be tested elsewhere in the Community.

Member States must notify the EC Commission and other Member States when measures are taken which result in a product being withdrawn from the market, where it is prohibited from being marketed, or its free movement is otherwise because it is either unsafe or because the product's nonconformity can be attributed to a shortcoming in either harmonised European standard, an international standard or a national standard. In these cases a "Safeguard procedure" is used by UK enforcement agencies who come across an unsafe product bearing a CE mark, to notify the CSU without delay when statutory enforcement action is taken, i.e. to seize or suspend the goods, or to institute legal proceedings.

This notification procedure serves two purposes: checking whether trade restrictions are being placed on complying product possibility due to interpretational differences, and it provides a mechanism to alert the whole Community of the appearance of product claiming compliance when it is unsafe. The CSU checks the notification for completeness, and passes UK notifications to the EC Commission and other Member States, and liaises directly with the enforcement authority concerned keeping them informed of the Commission's comments. In the event of an objection being raised by another Member State the EC Commission will immediately consult the Member States concerned.

In practice, enforcement agencies should notify the CSU whenever a suspension notice is issued or where a forfeiture order has been made in respect of all equipment covered by product safety regulations, where the product fails to satisfy the safety requirements. The CSU can then consider whether a RAPEX notification is justified, and ensure safeguard procedures are followed, taking into consideration any recommendations made by the enforcement authority. The CSU will also inform UK enforcement authorities about action taken in other Member States through Trading Standards Link (TS Link), and will consult relevant trade associations to present a coherent UK view on these notifications. An analysis of RAPEX notifications is shown later in Tables 21 and 22 in Chapter 5.

2.9 The Importance of Safety Standards

Some of the product specific safety Regulations refer to British Standards specifications, which means that the supplier must satisfy these standards to avoid committing offences. These standards can be termed "mandatory", as a failure to comply with them is liable to result in prosecution. Other published standards for consumer products in the UK and Europe provide an optional specification which manufacturers are free to follow or ignore. Whilst being voluntary in terms of manufacturing compliance, they act as a useful bench mark for construction and performance. They also provide an opportunity for ergonomics assessment of the safety of the product throughout the process of designing, producing and marketing products.

The use of ergonomics data in product design has tended to be limited due to the lack of specific, applicable data, and more often in the absence of practical methodological advice.

Some of these voluntary standards specify anthropometric data to assist product designers in addressing user variability. There are some sources of UK anthropometric and other ergonomic data in published literature, i.e. Thompson, Barden, Kirk, Mitchelson & Ward (1973) Pheasant (1986, 1987, 1991) and Galer (1987), but much of the literature is concerned with American populations and military data rather than civilian and domestic situations.

Steenbekker & Molkenbroek (1990) found that anthropometric data from USA, Germany and via the International Standard ISO/DP 7250 (1988) was not representative of the Dutch population as Dutch children are relatively taller and lighter and less broad than their American counterparts. The value of this anthropometric data in representing the UK population may be equally questionable. The CSU (1995) has published CHILDATA, as a handbook of information and data on UK children to make basic ergonomic data more accessible - i.e. anthropometric, strength, psychological and performance data - and aims to publish comparable data on adults and eventually elderly people in subsequent years.

The CPA (1987) introduced a new category of **Approved** Safety Standards, which defined the requirements which were deemed to represent "reasonable safety". These standards were designated via a list produced and updated a list twice yearly by the Department of Trade and Industry (DTI). There were difficulties expressed by UK traders in complying with certain of the Approved Safety Standards, and specific trade sectors made vehement representations to delay the programme of adopting approved standards, due to the declared difficulties in compliance. The standards were also criticised for inequality in compliance levels required in the UK when there were no European equivalent Approved Standards, or where they might pre-empt evolving EC standards. These standards were repealed when the GPS Regulations were implemented in 1994.

Jenkins (1989) is particularly concerned about the possibility that critical safety characteristics, which may be set out in voluntary standards as a level of good manufacturing practice, may not be seen or enforced as minimum safety standards. He cites important safety requirements in British Standard specifications for electrical equipment, which he urges should be enforced as a minimum safety standard, to prevent confusion for manufacturers and test houses, and to retain the safety control system. He also criticises many published British Standard specifications as being out of date, ambiguous and unfair and not comprehensive. He attributes these weaknesses to the standards making process, which he feels has far greater input from manufacturers and under-represents users and consumer groups. He notes that, whilst there is an increasing trend for inclusion of ergonomics considerations within standards, it is ultimately up to the designer to decide whether a particular recommendation is relevant.

Thomas, Dziambor and Bruckmayr (1990) criticise testing carried out in Germany in accordance with German equipment safety law (Gerätesicheheitsgesztz 1968), for the TUV Rheinland GS (gerprüfte sicherheit) safety mark, which resembles the UK British Standards Institute Kitemark as a safety mark. The GS mark indicates compliance with legal requirements, although it may relate to a component part rather than the complete product, and in some instances it also indicates that the product fulfils basic ergonomics requirements. They identify that many GS marked products do not include ergonomics testing, because in many instances, ergonomics criteria have not been identified. The mark therefore can be ambiguous as an indication of safety. The progress in the process of making European standards is therefore compounded by these national difficulties in seeking to establish a European norm.

The current moves within the EC to harmonise standards and the constraints on member states progressing individual national standards provide an opportunity to address Jenkins' criticisms and also the anthropometric variation described by Steenbekker & Molkenbroek as discussed above. However, there have been problems for standard making bodies being able to progress standards sufficiently quickly and in European standardisation bodies following a clear mechanism for selecting areas on which to work. In addition, priority has not always been placed on efficiency in the willingness to embark upon new work.

Bridges (1992) comments that European countries have subtle differences in safety expectations and priorities. Although in developing standards there is agreement not to compromise safety, the way a problem is perceived in one country may not be a matter of any concern in another. An example of this is the different view taken by other member states to address safety of domestic upholstered furniture. The UK approach has been to define standards for flammability, which are mandated by legislation, and to require labelling of relevant furniture to demonstrate compliance. These measures were unsuccessfully challenged in the European Court of Justice in 1993 as being by a restriction to trade from other EC countries who had adopted less stringent standards. Until EC legislation comes into force the UK flammability controls can continue, although the Commission was concerned to investigate the issue further through ongoing research.

WHICH? (1993) also reports other examples where the sale of goods from a wider range of countries may result in consumers facing more hazards, in the progress by the EC to harmonise different safety legislation in different Member States. For example, proposals for a European standard on high chair safety are less stringent than UK measures. Even when there is a common view on a problem, the solutions sought may be quite different. Harmonisation of standards requires "give and take" i.e. compromises on standards expected by UK consumers but gains from adoption of standards at a European level which may be higher than our own.

As to be discussed in Chapter 5, there would appear to be cultural differences in the level of utilisation of the RAPEX system for notifying unsafe products by different Member States. An analysis of RAPEX notifications by EC Member States from May 1992 to June 1996 carried out by the author shows differences in the number and nature of "unsafe" products notified. This may reflect different levels of "absolute" safety, differing availability of the questionable products, cultural differences in safety perception and risk assessment, a different process of hazard analysis, or a subtle combination of one or all of these factors.

The obligations placed on business in the interest of safety and consumer protection by each Member state can result in technical barriers to trade where there are differing requirements and procedures in different Member States. In order to avoid such barriers to trade and as a move towards the aim of a single market, the "new approach" to technical harmonisation and standards via the 100A directives has been adopted .

As Mackmurdo noted previously, these EC Directives have set out in general terms "essential" requirements relating, for example, to safety. Domestic legislation is subordinate and must implement EC Directives, and must not artificially set up barriers between Member states in the level of safety standards imposed. These *essential safety* requirements must be satisfied before products can be sold in the UK or elsewhere in the Community, and the detailed requirements are laid down within European standards. Recent Directives for gas appliances, medical devices, machinery safety, electromagnetic compatibility, electrical equipment and personal protective equipment specify what evidence is required to demonstrate that essential requirements have been met, i.e. the **methods of attestation.** These methods encompass routes from self-declaration by the producer or first supplier, through preparation of evidence demonstrating compliance verified by independent bodies, to type approval of products in combination with an appropriate quality management system for manufacturing.

Labelling of conforming product with the CE Mark (CE) indicates that these essential requirements have been met in production. The mark is well known on toys, and by 1997 will be required for the other products which fall within the scope of the new approach directives. Thus the CE mark is of pivotal importance for consumer goods and also for goods used in the workplace in demonstrating conformity to the relevant safety requirements.

2.10 Human Error and Accident Proneness

Wilson (1983) discusses the tendency to attribute accidents to human error, proposing that he believes the root cause to be due to the product/person interaction, which could have been addressed by better product design. He asserts that, too often the design does not anticipate the characteristics and limitations of the user, and ways they might use the product. Contrary to the views expressed in Chapter 1, Wilson suggests that most user safety problems are associated with the product design.

Human error has been the subject of much research, and the term frequently carries with it the connotation of cause or blame. It implies the existence of a clearly definable correct or appropriate behaviour, from which the error is a deviation. It is more useful to consider human error as an event whose cause can be investigated. Numerous definitions of error exist, but essentially, they are all concerned with the undesirable effect or potential adverse effect on the system or people. Although many errors are detected as a result of the degraded system performance, or undesirable effect on people, damage need not always result when human error occurs.

Error is frequently attributed to operators in the work situation, and users in the domestic situation. Freeman (1972) reported that about 85% of occupational accidents were due to human error. Conway, Muckler and Peay (1980) reviewed 12 consumer accident studies and found the percentages of accidents due to human error ranged from 4 - 90% with a median of 50%. Reason (1985) reported that 51% of occupational accidents in nuclear power plants were related to human performance, the remainder being due to deficiencies in procedures and documentation.

In considering these data, the percentage of accidents attributed to human error is not so much at issue as the somewhat erroneous conclusion drawn by many from these results that the person is at fault rather than recognising the need to change elements of the human/ product system.

Hale and Glendon (1987) consider humans as essentially error-making and error-correcting entities. Within the systems framework, then, error or deviation is an input to the human decision-making process, and cannot be designed out of the system. Rasmussen (1983) recommends that the designer's role should be to enhance possibilities of error recovery, and to produce an error tolerant system.

Swain and Guttman (1983) have developed a straightforward classification scheme for individual discrete actions:

- ◊ **errors of omission** involve a failure to do something
- ◊ **errors of commission** involve performing an act incorrectly
- ◊ **sequence errors** occur when a task is performed out of sequence
- ◊ **timing errors** involve failing to perform an action within the allotted time, either too fast or too slowly.

An alternative way of classifying human errors is through an information processing model.

Meister (1976) suggests that human error occurs when any element in the chain of **input - mediation - output** is broken, such as failing to perceive a stimulus, to misinterpret stimuli, not knowing what response to make to a particular stimulus, a physical inability to make a required response, or responding out of sequence. This type of model tends to classify commission errors as **intentional** or **unintentional**, where intentional refers to the intention in the performance of the act, rather than an intent to make a mistake.

The problem with the various classification schemes is that they are too simplistic for classifying the complexity of human error. The value of trying to classify error in this way is to see if it assists in reducing the likelihood of negative human error consequences. Hale and Glendon (1987) criticise this normative approach to classifying omission and commission errors when applied to humans, as they can produce far more varied errors of commission, and they have their own understanding of the task objectives, as well as having their own objectives outside the task defined. The same reason can lie behind both types of error, for example incorrect diagnosis of a problem, and there can be many different reasons behind any one omission, for example attention failure, misdiagnosis, memory failure, deliberate act, clumsiness, confusion of instruments. They suggest that such classification has no psychological validity, and cannot serve as a basis for estimating probabilities of error.

Hull (1986) suggests that there are two different factors operating when an accident occurs:

◊ **operational factors** - a dynamic response which was not performed, or was performed in a wrong manner, when proper performance would have prevented an accident;

◊ **condition factors** - a static quality or nature of the environment, product, or user, in a context as existing at a given time or place, not necessarily derived from a specific accident.

For each accident there must be at least one of each factor, but accidents typically involve several of each. Human elements are most often operational factors in accidents. When an accident occurs, Hull suggests that there is a combination of simultaneous and sequential circumstances, without any one of which the accident may not have occurred. He therefore concludes that the only realistic evaluation is to determine the mechanism of injury and relate it to product design. He thus shares Wilson's views about the significance of product design, although reaching the conclusion by a different route.

Another related issue is the concept of **accident proneness**, where the responsibility for an event has been attributed to a person rather than the inanimate object with which they were working. Hale and Glendon (1987) examine three possibilities for considering the question of human responsibility through control:

- ◊ **individualistic** - the skill or fault of the individual concerned
- ◊ **societal** - the responsibility of others in the group or society
- ◊ **fatalistic** - due to external, un-influenceable factors

People make judgements about who they think is responsible for a given situation, and then infer that their action/inaction caused the accident. Hale and Glendon (1987) state that attribution research has shown that events which happen to an individual are described differently than descriptions of events which happen to others. Individuals have a tendency to place more emphasis on the role of external circumstances when explaining their own behaviour, whilst attributing personal responsibility to be the cause of events involving others.

The implication of this bias is that blame for accidents tends to fall, by default, on the victim. Accident proneness is accepted as a "common sense fact" which requires no support from scientific research, and which is highly resistant to contradictory research findings. This bias can lead accident investigators to start with a hypothesis that the victim is to blame, and lead injured parties to believe that they are the victims of circumstances.

Hale and Glendon (1987) suggest that both biases lead to underestimating the influence of external circumstances on behaviour. They argue that the accident proneness model has been dominant for far too long in accident research. From its inception in the 1920s, the model flourished with extensive research until the post war years when research interest began to decline. Although the concept was still dominant until the 1960s, in more recent years its value has diminished, as they believe it offers no practical assistance to those wishing to improve health and safety. They criticise much of the research into accident proneness for methodological difficulties, and comment that studies showing individual differences in accident liability are more likely to be the result of a task specific problem, rather than a universal failure to cope with all types of danger.

As previously noted by Hall (1996), the low level of use of the civil remedies provided by the Consumer Protection Act as a result of consumer product related injuries may be as much due to consumers considering themselves to be to blame, as the difficulty in proving that the product was defective, and that it caused the injury. The influence of human error, or common belief in "accident proneness" may also lead to under reporting of product safety complaints which may have led to criminal investigations.

2.11 Product Safety - the chain of responsibility

Dewis & Stranks (1988) consider that designers, manufacturers, and installers are directly responsible for ensuring the safety of their products used in the workplace. Importers and suppliers need the assistance of designers and manufacturers to ascertain and describe the nature and properties of the products they supply for the workplace. However, the onus is on designers and manufacturers to incorporate safety features into products, rather than the importer, supplier and installer who are not involved in the production process.

The ultimate sanction against importers, manufacturers, wholesalers and retailers is prosecution where goods are not reasonably safe, i.e. failing to meet safety requirements set out in Regulations, relevant standards or other relevant circumstances. The different enforcement notices of Health and Safety and Consumer Safety legislation have much in common. Although there has been a greater trend for prosecution for consumer safety offences, there has been a recent upsurge both in Health and Safety prosecutions and the level of fines.

It is vital that safety considerations feature highly in decisions for consumer product design, and before launching "improved" or "new" consumer products. As we have seen, in law the first supplier into the EC has prime responsibility to take positive steps to ensure the safety of consumer products supplied. However, wholesalers and retailers have a responsibility to establish what steps were taken by the manufacturer, and to take such additional steps as may be necessary to ensure the safety of target user groups.

In order to establish a process model for controlling product safety, Jenkins (1989) proposes that businesses should be led by a **Product Safety Policy**. This should set out their intention to ensure all goods meet all relevant legal requirements and standard specifications with regard to safety, and to keep abreast of all technical and legal developments to maintain product safety.

To identify the legal risks of producing/supplying unsafe products, he proposes a **Safety Audit**, which includes carrying out a risk assessment process of the safety of each product, and exploring how to reduce such risks via improved design, manufacturing methods etc. This provides an early opportunity to carry out the process of product safety appraisal, rather than at the marketing stage, once the product is on the shelf.

He completes the management strategy by proposing a **Product Safety Team** comprising senior representatives from technical, marketing, commercial and legal departments to act immediately should a safety problem be identified. This team must continuously promote product safety, initiate product recalls when necessary, publish warnings and ensure the business responds effectively in the event of a safety emergency.

Wilson (1983) presents a useful cost/benefit analysis of this approach which emphasises the need for companies to determine safety policies addressing design review procedures as shown in Figure 7. He also comments on his research into the utility of safety design review committees as perceived by the manufacturers who participated in his study.

His preliminary conclusions were mixed, noting that such procedures were found beneficial by some manufacturers, but unwieldy, time consuming and something which appeared to be pursued for "cosmetic" value by many others.

Wilson's research pre-dates current safety legislation. It would be interesting to review manufacturers perceptions in the light of the Consumer Protection Act 1987, and the new General Product Safety requirements to determine whether there have been any significant changes.

Figure 7 : Cost Benefit Analysis of Product Safety Policy

Source Wilson (1983) p 115

Dodge (1987) proposes a similar top-down management strategy, describing the need to document systems and procedures set up to achieve product safety, as evidence that the business is concerned with the users of products, and is addressing safety problems. He sets out managerial responsibilities for General Management, Marketing, Engineering, Quality Control, Manufacturing and Purchasing, and Field Service.

The responsibilities become more detailed nearer to the manufacturing process and customer base, are summarised in Figure 8.

Figure 8 : Managerial responsibilities for Manufacturers

Source : Dodge (1987)

This approach is consistent with that suggested by Jenkins, and parallels the concept of Quality Assurance systems to ISO 9001 (formerly BS 5750 : Part 1) - i.e. "Right First Time". In the 1994 revision of the standard for design, development, production, installation and servicing there is a new requirement for design input requirements to include applicable statutory and regulatory requirements. This represents important progress towards recognising the need to address safety criteria as early in the production process as possible, rather than attempting to identify potential problems at the marketing stage where the choice of solutions is limited to post hoc amendments to warnings and instructions.

Mackmurdo (1993) also propounds the principles of quality management for companies to meet their Health and Safety responsibilities via a risk management strategy, driven by an effective health and safety policy with meeting the risk assessment duty as the keystone. Whilst companies can assess products, premises, operations etc. for health and safety risks in many ways, recording the risk assessment process facilitates updating and validity checking and increases the visibility and repeatability of the logic used in risk assessment, and risk judgements and the effectiveness of control measures.

Dodge allocates additional ongoing responsibility to a Review Committee to carry out a formal, documented, systematic review of design, for all new designs and design changes. He suggests that the Review Committee must consider a number of questions in this review process, as set out in Figure 9. As will be seen in later chapters, this covers many of the areas forming part of the process of product safety appraisal which is at the heart of this research.

Figure 9 : Items for consideration in a Product Design Safety Review

Source : Dodge (1987)

2.12 Conclusions

It can be seen from this review of legal requirements from the fields of Health and Safety and Consumer Safety, that there are sound reasons for carrying out a comprehensive product safety appraisal, as early in the manufacturing process as possible, and this should be the subject of ongoing review, by appropriate personnel. Ideally, this approach would flow from a comprehensive Health and Safety Policy which addresses the product life cycle from its cradle to grave, to encompass potential consumer safety problems. An integrated quality management system could incorporate Health and Safety and Consumer Product Safety legal requirements and combine the recommendations of Mackmurdo, Dodge and Jenkins.

However, all too frequently, safety testing is purely concerned with finished products. Finished product testing by retailers is too late in the life cycle of a consumer product to influence safe design, and is largely concerned with making the product safer in use for the target group, through warnings and safety instructions supplied. At best, finished product testing represents the final safety net to catch potentially unsafe products.

As we have seen in the review of civil case law, safety instructions and warnings provide an important legal component in avoiding product liability claims, and they are a key ingredient in the definition of a safe product under the GPS Regulations. They may also assist users in avoiding errors in product use. Although the user can be forewarned about certain hazards, warnings and safety instructions will not make an inherently unsafe product "safe". Whether this safety information influences their safety behaviour critically depends upon the attention users pay to such warnings and instructions.

Ideally, independent safety testing incorporating human factors considerations of foreseeable use/misuse must occur much earlier, preferably as part of the manufacturing process. Schell (1987) criticises emphasis on evaluation of near finished, or finished products for human factors consideration, as reactive testing of this type leads to :-

◊ patching up problems by changing the documentation, rather than the product;

◊ limiting changes to addressing minor problems only;

◊ delaying development where major changes are required, necessitating subsequent re-testing of the amended product.

Schell advocates strongly that ergonomists must work in partnership with designers, much earlier in design development, providing input to written specifications and throughout product development, as a more pro-active process. This view is shared by Jenkins (1989) who suggested that provision of appropriate tuition in ergonomics and legal concepts in formal design training provided by UK academic institutions may be one means of bridging the skill gap. Thomas, Dziambor and Bruckmayr (1990) advocate that ergonomics testing during product development can ensure product safety compliance and establish whether it meets market needs.

Despite the benefits of conducting safety appraisal early in the design process, in practice, ergonomics finished product testing does provide a marketing aid to check whether the product fulfils the identified needs of potential users. It is also a major component of the distributor's statutory defence, to show that all **reasonable steps** have been taken, and **all due diligence** has been exercised to avoid the commission of a safety offence. Analysis of the decisions held by Appeal Courts in criminal cases, can assist in interpreting what steps a supplier must take to plead due diligence successfully. In essence these cases indicate that a supplier must have done something. The scale of the supplier's business operation, and the safety risks associated with the product will influence how much should be done in terms of whether to commission safety tests or rely on seeking details of safety tests results carried out by others.

It is clear that the courts consider that the bigger the business the more that must be done to demonstrate "diligence". Dodge's managerial checklist provides a useful basis for business in developing a safety defence, although it would require tailoring to the individual requirements of the given business operation, be supplemented with necessary documentation, i.e. records of what steps have been taken, and include a reasoned testing programme including reliance on third party testing as appropriate.

Chapter 3 : Approaches to Safety Testing

3.1 Introduction

At the end of Chapter 2, it was concluded that safety testing should be carried out in order to design and manufacture a reasonably "safe" product and to reduce legal liability if the product subsequently injured a user. Stadtler-Estrin and Estrin (1987) suggest, however, that it is impossible to achieve a consumer product which is safe for every potential user, although this is the clear aim of safety legislation. Moll, Panitch and Moll (1985) comment that while manufacturers, designers, lawyers, insurance companies, standards organisations, law enforcers, and consumer pressure groups have an impact upon product safety, they have quite different safety expectations or special interests. While consumers frequently blame manufacturers for shoddy design, manufacturers argue that accidents are caused by misuse of well-designed products. Cushman and Rosenberg (1991) therefore suggest that a balance must be struck between manufacturing cost, quality, and safety.

Cushman and Rosenberg (1991) suggest that product safety testing has three objectives:-

- ◊ to verify that the product is generally safe for both intended and unintended uses - this includes an evaluation of all safety features, including safety instructions and warnings;
- ◊ to verify that the product meets or exceeds the requirements of all safety regulations and standards; and
- ◊ to discover any unforeseen ways that the product may be misused.

This includes elements both of behavioural testing - concerning performing an activity with the product, and also conceptual testing - to anticipate situations of foreseeable misuse and to evaluate the safety instructions and warnings.

As we have seen in Chapter 2, the UK legislative framework requires that a product's safety risks be reduced to the minimum within a context of its reasonably foreseeable use. Regardless of the size of business operations, someone, somewhere should have tested consumer products to establish their safety. Where larger organisations would be expected to embrace the model for controlling safety as previously described by Dodge (1987) and Jenkins(1989), smaller organisations may simply rely on assurances of their suppliers that testing has been carried in accordance with relevant safety legislation.

This Chapter considers the types of safety testing currently carried out on consumer products, seeks to determine any common approaches, and identify any essential elements for inclusion in a developing a model for product safety appraisal.

3.2 Product Safety Experts

There is a growing body of research into consumer product safety. As seen in earlier sections, work is also sponsored by the DTI and safety organisations to inform the process of legislative development, and for developing programmes of consumer education and other potential mechanisms of accident intervention. This has stimulated the level of safety expertise within these organisations. There are also consultants, and experts who may be based in academic or medical institutions, in trade or safety organisations who are prepared to express opinions on consumer product safety.

These product safety experts may be called upon by importers, manufacturers and other suppliers of consumer products to develop and evaluate their **Due Diligence** safety management systems, where necessary, providing independent evidence on behalf of the supplier in relation to the supply of an unsafe product. Equally, however, they may be requested to give evidence on behalf of enforcement agencies to examine goods that consumer goods are unsafe. As explored in Chapter 6, the results of the author's survey of local authority Trading Standards Departments indicate that 59% of respondents occasionally used product safety experts, and 13% regularly use them for safety testing services.

In carrying out safety appraisals of consumer products in the context of the General Safety Requirement, in the absence of prescriptive guidelines, there is typically an eclectic mix of contributions drawing on various academic disciplines, actual experience in the practical application and interpretation of the requirements of consumer protection legislation and standards, and knowledge of levels and types of consumer complaints. This may not include an ergonomics consideration of the consumer product. Many larger manufacturers and some major retailers and industry research associations employ in-house testing facilities which can provide a range of "objective" testing, and comprehensive physical facilities.

However, these testing regimes may also be vulnerable to the judgmental heuristics discussed in Chapters 1 and 4. Users and engineers are poor at estimating risk in many situations, and Dejoy (1987) has found that inaccuracies in risk assessment are not reduced by training or experience. An understanding of the susceptibility of individuals to this type of bias is vital in devising an appropriate safety test programme, in considering published accident statistics, and in interpreting "user" accounts of alleged injury associated with consumer products. The safety testing methodology which is the subject of this research and presented in Chapters 7 and 8 has been based on the various approaches to hazard analysis used by the organisations approached for assistance, and from available literature.

3.3 Established Test Houses

There are many established test houses in use by enforcement agencies, some of which are specifically accredited via national schemes for testing products against the requirements of specific regulations, or safety standards, or for type testing of product to apply a CE mark to indicate its compliance with "new approach" legislation mentioned in Chapter 2. Their authorisation to test consumer products in these specific areas in the UK may be given by the Department of Trade and Industry (DTI), or National Measurement Accreditation Service (NAMAS) or the British Standards Institution (BSI).

Typically, however, these test houses apply a very specific set of criteria in their testing programmes based on methodologies laid down in standards, and rarely consider the more subjective and human factors approach necessary to address the General Safety Requirement, and the interaction between the user, the product and its context of use. In fact, the rules of NAMAS accreditation for specific test methods preclude giving opinions based on test results to ensure consistency. This means that opinions are rarely given by these test houses on whether a consumer product is "safe" or "reasonably safe", and test reports will merely indicate the scope of the test carried out and a pass/fail result.

Baber & Mirza (1995) conducted surveys on organisations involved in the evaluation of consumer products to assess the role of ergonomics in the evaluation of "white goods", and the ergonomics methods employed in product evaluation. They recognise the importance of product evaluation as a means of testing whether a product meets a particular standard, and its role in relation to accident investigation, which though divorced from the design process can provide feedback into subsequent design activity.

They commented on the different models of user behaviour held by the original product designer (who will have been involved with the product throughout its development), the user (who may be encountering the product for the first time), and an evaluator (who may hold certain beliefs and assumptions concerning what would be "normal" human activity when using a particular product).

Baber and Mirza therefore stressed the need to make explicit the "model" of human behaviour in use in any testing protocol. In the six test houses of white goods surveyed, five were concerned with compliance with standards and legislation, and three were also concerned with accident investigation. They found little evidence of ergonomics in product evaluation, and the most common reasons given were lack of knowledge and lack of training. None of the relevant product standards in use required an ergonomics evaluation.

Their second survey concerned organisations employing practising ergonomists, to determine methods of ergonomics evaluation of white goods. Baber & Mirza identified two broad classes of method: observation of user; and self report through expert appraisal, checklists, questionnaires and interviews. These methods were used in different combinations but interestingly, ergonomists responding were more concerned with a product's usability rather than its safety. However, respondents felt that ergonomics evaluation would lead to safer products as well as products which were easier to use.

3.4 Institute of Consumer Ergonomics (ICE)

As briefly discussed in Chapter 1, the **Institute of Consumer Ergonomics** (ICE) carry out General Safety testing commercially, primarily for enforcement authorities. They also conduct ergonomics research for the Department of Trade and Industry. ICE is also frequently consulted by prosecuting local enforcement authorities to seek an opinion concerning whether a product is reasonably safe particularly where there is no published safety standard, and ICE are frequently called as prosecution expert witnesses.

Rennie (1981) provides an insight into the ICE approach, in describing the increase in interest in ergonomics since ICE was established at Loughborough in 1970 with joint funding from the Consumers' Association and Loughborough University. She comments on the contrasting dearth of published research on consumer product evaluation, suggesting this might reflect a researcher perception that such work may not be of general interest, or that it may not stand up to rigorous scientific examination. She stresses the need to conduct an ergonomic assessment, in order to consider the user / product interaction. Rennie describes three complementary types of ergonomics test:

◊ the **user trial** - employing potential or actual users;

◊ the **expert appraisal** - requiring an expert to evaluate the product based on previous experience and knowledge; and

◊ **performance tests** - attempting to simulate use of the product.

She advocates that the way the product is used, together with findings from seeking user opinion will tend to dictate which is the most appropriate test method. Rennie proposes that a task analysis is performed by systematically listing all of the operations involved when using the product, including occasional use such as cleaning and maintenance. Figure 10 summarises types of product evaluation, and the outline task analysis procedure.

The next stage of ergonomics assessment is to indicate relevant general criteria for each task, and evaluate the priority for each task and criterion based on the frequency of operation, and how critical it is.

Figure 10 : Summary of Testing Alternatives

PRODUCT EVALUATION

→ **TECHNICAL TEST**
No user reference

→ **ERGONOMICS TEST**
Consider user interaction

→ **USER TRIAL**

→ **EXPERT APPRAISAL**

→ **PERFORMANCE TEST**

DECIDE based on extent :	**DECIDE** based on
- ***of product/ user interaction***	- ***tasks involved***
	* day to day use
	* storage
- ***knowledge about product use***	* adjustment
	* installation
	* maintenance
- ***potential hazards***	* cleaning
	* understanding of instructions
- ***relevant criteria***	* safety
	* ease/ difficulty of use
	* convenience
	* comfort
- ***each task/criterion importance***	

Source : Summarised from Rennie (1981) p 164

Rennie indicates that user appraisals are expensive and time consuming, and suggests that expert appraisals can give valid and reliable results at less cost. She advocates the use of checklists to ensure that all aspects of the product are covered, to improve reliability where different experts are used, and which also serve as a useful record of product features. However, she stresses that a major pitfall in using experts is that they may fail to identify crucial points highlighted by the inexperienced user.

Rennie advocates use of performance tests where there may otherwise be risk to the user, or where full scale user trials would be too expensive or time consuming. Physical measurements can be made, and anthropometric data can be used to devise simulations of human interaction with a product. For example, finger probes simulating the size of children's and adult's fingers can be used to test potential finger trapping hazards, or whether heating elements in gas/electrical fires are capable of being touched. Indeed test fingers are included in relevant safety standards determining the essential safety requirements for example for fireguards for heating appliances.

However, Rennie comments that there may be conflicting results from user trials and expert trials if carried out in tandem. This can be due to the fallibility of user opinion, and the over attention by some users to aesthetic appeal at the expense of potential difficulties related to a particular feature.

3.5 Comparative Testing - Consumer's Association (CA)

Kirk and Ridgeway (1970 & 1971) describe consumer product testing procedures in two articles, referring to the ergonomics techniques employed. They were primarily concerned with early brand evaluation testing of the type published by the Consumers Association in "Which?" magazine. They discuss the role of physical testing to consider product safety, efficiency, reliability and desirability, and for conducting safety tests laid down in standards and legislation. Physical tests permit close control and standardisation, but their design must be relevant and closely simulate how consumers use the product, as established from preliminary investigations.

These preliminary studies are necessary to identify the actual and/or potential consumers, and how they use the product in day to day use, cleaning, maintenance and storage.

Kirk and Ridgeway suggest that ergonomics tests, almost by definition, require users in a representative sample to follow a carefully specified procedure for each aspect of use in realistic every day environments, for example in day to day use of the product, including short-term storage, cleaning, maintenance and repair, and also any differences associated with long term storage. As users run through each operation for each aspect of use, the safety, efficiency, reliability, durability and comfort can be assessed by observation and through systematic questioning of the users' views.

Kirk and Ridgeway caution about the apparent simplicity of observational techniques, however, as their success depends largely on the skill of the observer in recording behaviour. For this reason, they also advocate obtaining subjective preference data via self-reporting questionnaires or interview. They report greatest success with carefully constructed questionnaires based on each product operation, administered by the experimenter, immediately following each operation, to avoid interference of subjective biases in recall to be discussed in Chapter 4.

The framework of hazard analysis currently adopted for brand evaluation and comparison by the Consumers Association Research Laboratory (CA) was also considered as part of this research, following a visit to the CA test laboratory. Their current approach follows the physical testing model outlined by Kirk and Ridgeway, and draws upon a pool of a panel of 2500 volunteer "users" living near to the Research Laboratory who participate in user trials.

Butters (1995) discusses the technical performance testing currently carried out at the Consumer's Association Research and Testing Centre, which includes an assessment of the convenience of a product, encompassing all usability aspects including appropriateness of functionality, comfort, ease of learning, usage and maintenance. Convenience data are gathered from observed user trials at the CA testing centre and gardening sites; home user trials where subjects try a product out in their own surroundings; discussions with users; convenience checklists administered by testing staff and expert appraisals by an ergonomist. The testing method is chosen to provide comparative data rather than the exploratory or diagnostic data required in other testing protocols discussed within this section. Appropriate users are selected with regard to information on a database of panel members. Butters recognises that there is a difficulty as to whether their panel of volunteers are truly representative, being WHICH? subscribers and essentially self-selecting.

Where home user trials are employed to provided essential domestic realism, users are allowed sufficient time to familiarise themselves with the product, and to test it thoroughly according to the tasks specified. Where a greater degree of experimental control is required, particularly where a product has practical drawbacks for testing at home for safety reasons, or installation difficulties, Butters describes individual or group user tests at the research laboratory. These trials enable observation of users, their approach to the tasks, difficulties and errors made, but lack the realism of testing in a domestic environment.

The typical obstacles which would be encountered in a domestic setting are introduced into the test setting to maximise realism, and trials may be video recorded. Users then complete questionnaires using 5 point rating scales and may participate in interviews probing particular issues, and results are compared with observations. Discussion groups have been found to provide valuable information, but groups can be susceptible to opinions of one group member, a wish to share "the middle ground", or an unwillingness to admit negative aspects of product interactions.

The convenience checklists which have been designed with reference to standards, results from previous trials and ergonomics guidance on good practice, e.g. on dimensions, are used individually by a team of trained laboratory staff, who then discuss the findings to reach a consensus. However, Butters stresses the careful controls necessary over the design and use of checklists, so that they are sufficiently precise and prescriptive to ensure fair and consistent use by different testers - but also to avoid being too long winded and time consuming. Once produced for specific products, the checklists must be kept updated with changes in legislation and standards as well as product changes. Butters also cautions about the familiarity testing staff have with products, particularly when they have been involved in several product trials, such that they may be "too expert" to represent the naive user. She considers the strengths and weaknesses of using checklists and the regular reviews of the CA checklists to reflect changing consumer usage.

Butters describes the importance of expert appraisals to predict how a product is likely to suit a range of users over time and to identify design flaws which may lead to problems where a full-scale user trial is not possible or where assessment of compliance with standards is required. Butter agrees with Baber & Mirza (1995) in stressing that the expert's experience of the product and knowledge of likely user behaviour is vital, but comments that this knowledge may prejudice the opportunity to assume the role of user.

This process of convenience assessment is under review by the CA to shorten the time taken in data collection to provide reports quickly to maximise topicality and brand coverage, whilst maintaining a robust and reliable method of data production. A key concern is the size of user group to be used. Virzi (1992) has indicated that 80% of usability problems are detected with 4 or 5 subjects. Lewis (1994) found that additional users were successively less likely to reveal new information. Virzi and Lewis differed as to whether the most severe problems were likely to be identified by the first 4 or 5 subjects. Butters suggests that the CA will continue to apply a mixture of methods including periodic user trials to update and validate their convenience checklists coupled with observation of the product in use and interviews.

Brown (1995) emphasises the need for methods of product assessment to be developed that can fit within the increasingly short time spans demanded by industry, but still meet the high standards of reliability and validity of the ergonomics profession. She contends that manufacturers fail to understand the complexity of embracing ergonomics in product development and see ergonomics as "common sense".

She cites studies by Gould and Lewis (1985) which demonstrate that manufacturers fail to recognise the need for early focus on users and tasks, empirical measurement of product usage and iterative design in their pursuit of reduced product lead times from the drawing board to the market.

Brown also cites the increasing use in marketing of terms such as "user friendly" and "usability", reinforcing Rubin's (1994) view that "many companies simply jump on the usability bandwagon without first putting in the requisite effort to make genuinely usable products". She therefore argues for the continued need for comparative testing as carried out by the CA as their evidence from product testing and consumer surveys is that product differences do exist, and products are a long way from being fully fit from the purpose for which they are intended. She also believes the CA plays a vital role in the standards making process, and in elevating the importance attached to ergonomics issues, and in increasing consumer awareness to empower consumers to make informed decisions and to achieve measurable improvements in goods and services.

To ensure that there can be no conflict of interest, the Consumer Association Research laboratory only carries out testing and research for public bodies which precludes testing for individual suppliers or manufacturers. Their work is therefore always seen to be in the public rather than private interest which ensures their integrity in campaigning for consumer interests and enhanced product safety.

3.6 The Usability Laboratory

Benel and Pain (1985) propose the concept of a usability laboratory, staffed by multi-disciplinary teams of professionals, with a range of experimental equipment to measure :

- ◊ ambient conditions;
- ◊ light;
- ◊ sound - levels, vibration etc.;

- ◊ stimulus conditions - simulators, tachistoscopes, slide projectors, audio - visual equipment;
- ◊ outputs - timers, videotape systems, cameras, tape recorders etc.;
- ◊ physical characteristics of user - anthropometer, callipers, tape measures, scales etc.

together with equipment to analyse outputs, such as calculators, microcomputer software, video editing equipment etc. They advocate hazard analyses to assess safety aspects to identify patterns of product/user interactions contributing to accidents through accident statistics, reported injuries and deaths, and customer complaint data, to evaluate products for :-

- ◊ ease of use
- ◊ ease of learning
- ◊ pleasantness of use
- ◊ whether the product possesses features necessary for the task in hand.

3.7 In-house Testing Carried out by Enforcement Authorities

These different approaches for addressing usability would exceed local authority resources for Trading Standards Departments who carry out their own safety testing of products prompted by consumer complaint or where identified through officer initiative as being worthy of investigation.

As explored in more detail in Chapter 6, the results of the author's survey of local authority Trading Standards Departments indicate that 90% of respondents carried out safety screen testing, and 37% of respondents regularly and 46% occasionally operated their own internal screen test facilities. Screen testing is typically carried out to select items for testing by external test houses from a wide range of products.

However, in some instances it may extend to more in-depth tests where a testing programme can be readily developed in-house. In the survey of Trading Standards Departments 11% of respondents occasionally carried out screen testing for other Departments.

In carrying out in-house testing officers must identify relevant Safety Regulations, and in priority order consider harmonised European standards or UK legislation and standards and other published safety requirements relevant to the product under test. The testing approach does not include a systematic task analysis of the operations involved when using the product and relies heavily on the tester's intrinsic "expert" system. Such "ad hoc" testing rarely provides the opportunity or necessity for use of comprehensive or sophisticated test equipment, unless there is the need for frequent repeated testing of this type of product. As explored in more detail in Chapter 6, the author's survey results show that 90% of respondents indicated that they would be interested in applying a protocol for hazard analysis to assist in evaluating the safety of consumer products.

3.8 The Need for a Product Safety Testing Protocol

A professional body of enforcement practitioners was set up in March 1991, following a meeting of European Enforcement Officers in 1990. Funded by DGXV division of the Commission, the Product Safety Enforcement Forum of Europe (PROSAFE) provides a European forum for experts in consumer product safety and aims to achieve effective, efficient and fair enforcement of consumer product safety legislation. Membership is open to experts who execute the same legislation throughout the European Economic Area, and a key remit is to encourage liaison between enforcement practitioners to enable an exchange of ideas on the improvement of the enforcement function.

PROSAFE is currently researching instances of inconsistency of test house reports, and is seeking a protocol for risk assessment procedures for use by Member States to increase uniformity in safety enforcement. What has become increasingly clear, as indicated in Chapters 2 and 5, is that there appear to be cultural differences in safety expectations, and this may result in differentiation in the process of standards making. This has been demonstrated by European differences in the level of reporting via RAPEX and via the specific "safeguard procedures" in relevant Directives from different EC countries. Thus it is possible that there are different levels of safety being enforced by UK and European enforcement counterparts, hardly consistent with the concept of a single market, due to cultural differences in consumer complaining and/or the hazard analysis trigger for enforcement action.

A systematic approach to hazard analysis, drawing more formally upon ergonomics disciplines of hazard analysis and task analysis, which may utilise the common methods identified by Baber and Mirza, is likely to provide a more comprehensive and objective product appraisal. Greater discipline in applying this systematic approach would not necessarily restrict the scope for conducting safety testing by enforcement authorities, nor necessarily require the sophisticated testing equipment used by laboratories specialising in specific types of consumer product, or testing in volume. However, it would enable the circumstances where such equipment is essential to be identified, and provide a structure for safety testing which provides greater confidence in test results.

The two stage hazard analysis and risk assessment protocol developed by the author, and described in greater detail in Chapters 7 and 8 has been presented to the PROSAFE group at their meeting in September 1997, and is currently undergoing an evaluation by EC Member State representatives.

Chapter 4 : Risk Assessment

4.1 Introduction

This Chapter explores in further detail the interacting human factors contributions of the person or user, the product, and the task or activity, which were introduced in Chapter 1, and it draws on research in fields of consumer product safety, and occupational safety. Inevitably, it is difficult to address each system component separately, and there is a degree of overlap in the literature discussed and concepts presented.

In considering the **user**, the contribution of cognitive factors such as perception, risk assessment, information processing, and decision making are examined in further detail, developing the definitions outlined in Chapter 1. The review of literature on risk seeks to consider the different meanings of risk and how it is assessed. Issues regarding user awareness and comprehension of safety instructions and warnings are also considered to assess how this information contributes towards safety behaviours in product usage.

In considering the **product**, the "clues" briefly mentioned in Chapter 1 are explored, and literature is reviewed demonstrating the importance of design and design review for product safety and occupational safety.

It is much more difficult to address the fourth interacting component in the model represented in Figure 1, to explore the diversity of **tasks** and **locations** the user experiences in everyday life to distinguish the circumstances giving rise to accidents from those which do not. In considering these environmental aspects, or contingencies, the "real world" is an open system which is conceptually "noisy" and it is difficult to separate the individual and interactive contributions of user, product, task and location.

Occupational safety research in the "real world" is arguably more able to restrict the range of tasks, locations and user experience under scrutiny, but it is debatable how far these findings can be extrapolated to everyday domestic situations concerning use of consumer products. Thus, where relevant, the importance of location or situational factors is considered within the sections examining user, product and task factors.

Following consideration of ergonomics approaches to task analysis, the Chapter concludes with an overview of the contribution task analysis makes to the process of hazard analysis and implications for developing a safety testing protocol. Based on the conflicting evidence within much of the risk assessment research, the overwhelming conclusion would appear to be that the research asks the wrong questions to be practical use in developing an approach towards safety appraisal. Of greater practical value in addressing the research objectives are the techniques of hazard identification and hazard analysis.

4.2 The User and Understanding Risk

The concept of risk is a thread which runs throughout this section, and which appears to a considerable extent in the foregoing sections. A review of literature concerning risk is essential in addressing the psychological factors which are important when the user interacts with a consumer product, considering theories of risk perception and cognition, the decision making processes of risk assessment, and individual differences in the way these psychological processes influence subsequent behaviour.

The legal requirements considered in Chapter 2 address "risk" in its legal context. The concept of risk is increasingly key in consumer safety and occupational safety, and is fundamental to European legislation implemented within the single market. There has been a proliferation of literature on risk, but it is apparent that many researchers and professionals use risk to mean different things in different contexts. In fact, Doderlein (1987) suggested that attempts to define the concepts of risk have proven to be a useless exercise. As such, it is difficult to draw unequivocal conclusions based on the literature to determine those factors of major importance.

Brehmer (1987) cites the list of risk definitions used by Vlek and Stallen (1981), as shown in Figure 11, which produces context free abstract definitions concerned with probability and loss, requiring an expert judgement of objective aspects of risky events under consideration. Brehmer criticises their limited psychological validity and remarks that work has been more concerned with identifying factors which affect risk assessment, rather than relating subjective risk to objective risk.

Figure 11 : Common Risk Definitions of Risk

- the probability of a loss;
- the size of probable loss;
- a function, mostly the product of probability and size of loss equal to the variance of the probability distribution of all possible consequences of a risky cause of action;
- the semi-variance of the distribution of all consequences, taken over negative consequences only, and with respect to some adopted reference value;
- a weighted linear combination of the variance of and the expected value of the distribution of all possible consequences.

Source : Vlek and Stallen (1981)

Subjective risk is an individual's perceived risk, and **objective risk** is the actual risk of an accident occurring. Hale (1987) suggests that the subjective risk approach requires a study of situations which the person(s) being studied **consider dangerous**, whereas objective risk approaches require an arbitrary definition imposed by an **expert** of situations which **are dangerous**. He concludes that the only difference between the approaches is who imposes the definition. In each case, the factors taken into account, and the suitability of the definition for its purposes are important.

The Consumer Safety Unit (CSU) (1989) remark that:-

> " There are many definitions of the word "risk" when it is used in the context of studying consumer safety. Risk is often regarded as a measure of the uncertainty involved in being exposed to a hazard. Risk measures the likelihood that there will be an undesirable outcome arising from some activity compared with the possibility that the outcome will be favourable."

The CSU also establish a link between "safety" and "risk" and in so doing underline the contradictions inherent in this field:

> "To say that something is safe, effectively means that the risks are known and deemed to be acceptable for the benefits conferred..... To define safety as is done above, in terms of "knowing the level of risk" involves contradiction, since risk is a measure of the unknown not of certainty."

4.3 Objective Risk

It was mentioned in the introduction in Chapter 2 that the public erroneously believe that accidents are more likely to occur in the workplace than the home, and that the low incidence of catastrophic injuries and deaths tends to attract greater interest than the higher proportion of deaths due to natural causes. This underlines the gulf which can lie between subjective and objective risk.

Morgan (1989) quoted the Royal Society Group (1983) definitions of risk as:

> "The probability or the likelihood that something unpleasant will happen"

He then endeavours to provide objective indices of risk assessment citing data provided by the BMA (1987), ranking a number of important events and aspects of human activity and behaviour in order of risk assessment. Although only 3% of deaths were due to accidents and violence, their significance is increased, as this proportion accounts for a large number of premature deaths in the young.

Table 4 sets out the objective "risk" of dying from various causes as summarised by the BMA (1987). Smoking is four times more likely to kill than natural causes, yet smoking behaviour is accepted by many individuals as commonplace. The risk of death from influenza is five times higher than the risk of death by accident at home and nine times higher than the risk of death at work.

Table 4 : Risk of an individual dying in one year from various causes

Smoking 10 cigarettes a day	1 in 200
All natural causes, age 40	1 in 850
Any kind of poisoning	1 in 3,300
Influenza	1 in 5,000
Accident on the road	1 in 8,000
Leukaemia	1 in 12,500
Playing Soccer	1 in 25,000
Accident at Home	1 in 26,000
Accident at Work	1 in 43,000
Radiation / Working in radiation Industry	1 in 57,000
Homicide	1 in 100,000
Accident on Railway	1 in 500,000
Hit by Lightning	1 in 1,000,000
Release of radiation from nearby nuclear power station	1 in 10,000,000

Source BMA (1987)

HSE (1997) comparative statistics for occupational deaths, as shown in Table 5, provide an objective indication of occupational safety risks, demonstrating that fatal injuries are most likely in agriculture and construction industries. In comparing these data with equivalent statistics for Germany, France, Spain and Italy, HSE note that British rates of fatal injury are one of the lowest in Europe.

Table 5 : Rates of occupational fatality in Great Britain per million at risk (1994)

Industry	Deaths per million employees and self employed	Ratio of workers per death
Agriculture	85	1:12,000
Construction	69	1:14,500
Transport	20	1:50,000
Manufacturing	12	1:83,330
Utilities	6	1:166,650
Other services	4	1:250,000
All industries	9	1:111,100

Source : Health & Safety Executive, Government Statistical Service (1997)

In examining how deaths occur, Morgan identifies falls primarily occurring in the home as the second major killer following traffic accidents. Fire is the next major cause of home deaths, followed by poisoning and suffocation. Morgan concludes that in living with risk, people spend an undue amount of time worrying about small risks over which they have no control, rather than the large risks about which they could do so much more.

Through Home Accident Surveillance Statistics, the CSU endeavours to collect, study and analyse accident statistics as a basis for information on the safety and risk associated with different consumer products and different circumstances. This recognises that safety is only one factor which people take into account when organising their lives, and that acceptance of risk is a fundamental part of daily life. The CSU tries to balance the level of risk and safety in consumer products by endeavouring to control hazards through legislation and standards.

Consumer safety policy in the UK leaves consumers to choose their personal risks based on information on possible risks and sensible safe behaviour. A new focus in research work conducted by the CSU during the 1990s has been through ergonomics studies of safety of consumer products, and psychological study of consumer attitudes to risk, including the cognitive psychology of risk, feelings of control, benefits of taking risks, and the difference between attitudes and behaviour, risk compensation, and the social psychology of risk.

4.4 Individual Biases in Risk Perception

Before developing the discussion concerning theories of risk perception, the judgmental heuristics identified by Kanis and Weegels (1990), Dejoy (1987) and Tversky and Kaneman (1978) discussed in Chapter 1 must be highlighted as a source of bias in individual risk perception, i.e. availability, suppression, anchoring, over-confidence, hindsight, and causality.

Loftus and Palmer (1974) studied perception and retention of accident scenarios and found that the way questions were phrased influenced people's recollection of events. A group of experimental subjects was shown a film of a car accident and were asked a question estimating the speed of the vehicle using phrases "smashed", "bumped" or "hit" in relation to the collision between the two vehicles depicted in the film. The word "smashed" within the question resulted in a higher speed being estimated in response. On a follow up retention study, more of the group incorrectly reported seeing broken glass in the film where the question included "smashed" than the group where alternative phrases were used.

In her study of eye witness testimony, Loftus (1979) also identified three stages which could lead to inaccurate reporting of an incident:

◊ **acquisition** - when an event is perceived and information about it is initially stored in memory;

◊ **retention** - when information is resident in memory;

◊ **retrieval** - when memory is searched and pertinent information is retrieved and communicated.

This literature underlines the ways in which our perceptions can be coloured, and why individual risk perception cannot be readily or consistently predicted.

4.5 Risk Theories

Smith (1989) identifies three behavioural factors which cause people to take unnecessary risks:

◊ **misuse** - either knowing misuse of a product to make it easier and quicker to use, or unknowing misuse;

◊ **lack of awareness of hazards** - which can overlap with unknowing misuse;

◊ **misperception** - where risks are perceived, but the perception is inaccurate.

Wilde (1982) introduces the concept of **Risk Homeostasis Theory (RHT)**. This suggests that individuals have a target level of objective risk and that they will vary the level of subjective risk they are prepared to take to keep the objective risk constant. He contends that introduction of safety measures intended to promote safer behaviour will fail, because the user will increase the personal risks taken to maintain an equivalent level of objective risk.

For example, if a bitter tasting substance is added to bleach to discourage children from swallowing it, parents now perceive that this product is safer, i.e. its subjective risk is reduced. The risk homeostasis theory suggests that this will result in parents taking less care to keep bleach out of children's reach, so that the objective risk remains constant.

Risk Homeostasis theory questions the efficacy of introducing safety measures and their impact on safety behaviour. It emphasises the importance of attitude changing safety measures to increase people's attitudes and desire to be safe as a means of influencing safety behaviour, and lowering objective risk.

McKenna (1985) is critical of the validity of the risk homeostasis theory, questioning the assumptions Wilde made, that people :

◊ have a simple straightforward representation of accident risk
◊ can detect all changes in this accident risk
◊ can, over time, completely compensate for changes in accident risk
◊ cannot be discouraged or prevented from compensating for changes in accident risk.

McKenna cites research by Slovic et al (1982) identifying the difficulties people have in dealing with objective risk, and systematic biases in the way the risk information is presented which affect risk assessment. In a similar vein to the findings of Loftus previously cited, Slovic states that expressing an increase in likelihood of death as 30% higher per year, rather than stating the increase as from 1 to 1.3 per 10,000, causes a more dramatic change in risk assessment of annual mortality. Similarly, Slovic et al (1977) found that although people were willing to buy insurance against moderate to high probability losses, they tended to ignore low probability high loss events.

McKenna also argues that some safety measures are psychologically "invisible", and as such, they should provide a means of preventing compensatory behaviour. In support of continued use of safety measures to improve safety behaviour, McKenna cites various research where he considers that safety measures were effective in improving safety behaviour, and questions whether people do compensate for change in risk, and whether such compensation can be effectively discouraged. Wilde (1984) responds to these criticisms by questioning the methodological validity of some of the studies cited by McKenna, the way in which McKenna interprets their findings, and McKenna's fundamental reasoning.

In the context of everyday interactions between users and consumer products, risk homeostasis theory is useful in considering how best to influence the user to behave more safely. Safety campaigns or safety instructions should minimise changes in perceived risk whilst maximising the change in objective risk. Thus, the introduction of kick-back devices on chainsaws must not be oversold, or users' subjective risk may be reduced to the point that they think chainsaws are safer than they really are. Risk homeostasis theory predicts that users will take more risks to keep the objective risk constant. This will result in increasing the objective risk. If legislation were introduced requiring such devices on all chainsaws, publicity and general user awareness should not only mention kick-back injuries, but also risks of loss of control through inattention, loss of balance, and the need to keep children and pets well clear. This should redress any risk homeostasis due to extolling the benefits of the kick-back safety features. Also of relevance is trying to encourage social approval of wearing of the necessary protective clothing when a chainsaw is in use.

RHT theory therefore, has implications of relevance to user, product, task interactions in influencing enhanced/reduced safety behaviour. The following factors are important to consider in planning national safety campaigns or implementing safety legislation:

◊ **factors which may reduce safety benefits**
- high visibility
- high publicity
- low risk visibility

◊ **factors which may reduce risk compensation**
- low visibility of safety device
- low publicity for safety device

◊ **factors which may accentuate safety benefits through compensation**

- misleading publicity as to safety benefit
- obvious apparently negative safety benefit

Stoner (1961) reports that individuals within a group tend to shift their individual risk perception towards the group consensus, known as Risk Shift. In the research, individuals reported their own risk assessment of the probability of success of a course of action, i.e. **pre-consensus**, and then discussed the alternatives within a group, i.e. **consensus**. They then reported their own assessment, i.e. **post consensus**. Stoner found that the consensus and post-consensus judgements favoured a riskier decision than the average pre-consensus results would suggest.

Moscovic and Zavalloni (1969) reported this shift in risk is not always towards a riskier decision, but tends to be towards the average individual judgements, which they termed **group polarisation**.

This is again of relevance in attempting to predict individual risk perception. An individual may be reluctant to use a pressure cooker having heard of instances of pressure build up and explosion. Discussing this with friends who use pressure cookers and consider them to be safe, the person may change the original perception of the risks involved. Conversely, if friends also strongly believed that pressure cookers were dangerous, this would strengthen the original perception and the individual's resolve not to use a pressure cooker.

Gärling and Gärling (1990) studied parents' and non-parents' reactions to various scenarios to assess reported indicators of residential satisfaction as to perceived safety, perceived attractiveness, intentions to protest, and intentions to move. The scenarios were intended to increase/decrease children's accident risk in the home, and in neighbourhood play spaces: to increase/decrease children's traffic accident risk in the neighbourhood; and other scenarios having no bearing on accident risk.

Parents and non-parents were asked to rate :

◊ the attractiveness of their home and neighbourhood,
◊ how safe they felt,
◊ how strongly they would feel about protesting about these changes,
◊ whether they would move,
◊ the perception of children's accident risk,
◊ the likelihood of an accident being caused to a child in the specified age range due to :
    ♦ causes in the environment
    ♦ the child
    ♦ the parents
    ♦ other people
    ♦ chance.

Interestingly, parents and non-parents recognised an equivalent extent of risk in each scenario and felt that the environment played a greater part in accident causation, but they rated residential satisfaction with each scenario differently. Parents' residential satisfaction was affected by their perception of children's accident risk. Non-parents were less concerned with measures which increased child accident risk, and responded less favourably to scenarios decreasing child accident risk. This work highlights the importance of attitudes in risk perception, and as discussed previously, the value of influencing attitudes to safety behaviour.

4.6 Attitudes to Risk and Behaviour

There is an assumed relationship between attitudes and behaviour. Attitudes are not directly observable and historically have been measured indirectly through rating scales after Thurstone (1929), Likert (1932), and Osgood (1957). Reich and Adcock (1976) comment that it is much easier to predict someone's attitudes and values from their behaviour, than to predict the converse. They advocate concentrating on changing behaviour as a means of influencing attitudes and values.

It is interesting, therefore, that much of the emphasis in safety awareness campaigns is on influencing attitudes as a means of modifying behaviour.

In simple terms, which Rosenberg and Hovland (1960) identified three components of an attitude as illustrated in Figure 12:

- ◊ **cognitive component** or beliefs about the attitude object
- ◊ **affective component** or feelings about the attitude object
- ◊ **behavioural component** or tendency to react to an attitude object in certain ways.

Figure 12 : Three Component View of Attitudes

Source Rosenberg and Hovland (1960).

The affective component may vary in intensity and direction, and as it is the most deep rooted of the three, it may be the most difficult to change.

Festinger (1957) proposed the **cognitive dissonance theory**, and predicted that people are likely to expose themselves to attitude **consonant** information, and avoid attitude **dissonant** information in order to stabilise a decision or existing attitude. For example an enthusiastic hang glider may avoid information stressing the dangers of hang gliding, but have regard to the perceived benefits such as keeping fit.

Frey and Rosch (1984) observed selected attention to certain information in their **selective exposure hypothesis**, but Frey (1986) also found that people sometimes select dissonant information. The research previously cited of Stoner (1961) showing shift in risk perception towards consensus, and early work by Asch (1956) and Vaughan and Mangan (1963), which demonstrated the tendency to conform with the majority opinion, even though their responses were incorrect, exemplify the power of conforming to the norm.

Fishbein and Ajzen (1975) propose a **theory of reasoned action** as illustrated in Figure 13, to demonstrate the relationship between attitudes, beliefs, behaviour, and behavioural intention. **Behavioural intentions** are a pre-disposition towards a certain action, and are not affected by attitudes and subjective norms. Both of these are influenced by **beliefs** or opinions held about the attitude object.

Figure 13 : Factors determining a person's behaviour : Theory of reasoned action

Source Ajzen & Fishbein (1980)

This demonstrates that attitudes are only part of behavioural intention, and therefore of subsequent behaviour. This has a major implication for safety awareness messages or campaigns. Various strategies need to be employed to ensure a greater probability of safety behaviour change through influencing attitudes.

Hale (1987) introduces the concepts of **hazard** and **danger**, and **harm**, as defined within a systems framework in Chapter 1, which are applicable in this examination of subjective risk. He poses various questions about subjective risk assessment in order to try to explain, predict and modify behaviour in the face of danger:

◊ Why did an individual act in a particular way which contributed to events leading to an accident?

◊ How can behaviour which could materially contribute to an accident be predicted?

◊ Why do individuals in some circumstances take considerable precautions against accidents whilst on others they ignore or even flout established safety standards?

◊ Why is the level of protest against dangers of certain processes and technologies greater than that against others?

◊ What training, motivation and changes in design of the environment (work or other) can modify behaviour so as to reduce the toll of accidents?

Source: Hale (1987)

These questions prompt the concept that there are risk-taking behaviours, which will be of particular relevance in later chapters dealing with hazard analysis and safety testing.

4.7 Understanding Subjective Risk

Brehmer (1987) stated that the term "risk perception" is a misnomer, for we actually do not perceive risks, we actually perceive various features of decision problems which lead to feelings of risk. Risk research concerned with gambles based on statistical decision theory has then been extrapolated to all kinds of decision making. However, this work has not led to broad generalisation about decision making or risk, except that people are not rational in the sense of statistical decision theory as they do not follow the expected value principle when evaluating gambles.

Rasmussen (1983) propounded the view that human choice is not based on rational analysis, but on holistic, intuitive, and mostly sub conscious judgements, where risk is only one feature of the value perception underlying intuitive choices. Quality aspects of life, such as striving and obtaining skill improvement influence choice of entering activities like mountaineering and high speed driving more than risk perception does. Once absorbed in performance of the activity, control by risk potential is unlikely to change people's actual judgements.

Hale discusses research by Pérusse (1980) endeavouring to provide subjective definition of situations which are dangerous, and research which generated scales to differentiate between these hazards, (Green & Brown 1976, Pérusse 1980), or provided scales to differentiate them (Fischhoff et al 1978, Vlek & Stallen 1981). Hale describes the attempts made to analyse the scales. However, he states that there is a weakness in making comparisons of the results from research by these authors, due to their use of different techniques. This inevitably limits grouping of their different research findings to glean an overall picture.

Brehmer (1987) cites a two-dimensional factor analysis taken from Slovic et al (1984) as shown in Figure 14 where the dimensions of how **observable** or apparent are the consequences of action, against how **controllable** are the consequences are identified.

Five examples of observability and nine examples of controllability given are polarised into positive/negative consequences as shown in the illustration. Any given situation can be represented based on the combination of classification. The greater the number of classifications as not observable and not controllable, the greater the perception of risk.

Figure 14 : Two-dimensional factor analysis 16 Risk Characteristics Combined to show inter-relationships in Factors 1 and 2

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Source: Slovic et al (1984)

This summary acknowledges the importance of Slovic's dimensions of control and observability, but recognises the contribution of individual difference, and perception of hazards, causality and outcome.

Hale (1987) however, suggests nine dimensions are relevant to form an overall picture, which have been summarised in Figure 15 based on a review of various authors' work

Figure 15 : Summary of Risk Dimensions

DIMENSION	INSTANCES CITED IN RESEARCH
Types of hazard	- threats to physical, mental, social well-being - detection of error
Causal links	- 'what if' strategies - experience - false beliefs superstitions - creativity and cognitive styles
Victims of harm	- me versus someone else
Control over occurrence of danger	- personal degree of control - over confidence - me versus someone else's responsibility - voluntary versus involuntary
Time remoteness of harm	- immediate versus long term - hindsight bias - acute versus chronic
Uncertainty versus Obviousness	- familiarity - common-place versus unknown - prominent versus latent - availability of reminders to hazard - cost benefit and control techniques - adaptation / habituation proximity
Complexity and credibility	- predictable versus far fetched - bounded rational choice
Vividness, dreadfulness and severity	- availability of recent events - personal experience - dreadfulness
Individual differences	- cognitive styles - how individuals derive dimensions from dangerous contexts

Summarised from Hale (1987) p 71-79

Hale identifies various areas of commonality in structure from the contributory authors:

◊ **consequences**

- types of harm
- dreadfulness / vividness of consequence
- range of potential future states considered

◊ **probability**

- remoteness in time
- lack of knowledge / predictability
- choice and controllability
- number of rare events needing to occur together

However, Hale questions the psychological validity of this simplistic logical scheme as there is growing evidence that factors do not group themselves psychologically as conveniently as this suggests. In particular, Hale is uneasy with the relationship between assessments of controllability of risk exposure or risk occurrence.

The model proposed by Brehmer, and dimensions identified by Hale are presented as a basis for consideration in a safety testing approach, which attempts to capture these psychological features in interactions of users and products. Of particular interest is research concerned with the familiarity of products or tasks, the level of user experience with the product or task, perceptions of the probability of occurrence of a hazardous consequence, and individual differences in risk assessment.

In this context, the hazard is something tangible, a source of energy or specified agent which could cause injury to a person or property, whereas risk is a subjective perception of the probability of exposure to the hazard and the degree of potential injury or damage. In considering this research and the more limited research on the user/ consumer product interaction, it is important to recognise that the **user/product/task** interaction in the real world is subject to much more "noise" in data terms than experimental research encounters.

As discussed in Chapter 3, the type of safety testing which is the focus of this research attempts to simulate use in the "real world" where is not possible to modulate interfering variables. The safety appraisal model developed by the author carrying out a systematic hazard analysis of the product/user interaction, followed by a task analysis led process of risk assessment to weigh up the potential for injury in different situations, as described in Chapter 6, attempts to address these complex and interactive dimensions in a two stage process.

Johnson and Baker (1974) contrast "field testing" with laboratory experimentation and summarise the major differences in independent variables (input) and dependent variables (output), and also noted major differences in control, as presented in Table 6.

Table 6 : Major Differences between Laboratory and Field Testing

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Source Johnson & Baker (1974) p 209, 210.

As distinct from occupational safety, where many behaviours are regulated and monitored by safety rules and supervision, within the consumer safety system we can suppose that the user is able to exercise choice, rather than being involuntarily subjected to hazards associated with the employment environment. This means that research into major catastrophes involuntarily triggered may be of lesser interest, other than the light it throws on an individual's contribution to the disaster through human error, as briefly discussed previously. When a consumer product is used in the home environment there is limited opportunity to place the responsibility on others, such as safety managers. It may therefore appear that the issue of control over the occurrence of danger, and attribution of responsibility to others may not be relevant in the home environment.

However, Glendon (1987) cites the results of a small community survey on attitudes to safety as illustrated in Table 7, which rather unexpectedly shows that 31% of the small sample felt that others were responsible for their safety at home.

Table 7 : Perceived responsibility for safety in three environments

Source : Glendon (1987) p 89

Glendon also stresses that much of the published work on hazard perception has utilised different methods of data collection and different methods of data analysis, and has largely ignored the human risk taking behaviours in the everyday world. He advocates triangulation of research techniques investigating risk and behaviour on a much broader scale, preferably involving actual behaviour rather than just self-reporting. However, he also identifies the difficulties due to the cost and feasibility of this work, which limit the likelihood of it being undertaken.

In presenting a simplified relationship as shown in Figure 16, Glendon takes a more pragmatic approach that it is ***hazards*** rather than risks that are actually perceived.

Figure 16 : Relationship between Risks and Hazards

Observable outcomes

Source : Glendon (1987)

He suggests that risk is a concept to be used in context of a cognitive appraisal, including the decision-making process. The view that users perceive hazards, and understand risks through experience with hazards in their environment is key to the approach developed by the author in developing a general safety test based on hazard identification and analysis. Certainly, with the research goal in mind of devising a comprehensive and practical consumer product safety testing programme, it is more productive to concentrate on identification of observable and tangible hazards rather than to test for intangible potential individual variations in risk perception, and risk-taking behaviours.

Glendon cites ample evidence of the great variety of risk cognition between individuals. He postulates a developmental model of risk cognition where individuals move through a series of environments with a number of orthogonal cognitive dimensions, which are used to assess risks and which interact with behaviour. Thus, environmental feedback is important when encountering new hazards to extend the dimensions within the model.

We start with experience in the home, we move into the street, and then encounter school, public places and the workplace. We learn to understand risk through our experience with hazards in these environments, balancing costs and benefits of risk taking, with concomitant costs in terms of accidents and injuries. We label new dimensions as each new environment is encountered, and learn to switch dimensions as environments change.

In dismissing two dimensional approaches to risk, Glendon proposes a pluralist view loosely based on Perrow's (1984) three dimensional model, utilising:

- ◊ system complexity
- ◊ degree of coupling (loose-tight continuum of flexibility or slack within
- ◊ the system to respond to situations)
- ◊ value dimensions (to decide whether any given risk is acceptable)

to recognise that in every day experience every person is a professional risk taker, at the same time as being an amateur outside the specific context of their expertise.

So called risk assessors or "experts" cannot reassure the public or provide answers, and may address the wrong problems, i.e. :

> " A person evaluates risk like other people, like some other people, and like no other people."
>
> Kluckholn & Murray (1953)

Glendon concludes that links between hazard perception, risk cognition and behaviour remain problematic. As such, it may be expedient to consider the cognitive processes of risk perception and decision-making as "black box" processes which cannot be reliably predicted by the "safety expert". Until there is a greater preponderance of research into the link between attitudes and behaviour, and to identify hazards which form the environment for risk cognition, it would appear expedient for the safety tester to concentrate on hazard identification and analysis, coupled with epidemiological data on accident and injury behaviour.

Ramsay (1985) combines the mental and physical activities involved in the process of avoiding an accident as a serial sequence, as illustrated in Figure 17. The first two stages are the perception of hazard, followed by the cognitive process of associating the hazard with its probable consequences. The third stage involves a decision to avoid further risk, based on available knowledge, to take corrective action in the fourth stage. The probability of successful manoeuvre, and avoidance of an accident, depends on factors such as muscle strength, motor skills etc.

Figure 17 : Accident Sequence Model

Source : Ramsay (1985)

Hale and Glendon (1987) propose a more comprehensive model as illustrated in Figure 18, within a systems framework to deal with the concepts of danger, behaviours which can lead to danger, hazard detection, assessment of danger, and means of mitigating danger. Their definitions of hazard and danger within this systems approach were introduced in Chapter 1. They explain that in most instances there is no conscious consideration of hazards, individuals have learned programmes and procedures for carrying out tasks, but that errors can cause them to act in a way which leads to danger. As danger increases in intensity, conscious attention may be given to it, at which point strategies are employed, based on experience, which are either successful or unsuccessful in avoiding harm.

Their model expects that the individual will follow a pathway receiving a "Yes" answer, to arrest increases in danger before harm starts to occur. Although the model illustrates a single line, so that a "No" answer at any one point theoretically requires that the whole process must start again, in practice there may be feedback loops to previous stages. The model relates both to behaviour a routine level of operation which may lead into or out of danger, and also behaviour which is consciously directed towards coping with danger.

Figure 18 : Systems model of behaviour in the face of danger

Source Hale & Glendon (1987) p 40

Saari and Näsänen (1986) examined perception of hazards, and in reviewing occupational safety research in this field, concluded that workers take precautions against hazards they consider to be dangerous.

Wogalter, Desaulniers and Brelsford (1987) used questionnaires to evaluate perceptions of consumer product **hazardousness**. From questionnaire responses, perception of product hazardousness was best predicted by reported severity of injury. They also supported earlier work by Slovic, Fischhoff and Lichtenstein (1980) which suggested that a combination of severity and probability of accidents determines perception of product hazardousness.

Research by Wogalter, Desaulniers and Brelsford (1986) and La Rue and Cohen (1987) was concerned with rating of hazardousness of a range of consumer products, and how the perceived hazardousness or dangerousness of the product influenced perception of warnings associated with the product. La Rue and Cohen replicated the findings of Wogalter et al (1986) on a small sample of the general public rather than college graduates, and noted sex differences in the perception of the need to have a warning, and the tendency to read them. Women were more likely to feel products should have warnings and were more willing to read the warning, regardless how dangerous they felt the product was. Conversely, men tended only to read warnings when they felt the product was dangerous, was unfamiliar, or needed a warning.

4.8 Importance of Instructions and Warnings

At the beginning of Chapter 3 the view of Stadtler-Estrin and Estrin (1987) that the concept of a **totally safe** product is untenable was discussed. The public and the courts appear to have recognised that cost constraints restrict designing out/guarding against all possible hazards associated with a specific product. Also consumers cannot or will not buy such a product which is not going to be manufactured anyway because of its inflated price. In recognising cost constraints, Stadtler-Estrin and Estrin therefore express a marketplace reality, that users must be warned against potential hazards resulting from reasonable and foreseeable misuse.

As was discussed in Chapter 2, it is not enough to concentrate purely on structural and functional design, or on manufacturing quality control to minimise potential safety defects. Any product suffers from a **defect** if it lacks a warning, or if an inadequate warning is provided. Ideally, warnings permit the identification of hazards associated with a specific product by the consumer, and thus will alert the user to potential risks of injury. Without a warning the consumer is not able to identify that the hazard exists, and in specific sets of circumstances it is likely that injury will result.

Edworthy and Adams (1996) comment that:

> "Placing a warning on a product because it is likely to be effective is unfortunately not the only reason for placement. A manufacturer may place a warning label on a product because it is mandated (even though it may actually be ineffective) or because it affords some protection against litigation".
>
> Edworthy and Adams (1996)(p26)

Laughery (1993) comments that manufacturers may be assuming too much about consumer's ability to detect hazards, and that there is insufficient known about what users know, or will do with safety information which is provided. He remarks that the modern society suffers from an "Everybody Knows" problem. When products are marketed which have associated safety problems, safe use of these products requires knowledge or information on behalf of the users, which some users may not or do not have.

A parallel to the "Everybody knows" problem, is that human factors considerations are just "common sense". Laughery asserts that users do not know about hazards associated with common products because the hazard may be hidden, as a result of new technology, the product misleads (probably unintentionally) about safe use, or users may have an inappropriate model of the product or environment - what it is, and how it functions. Also as individual users rarely experience accidents, they may have had little opportunity to learn about their causes, or ask questions about safety issues, they do not think that the product is hazardous, or do not think about hazards at the proper times.

Laughery proposes that the "design it out/guard/warn" prioritisation is most consistent with human factors philosophies. However, those who design and market consumer products do not appear to address these issues of consumer hazard perception and knowledge adequately, failing to recognise the limits of user perceptions, knowledge and patterns of behaviour - i.e. what "not everybody knows". The potential problems of attention, distraction, and task overload also present a major challenge. He concludes that human factors and ergonomics professionals must become more aware of human hazard and risk perceptions and knowledge when designing products, and need to be more involved in field testing and market testing of products, to address the "everybody knows" problem both in consumer product safety and in the workplace.

In their review of empirical research on attitude-behaviour relations Ajzen and Fishbein (1977) concluded that investigators attempting to explain a certain phenomenon in terms of attitudinal analysis must first define the behaviours of interest, the targets in which they are directed, and the context and time of their occurrence. Attitude measures will explain behaviours which involve identical target, action, context and time elements. Attempts to influence behaviour by means of attitude change must also consider the degree of correspondence between the behaviour to be changed and the attitude at which the influence attempt is directed.

Demonstrating attitude change does not guarantee behaviour change, only behaviours which correspond directly to the attitude are likely to change. Any relationship established between attitudes and behaviours is only reliable if appropriate attitudinal and behavioural measurement procedures are employed. These conclusions are extremely pertinent when considering the thrust of government education programmes to encourage safe behaviours, and to have greater regard to product labelling.

There is much less behavioural research in the field of consumer safety due to ethical issues, than research on reported behaviour and perceptions. That reported behaviours and perceptions may not translate to actual behaviours, is an inherent difficulty in applying research findings, and limits its pragmatic value to consumer product manufacturers and suppliers.

In relation to product safety warnings, Wright (1981) commented about reading ability within the general public, and cites Morphy (1980), who estimated that 2 million adults in the UK would find difficulty in reading the labels on packets and bottles in local supermarkets. The DTI Consumer Safety Unit (1997) reported on research being carried out by Nottingham University into use of pictorial warnings and their effect in safety behaviours, recognising that:

> "Wherever they go and whatever they do consumers are bombarded by pictorial information. Signs and symbols are used as marketing tools, as sources of information and as warnings on the street, on products and instructions".....
>
> "With the growth of the European market, symbols which could cross the language barrier would be immensely useful."

The research established that pictograms appear do not appear to provide a language free answer to safety warnings and their effectiveness in influencing behaviour depends upon their noticeability, in terms of size and location. The general education of consumers relating to specific product hazards appears to be more effective in achieving compliance.

The DTI Consumer Safety Unit (1998) cite research to develop a best practice guide for industry to provide clearer and easy to read safety instructions, commenting that:

> "Whilst there has been a gradual improvement over the years, the study has already shown that many consumers will only read safety instructions if they are extremely concise and directly helpful, and producing such information can be far for easy, particularly as products get more and more complex."

In Chapter 2, Weinstein et al (1978) posed a critical question to consider in determining the efficacy of safety warnings in influencing user behaviour and provide legal protection - i.e., can the dangers be designed out of the product? Subject to the comments of Stadtler-Estrin and Estrin (1987) on cost-benefit analysis, a warning used as an alternative to safe design is unlikely to provide legal protection.

In UK case law, there are various reported cases regarding use of **disclaimers**, which are signs or phrases typically displayed to ensure prospective purchasers do not draw an incorrect inference from comparative pricing indications or descriptions regarding for example an incorrect vehicle mileometer indication. The main thrust of these cases is that any disclaimer must be as " bold, precise and compelling" as the description it seeks to disclaim *Norman v Bennett* (1974). Additionally, disclaimers which are too general *Zadwaski & Others v Sleigh* (1975), or embedded in "small print" *R v Hammerton Cars* (1976) are insufficient to prevent incorrect inferences.

The purpose of these disclaimers is to prevent an incorrect inference being drawn from a potential misdescription. In contrast, the purpose of safety instructions and warnings is intended to provide an outcome of intervention to prevent potentially unsafe behaviours.

Therefore, although description "disclaimers" and safety "messages" have different purposes, in practice, in many circumstances both mechanisms are used as tools to avoid legal liability. Thus, from a legal perspective, the conclusions drawn regarding the particularity and prominence of disclaimers about such product descriptions may also be important in considering the particularity and prominence of safety messages.

The major implication of research regarding safety messages for manufacturers, is that failure to locate warnings where users expect to see them, i.e. close to the product, may lead to an assumption that the product is less hazardous than it actually is - and lead to incorrect handling. Although Ursic (1984) concludes that manufacturers should not be overly concerned about detracting from the appearance of products when locating warnings so they can be clearly seen, McCarthy, Robinson, Finnegan and Taylor (1982) propose that warning labels should be reserved for consumer products where there is a significant risk compared with the total risk of home activities. A plethora of warnings may be counterproductive, because they would compete with one another for attention. Users will read a warning if they really feel the product needs one.

If manufacturers have regard to their target consumer users, and the possible gender differences identified by La Rue & Cohen (1984) they can create more effective warnings. Frantz and Rhoades (1993) propose a task-analytic approach to warning design locating product warnings to interrupt the completion of the task to be carried out by the user. This task-analytic approach, which addresses both the user's cognitive and behavioural activities during product use, is a useful tool for specifying characteristics of the warning, including its spatial and temporal placement. Carefully placed warnings can have a substantial effect on product use. Where users are likely to apply previously learned skills and rules it is important to consider how to use task interference as a means of presenting safety information.

In summary, however, safety experts are divided on the issue of warning label effectiveness in influencing behaviour, and research findings appear to be divided on the situations where warning labels are effective, and those where they are not. There is also the potential difficulty, as discussed elsewhere in this chapter of whether the research which has been carried out is sufficiently concerned with changing actual behaviour, rather than their reported perceptions of risk assessment or reported projected behaviour.

The review of safety instructions and warnings research indicates a number of issues which may influence safety behaviour to be incorporated into the safety appraisal process to be described in later chapters. Where possible, the product safety warning research findings are incorporated into the model for safety appraisal. In particular, issues such as familiarity, and perceived hazardousness are addressed through the systematic checklist developed for carrying out the process of hazard analysis of the product/task interaction in the first stage of the safety appraisal process. The use of questionnaires provides an opportunity to determine the influence of these subjective factors in the process of risk assessment, and the contribution of the previous experience and skills of Trading Standards personnel participating in the research.

4.9 Product Design Issues

The importance of good design, and application of ergonomics principles as early as possible in a product life cycle has already been stressed. Wilson (1983) cites the Corfield Report (1979). This criticises the typical UK design process for failing to interpret design as a total concept, covering manufacturing purposes, installation, ease of use, reliability, repair, maintenance, appearance, and ultimate disposal or replacement. It also criticises the failure to address user behaviour and variability in types, abilities and limitations of product users. Wilson suggests that UK attitudes towards allocating insufficient resources for consumer product design must change.

He argues that all stages in a consumer product life cycle, its manufacture, transportation and storage by manufacturer and to wholesaler to retailer and consumer, and its use in the home must be considered. He advocates involvement of designer, ergonomist and manufacturer to assess the requirements expected of the product, and consequent constraints on design.

Hull (1986) proposes a design strategy to address the foreseeability of conditions for injury against product cost, utility and benefit, and proposes various criteria for design of consumer products:

- ◊ function
- ◊ affordability
- ◊ human elements
    - ♦ **aesthetics** - psychological impression of a product;
    - ♦ **human factors** - comparability with expected physical and psychological characteristics;
    - ♦ **social acceptance** - environmental impact and utilisation of resources;
    - ♦ **safety** - foreseeability of accidents and associated injuries.

Designers and manufacturers are facing increasing pressures to improve quality and safety of their products, which Wilson (1983) conveniently divides into four types, although recognising that in reality there is considerable overlap :

- ◊ **technological** - changes in technology and increased availability of microelectronics components, fashion influences, decreasing costs, and increasing availability all contribute toward greater design flexibility and capability. They also can cause user interface problems related to efficiency, convenience and safety.

- ◊ **commercial** - the marketing drive for launching competitively priced products speedily must be balanced against the delays in advancing product development to ensure safety and quality, to minimise ill conceived projects.

This requires a recognition of the marketing benefits of safer design, and the enhanced product image and repeat sales stemming from reduced user problems and good design.

◊ **social** - in the UK the DTI, CSU, Office of Fair Trading, and the government sponsored National Consumer Council, plus other consumer bodies for privatised public utilities represent a network of governmental and quasi-governmental bodies concerned with consumer issues. Underpinned by local authority law enforcement via Trading Standards Departments, and voluntary bodies such as the Consumer's Association and Citizens Advice Bureaux and other consumer groups, this has led to increased customer expectation in relation to the quality of goods and services. EC legislation echoes this social conscience in including the right to safe products within its "charter" of consumer rights, which as discussed in Chapter 3 has led to the pressures from the EC influencing UK safety legislation.

◊ **legal** - an analysis of the various UK legal pressures is discussed in Chapter 3 through civil and criminal legislation, and remedies or sanctions are explained where products are found to be defective, or not reasonably safe.

Wilson (1979) proposes a model for a UK Consumer Safety System, linking these influences with sources of accident data which were discussed in Chapter 1.

Figure 19 : Final Links Associated with Design in a Consumer Safety System.

Source Wilson (1983) p 113

He recognises that the link between accident data and manufacturers design and development departments is hypothetical, but represents the feedback offered in Figure 19.

Wilson (1983) discusses research investigating use by various manufacturers of published HASS data, and he accepts that few of the manufacturers involved made good use of the information. The information is often too general to assist manufacturers to identify the brand or model of consumer product implicated in a consumer accident, and manufacturers were largely unaware of the availability and applicability of general ergonomics information.

Wilson attributes this to the failure by consumer ergonomists to communicate and establish the relevance of their research to manufacturers. He refers to the importance of retrospective data, such as accident statistics, and customer complaints either direct to manufacturers, or routed via retailers, and also of prospective data from ergonomics or source testing. This includes anthropometric and biomechanical data about people's physical characteristics, their cognitive capacities, and an allowance for age, mental ability, sex, health and disability differences.

Certainly, consideration of such information is vital in satisfying the new duty for suppliers to keep an ongoing risk assessment of consumer products. Although Wilson also refers to data on people's perception of hazard, risk-taking behaviours, and behavioural expectations and stereotypes, he does not indicate likely sources of such information.

Wilson discusses the tendency to attribute accidents to human error, proposing that he believes the root cause to be due to the product/person interaction, which could have been addressed by better design. He asserts that, too often the design does not anticipate the characteristics and limitations of the user, and ways they might use the product. Contrary to the views expressed in Chapter 1, Wilson suggests that most user safety problems are associated with the product design.

Hale and Glendon (1987) consider how individual safety behaviour can be influenced to reduce accidents and injuries. This is also a central topic of concern for the CSU in planning safety campaigns and determining when to introduce safety legislation, and to the author in appraising products and information supplied with them.

Hale and Glendon suggest that intervention strategies should be as early as possible in the accident sequence, and should aim to enhance the ability and opportunity for the system to detect and correct its own deviations. They explain that intervention strategies are typically classified as:

◊ elimination of danger
◊ isolation of danger source
◊ isolation/protection of the individual
◊ injury limitation

Hull (1986) suggests that as a first principle, design strategies must be adopted to ensure a reasonably safe product reaches the market place. A process of hazard analysis early in the design stages is essential to identify hazards associated with the product. Processes of hazard analysis are discussed in some detail in Chapter 5. Based upon an earlier philosophy proposed by Hepburn (1948) in relation to machinery safety, Hull (1986) proposes four principles for product design safety, which he feels are equally applicable in this context :

◊ **principle of inevitability** - i.e. products which contain a hazard will inevitably be involved in an injury producing accident. The probability of injury or occurrence is just as likely on first usage as on future usage.

◊ **principle of intrinsic danger** - i.e. products which contain a hazard are intrinsically dangerous, in that they have caused accidents in the past and will continue to do so in the future. An accident will inevitably occur if there is an intrinsic hazard.

◊ **principle of non-reliance** - no reliance should be placed on the co-operation of any person in avoiding an accident when assessing hazards in a product and potential risks to users.

◊ **principle of no risk / non use** - if a product contains an intrinsic hazard it must not be used until being rendered safe, by eliminating the hazard.

◊ **principle of safety precautions** - as well as eliminating hazards, users must be properly and constantly informed of hazards and safe practices to reduce the likelihood of unsafe situations which may trigger injury.

Hull therefore proposes four design strategies to be followed to implement these principles, which are consistent with those identified by Hale and Glendon above :

◊ **modify patterns of use** - given that the hazard can be located and assessed properly, it can be countered with *safe practices* and *safety instructions*. This shifts responsibility from the designer to the user, and is flawed if there is no such thing as a *safe* individual. This strategy is useful in increasing user awareness, but in practice it is difficult to separate human, product, and environmental contributions from instances of accidental injury. In context of Wilde's RHT views described earlier, the efficacy of such a strategy is also doubted in influencing levels of safety behaviour.

◊ **safe design** - design processes should attempt to eliminate hazards where possible, or at the least ensure use of safety devices or guards to protect against contact with the hazard. This demands a systematic analysis of potential hazards in foreseeable use / misuse, and thorough exploration of methods of elimination or guarding.

◊ **injury prevention** - by preventing foreseeable occurrence of accidents, the consequence of accidents i.e. injury, damage to property and death will also be reduced. He believes that this is the essence of human factors, and requires an exploration of mechanical factors associated with injury while using a product. The analysis must be from the product's cradle to grave, and should determine a reasoned set of criteria designed to eliminate injuries caused by a product. A *crashworthiness* concept falls within this strategy, where the inadvertent injury is considered regardless of the error of the user, who uses the product in a way never intended by the designer. Thus car designers must address potential injury caused by dashboard and gear shift design in a crash situation which may have been caused by e.g. defective steering or by driver error.

◊ **injury mitigation** - this assumes that injury or death are not only foreseeable, but that the extent of injury can also be reduced in magnitude. The only effective solution of foreseeable injury is to reduce the extent of injury involved. The strategy requires an understanding of biology and biophysics, and the capacity and limitations of the human body in response to physical stress. It attempts to isolate and control the mechanism of injury, and in context of the crashworthiness concept, aims to lessen induced trauma through design of emergency devices to come into play should some failure, howsoever caused, occur.

It is suggested that all strategies must ideally be considered, and combined at initial design, and as designs are reviewed and modified. In relation to developing a safety test programme for finished consumer products, such contributions will be a feature of the past, and cannot form part of the test programme. However, as we have seen, the thrust of the EC General Safety Directive is that the results of finished product safety testing should be reported back into the continuous design review process to enable any safety deficiencies identified to be rectified.

In many instances, this would necessitate improving the quality of the production processes and/or some design modification. Any attempts simply to modify safety instructions and warnings cannot get to the root of inadequate quality assurance or control procedures, or an ill thought out design.

The author would support Jenkins (1989) in his view that formal training for designers would benefit from greater ergonomics input, and inclusion of some formal training in the requirements of consumer product safety and occupational safety legislation.

4.10 Task Analysis

In defining the meaning of "safe", and as suggested by Rennie in Chapter 3, the common concern in a user-product interaction is how the product is used, and how it may **foreseeably** be used or misused. Thus, a systematic consideration of actual and potential use is a vital component in a comprehensive safety testing approach. The technique of **task analysis** enables this consideration to be explicit, rather than intuitive. Sanders and McCormick (1987) describe task analysis as the basis for designing human-machine interfaces (controls, displays, work stations etc.), for preparing instruction manuals and training manuals, and provides a means of evaluating the system.

Fleishman and Quaintance (1984) consider definitions of **task**, which is a conceptual construct, and they describe four approaches:

- ◊ **Behaviour description** - based on observations and descriptions of what operators do while performing a task, rather than what is required or expected to reach criterion levels of performance;
- ◊ **Behaviour requirements** - emphasising cataloguing behaviours that should be emitted or which are assumed are essential for criterion levels of performance;
- ◊ **Ability requirements** - contrasting and comparing abilities that a given task requires of the individual performer;
- ◊ **Task characteristic** - describing the properties of the task, its divisibility, dependencies, complexity, difficulty, criticality and temporal relations (Meister, 1976).

Fleishman and Quaintance suggest that the task analytical approach used will depend on the purpose of classification. They advocate that a disciplined approach is necessary in carrying out classification. Firstly, a strategy for selecting attributes and descriptors for evaluation must be employed.

Secondly, a reasonably objective definition of descriptors in operational terms, which permits some quantitative assessment is vital, which will also improve reliability. Thus, by developing objectives and using concise definitions, clear and consistent distinctions among descriptors are permitted.

Descriptions must, at the minimum permit nominal scaling, i.e. to give an indication as to whether the descriptor does/does not apply to the task being examined. The use of ratio, interval or ordinal measurement scales permits greater sophistication in comparing descriptors, but necessitates a consideration of **degree**. It is important that classification systems are sound, and both internally and externally valid.

Fleishman and Quaintance discuss and compare examples of these types of approaches towards classificatory systems. The most detailed system for classifying behaviour descriptions, which goes beyond straight description of human task performance, and compares tasks on multiple dimensions, before assigning them to categories based on similarities or dissimilarities is the Meister taxonomy. This was developed by Meister et al in 1970 to classify behaviours in the man-machine interaction within a hypothetical multicrew scientific laboratory. It includes three levels of description of human behaviour into functions, tasks, and behavioural elements, and a further dimension of task characteristics. However, despite being the most comprehensive classificatory system reviewed by Fleishman and Quaintance, it has had only limited evaluation. They also consider use of computer databases to index, store and retrieve information obtained within a classificatory system. The rationale behind classification theory is to organise information into groups of related items, for retrieval by an alphabetic or hierarchical index.

Many authors combine the two processes of task description and task analysis. Meister (1985) draws a distinction between **task description** which focuses on the picture of what physically occurs, and **task analysis** which attempts to abstract behavioural implications from this description, identifying the behavioural requirements needed for task completion.

Sanders and McCormick (1987) describe task analysis data, as data about the work activities of people who are, or who would be involved in the specific system or work situation in question. They suggest using film, observation, and eye movement recordings etc., supplemented by interviews with experienced personnel about the frequency and importance or various activities. Their discussion focuses on the workplace and the human-equipment interaction, where each component part of equipment is analysed to determine frequency of use/potential use, and importance of use. As importance and frequency are not perfectly correlated, a composite frequency-importance index may be more useful.

They suggest using 5-point rating scales for each factor, and comparing different methods for combining the values on frequency of use and importance of use, for example, looking at adding the values, multiplying them, and differentially weighting the values and then adding or multiplying them. They also consider the relationships or **links** between components, i.e. communication links, control links, and movement links. Their proposed method is useful in workplace design considerations, such as precise location of critical controls etc., but is of limited use in examining finished consumer products within the context of safety testing.

Cushman and Rosenberg (1991) suggest that the task analytical method chosen should be appropriate for each specific task under study. The task analysis approach advocated by Rennie in Chapter 3 may be more useful as the basis of developing a consumer product safety appraisal. They recommend that several task analysis methods may be used for different tasks associated with the same product.

Tasks are essentially classified as :

◊ **sequential** where subtasks or task elements must be performed in a predetermined order;

◊ **branching** where the user has a finite set of choices available at each step in the task - each set of choices to an extent depends on previous choices made;

◊ **process control** where continuous monitoring, user responses to change, and feedback are examined.

Cushman and Rosenberg (1991) set out the approach for a simple sequential task, as shown in Figure 20, considering critical elements and ergonomics problems; and for a more complex task, as shown in Figure 21, the information for each sub task in terms of information requirements, display, control and feedback is identified.

Figure 20 : Change Batteries in Camera Analysis of a simple sequential task

Aston University

Content has been removed for copyright reasons

Source Cushman and Rosenberg (1991) p 37

Figure 21 : Approach for more complex task : making multiple photocopies

Aston University

Content has been removed for copyright reasons

Source Cushman & Rosenberg (1991) p 38-9

Sanders and McCormick (1987) suggest that the nature of the process is to list in sequence all of the tasks which must be performed to accomplish the functions in which a human plays a part. Each task is then further broken down into the steps required to carry out the task. Each step is then analysed to determine such things as the stimuli that initiate the step; decisions the human must make in performing the step; actions required during the step; information necessary to carry out the step; feedback information resulting from performing the step; potential sources of error or stress; and the criteria for successful performance.

In addition, the difficulty of the task and its criticality can be determined, and the number and skill level of people needed to operate the system be estimated in order to determine any training requirements.

However, this two-dimensional framework cannot easily represent the relationships between the components or deal with interacting activities in complex tasks, where the user faces an almost infinite number of choices.

Sanders and McCormick (1987) suggest that it may be inappropriate to apply sophisticated quantitative analytical methods to address simple problems, although such quantitative methods may be justified for complex systems with many components such as human interaction with consumer products in everyday situations. They also discuss the use of linear programming techniques in addressing consumer product safety interactions, which optimises a dependent variable by manipulating various independent variables. However, they cite Francis and White (1974) who argued that quantitative methods may not be justifiable in many circumstances where simpler approaches can produce substantially similar results.

4.11 Conclusions

This Chapter has considered a large volume of research to guide and inform the approach for developing and implementing a model for consumer product safety appraisal. What is clear from this discussion is how complex many of the concepts are, and that many of the conclusions are conflicting. Many of the issues investigated are not directly relevant in addressing the research objective, or the wrong questions are asked. This difficulty in reconciling the thrust of research is complicated by the gulf in understanding of these issues between academia and safety practitioners. When safety practitioners talk about "risk" and techniques of risk assessment, they are unaware of the number and complexity of contributory factors and subjective influences considered in the literature.

Safety practitioners consider "risk assessment" to be a finite process for determining the safety of consumer products, and they are largely unaware of the judgmental heuristics implicitly applied when they examine consumer products for the presence of safety hazards. These risk assessors or "experts" may themselves address the wrong problems. The links between hazard perception, risk cognition and behaviour remain problematic. The author has previously commented that until there is a greater preponderance of research into the link between attitudes and behaviour, which identifies hazards which form the environment for risk cognition, it is more helpful for the safety tester to concentrate on hazard identification and analysis, coupled with epidemiological data on accident and injury behaviour.

In support of the views of Sanders and McCormick (1987) the author considers that it is difficult to balance the complexity of quantitative methods necessary for carrying out a product safety appraisal with the simplicity or complexity of the system to be analysed. It may be as Francis and White (1974) contend, that a simpler approach can produce substantially similar results.

As will be seen in later Chapters, the author has developed a two stage process for safety appraisal, which attempts to draw upon the published research. Despite the difficulty in identifying and representing all of the potentially interacting components, a systematic two dimensional framework for hazard analysis of the product/user interaction is proposed to identify potential hazards. In the second stage, a two dimensional task analysis framework provides a useful foundation for making an objective risk assessment of hazards identified at each process of potential use of misuse. By enabling repetition of the process to consider different potential target users, and/or in different locations, it is intended that the model will provide flexibility to deal with the multiplicity of potential combinations.

Chapter 5 : Techniques of Hazard Analysis

5.1 Introduction

As discussed in Chapters 1 and 4, the techniques of hazard analysis and risk assessment are at the heart of process of accident analysis, in making predictive estimates of safety behaviour and in developing consumer safety accident prevention programmes. The importance of risk assessment in occupational safety legislation has also been emphasised through published guidance on methodologies of risk assessment.

In this chapter, these developments in occupational and consumer safety are explored further, and many different techniques of hazard analysis and risk assessment are explored to identify the key features of a comprehensive and robust model for use in evaluating consumer products. Systematic task analysis, as discussed in Chapter 4, provides the foundation of the process of hazard identification and analysis through the preparation of a comprehensive list of the interactions of tasks with user/product/location to ensure that all possible hazards are identified.

Stammers (1996) describes the development of Hierarchical Task Analysis (HTA) as a general approach to analysing tasks, rather than a tightly formulated methodology. He comments however, that as there are no strict rules on using this approach, it has been misinterpreted as a model of cognitive activity rather than as a convenient means of representing complex tasks. Stammers describes the basic principles of the approach, beginning at an overall general task description, which is broken down into more detailed descriptions through a process of progressive re-description through each operation and sub-operation. Each unit of analysis consists of an operation, which can provide an instruction to carry out an activity. At each stage of re-description a deliberate decision is required to determine whether further breakdown is necessary. The HTA process is documented via hierarchical diagrams, plans and tables which can be used for cross referencing interactions, for accessing designs, or building up task scenarios. As such it provides a flexible approach to collecting and representing information.

Stanton and Baber (1996) build upon the process of HTA to propose a method of evaluating consumer products in developing human error identification techniques. Their approach has three elements :

◊ HTA which provides a description of human activity,

◊ State Space Diagrams (SSDs) which describe product activity - i.e. "on/off/waiting"" etc., and

◊ Transition Matrices (TMs) which combine data from both of these descriptions in a matrix, to provide a mechanism to explore potential errors in human/machine interactions i.e. the wrong task/wrong stage interaction.

The overall mapping process of the three components of the human machine interaction provides Task Analysis For Error Identification (TAFEI). They suggest that this method can be applied to product design and evaluation at all stages in the product design life cycle. The process can be applied hypothetically to design concepts, and re-iteratively during prototype development. The method can also be used for finished products, particularly where extensive observation would be too time consuming or costly. They report that the method has been successfully used for evaluating a number of products and seek more active use of this method.

The qualitative stage of the safety appraisal protocol which is discussed in Chapter 7, uses a hierarchical task analysis process to identify hazards associated with product use, and then quantifies and assesses risks of injury. In this chapter, a number of methods of hazard analysis, of risk assessment and of error identification are examined to consider how features from these approaches can be combined with approaches on consumer product evaluation in order to develop a safety appraisal model for evaluating consumer products by safety enforcement practitioners.

Many of the risk assessment methodologies discussed in this chapter consider a given task/sub-task in a given location to score the likelihood of occurrence of injury to determine an objective index of "risk". The process of risk assessment has become a powerful tool for informing decisions on management of risk through central government departments, to improve the way in which the Government communicates with the public on health and safety matters. The Interdepartmental Liaison Group on Risk Assessment (ILGA) 1996 have reported on the increased practical application of risk assessment, and how the provision of such information to Ministers has increased, to assist them in reaching their decision on any regulatory proposal affecting business and to satisfy themselves of the balance struck between cost and benefit of regulation.

The report comments that the public are more preoccupied with risks to health, safety and the environment, despite living longer and following a healthier lifestyle than at any other time in history. There is an expectation that more will be done about health, safety and the environment. Additionally, the report comments that, although the public are apparently prepared to pay more for safer goods, market forces are unable to fully regulate the price of goods or services according to the level of risk they entail. The social costs of a product may not be reflected in the business costs to the firm that produces it. For example, the burden of the costs of air pollution fall largely on those who do not purchase the polluter's product. As such, the market cannot penalise polluters for their failure through consumers purchasing their products.

ILGA suggest that Government intervention is therefore necessary to correct these market failures. However, if the overall costs of regulation exceed the social benefits they engender, then there will be a reduction in overall well-being. As a mechanism in legislation, risk assessment places duties on those creating risks to man and the environment, for deciding what goods should be on the market; and by inspectors in assessing compliance with regulations. ILGA consider that assessing risks is simple in practice - in identifying hazards or examining what a particular situation could cause harm or damage, and then assessing the likelihood that harm will actually be experienced by a specified population and what the consequences would be, i.e. the risk. Conceptually, this represents two stages, risk assessment - evaluating likelihood of harm and the consequences, and risk control - prioritising risks and introducing measures to reduce or prevent injury.

However, ILGA recognise that it is difficult to differentiate between these stages in practice, or to assess risks without making a number of assumptions, and drawing upon scientific data from toxicology, engineering, statistics, economics, demography and psychology. Uncertainty permeates throughout the process, due to lack of knowledge about the particular effects of given circumstances and due to the random nature of events which may themselves depend upon natural circumstances and their timespan. Because of this, there is a tendency to err on the side of prudence or safety in decision making.

5.2 Occupational Safety Risk Assessment Methods

Fairman and Parkinson (1992) comment that occupational risk assessment has become an increasingly important area for the environmental health professional. They state that experienced practitioners are comfortable and competent in the identification of occupational hazards, although less certain in the area of assessing the likelihood of injury, ill health or damage. They advocate combining the probability of occurrence of an event and the magnitude of its effect in building a risk scale to compare events objectively.

Fairman and Parkinson discuss the four basic components common to methodologies of risk assessment:

- ◊ hazard identification
- ◊ establishment of dose-response relationship
- ◊ determination of exposure
- ◊ risk characterisation

Fairman & Parkinson describe **hazard identification** as a qualitative process. It is fundamental that all potential hazards are identified whether chemical, physical or biological, through epidemiological information or the results of testing. They suggest that occupational hazards in a particular workplace may be identified through physical inspections, examination of organisation charts, safety statistics, accident records, insurance claims and from safety policies and the results of safety audits. They advocate techniques such as Hazard and Analysis and Critical Control Point (HACCP) and fault tree or event tree analysis.

The **dose response assessment** is concerned with the intensity of exposure to the hazard, age patterns of exposure and other factors such as gender. There are problems, however. Epidemiological data are not available for every hazard and there are ethical and practical issues in the study of human exposure. There are also external factors which cause difficulties in establishing direct links between cause and effect.

Exposure assessment requires the identification of those exposed to the hazard, evaluating their susceptibility, routes of entry for the hazard, and the magnitude, frequency and duration of exposure. In depth investigation is necessary to identify and describe the operation, for example occupation, job description, living and working conditions, place of residence, health status, sex, age and other factors affecting a particular population.

Their final step is to estimate the magnitude of problem through risk **characterisation**, by combining information on dose response relationship and exposure assessment - specifying any inherent uncertainties.

Kazer (1992) is concerned that the process of conducting risk assessment to meet legal liability can be over-complicated by attempting numerical assessments of minor injuries, such as bruising, when this approach may be more appropriate to occasions of catastrophe potential. He proposes applying numerical weighting scales to circumstances of possible major injury or fatality, and introduces a weighting factor for the frequency of the task combined with the number of persons at risk to determine a risk rating for a task or sub-task. His risk ratings are shown in Table 8, where:

Risk Rating = Frequency x No. persons at risk,

Additional factors can be introduced into the risk assessment to deal with the duration of the task, to compare for example tasks with/without guards on one/two sides, and activities carried out at different heights.

Table 8 : Risk weighting factors based on frequency of activity

Source Kazer (1992) p 40

Table 9 sets out a hypothetical programme for determining relative risk ratings of falling injuries using these relative weighting factors. Kazer proposes that this type of programme might be completed for various occupational tasks to meet the new legal requirements for risk assessment, and to enable risk ratings to be used for prioritising those tasks requiring action.

Table 9 : Hypothetical programme for rating tasks for falling injuries

After Kazer (1992)

Mackmurdo (1993) cites the Management of Health and Safety at Work Regulations 1992, which require the recording of "significant" hazards and risks. Although this would appear to accord with Kazer's interpretation that trivial risks can be ignored, Mackmurdo recommends that employers should assess **all** risks through the process of risk assessment, to determine a complete range of risk ratings. Only then should a cut off point of "trivial" risks be set - taking into account the relevant legal requirements and the aims of the employer's safety policy - in order to plan appropriate action.

Steel (1992) proposes the determination of a Hazard Rating Number (HRN) for occupational hazards by combining four factors as shown in the formula:

HRN = PE x FE x NP x MPL Where:

◊ **(PE) is the probability of exposure to the hazard *(LO)***

0	Impossible	-	cannot happen under any circumstances
0.1	*Almost unlikely*	-	*possible only in extreme circumstances*
0.5	*Highly unlikely*	-	*though conceivable*
1	unlikely	-	*but could occur*
2	Possible	-	but unusual
5	Even chance	-	could happen
8	Probable	-	not surprised
10	Likely	-	only to be expected
15	Certain	-	no doubt

NB : text in italics added by BS EN 292 Part 1 (LO) is likelihood of occurrence

◊ **(FE) is the frequency of exposure to hazard**

0.1	Infrequently
0.2	Annually
1.0	Monthly
1.5	Weekly
2.5	Daily
4	Hourly
5	Constantly

◊ **(NP) is the number of persons at risk**

1	1 -2 persons
2	3 - 7 persons
4	8 - 15 persons
8	16 - 50 persons
12	not < 50 persons

◊ **(MPL) is the maximum probable loss *(DPL)***

15	Fatality
8	Loss 2 limbs/eyes/ serious permanent illness
4	Loss 1 limb/eye/ serious temporary illness
2	Break bone/minor permanent illness
1	Break bone/minor temporary illness
0.5	Laceration/mild ill health effect
0.1	Scratch/bruise

NB : text in italics added by BS EN 292 Part 1 (DPL) Degree of Possible Harm
(These losses could also include quantitative aspect of damage or losses based on costs).

As noted in the footnote of Steel's model, this framework, with minor differences in terminology has been adopted as a European standard for risk assessment, BS EN 292-1 (1991). Steel suggests that this simple technique provides a degree of objectivity, and can be developed into a more complex means of preparing accurate observations where based on statistical evidence.

However, Steel cautions that any risk estimation technique involves elements of subjectivity and almost always relies on past events or experiences. Steel uses HRNs to prepare an action table which reflects the importance of risks identified and the action required. Values can be assigned to the table and action priorities selected appropriate to a given industry sector as shown in Table 10.

Table 10 : Table showing risk ratings and appropriate action timetable

Risk	HRN	Action timetable
Acceptable risk	0 - 1	Accept risk/consider action
Very low risk	1 - 5	Action < 1 year
Low risk	5 - 10	Action < 3 months
Significant risk	10 - 50	Action < 1 month
High risk	50 - 100	Action < 1 Week
Very high risk	100 -500	Action < 1 day
Extreme risk	500 - 1000	Immediate action
Unacceptable risk	> 1000	Stop the activity

After Steel (1992)

Steel suggests that remedies can be effected by reducing the value of any factor, but ideally by reducing all factor values. PE can be reduced almost to zero through introduction of safeguards and fail-safe back up devices supporting engineering revision. MPL can be reduced by reducing the amount of energy involved in the hazard when exposure occurs, and by providing energy absorbing barriers such as personal protective equipment. FE reduction can be achieved through automation, design or process changes.

Kletz (1986) proposes the use of a creative open-ended technique for use in situations where new design has occurred, where a checklist of hazards may be too prescriptive or may not address all potential hazards. The technique known as HAZOP - Hazard and Operability Study - has been used in process industries to match the complexity of modern industrial plant to identify what hazards are present in a plant or process. Using flow diagrams setting out the **intended** construction and operation of the plant, guide words such as **none, more of, less of, part of, more than** and **other** are used to focus on each stage, to identify potential deviations from what is planned. For each potential deviation causes and consequences are determined, however improbable. If the deviation is judged to have both a realistic cause and hazardous consequences, it is necessary to consider appropriate **action** to deal with the hazard.

Ozog and Bendixen (1987) stress that HAZOP is a versatile and effective technique for hazard identification, particularly when combined with a hazard analytical technique - HAZAN. HAZAN takes the identified hazards and assesses them, to consider ways of removing them, or to increase protection to people and property.

The probability of an accident and the extent of the consequences are compared with a target or criterion in three stages:

◊ estimating how often the incident will occur : **how often** ?

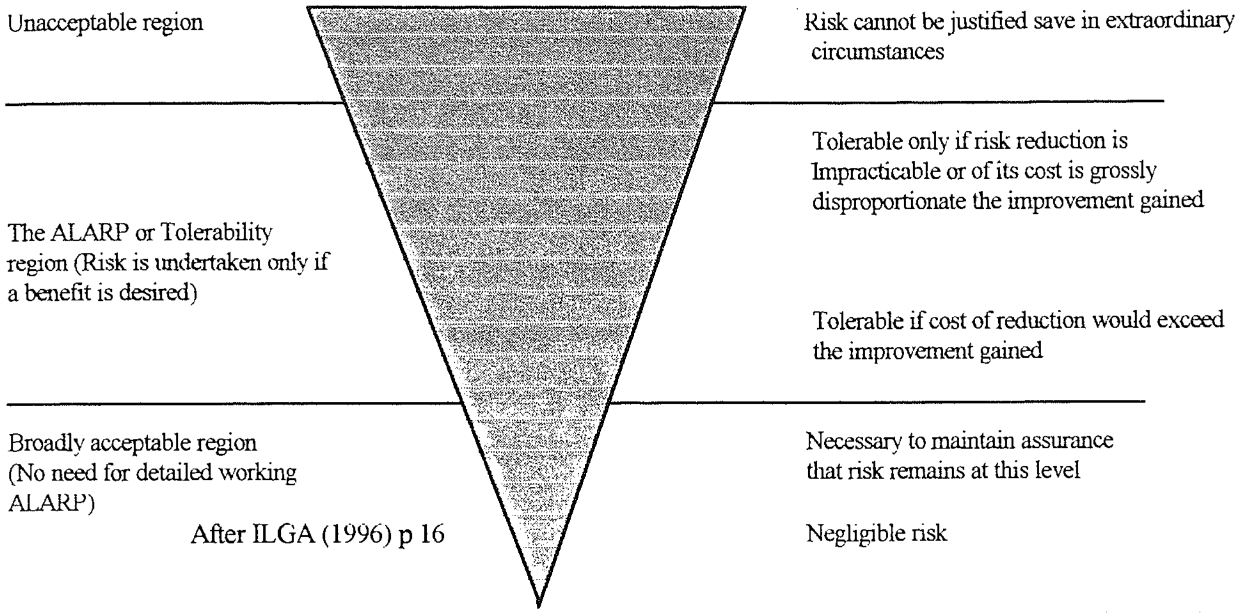
◊ estimating the consequences to employees, members of the public, plant and profits : **how big** ?

◊ comparing the results of the above stages with a target : **so what** ?

However, there are problems associated with HAZAN techniques, in that the model may be so over-simplified that it bears little relation to reality. Also if all hazards have not been identified, there may be little point in quantifying those which have. The draft proposals for risk assessment of the safety of machinery CEN/TC114 (1990) refer to these HAZAN principles as an example of hazard analysis techniques, and they are also included in the draft standard on risk assessment pr EN 954.

The Interdepartmental Liaison Group on Risk Assessment (ILGA) 1996 reports that the Health and Safety Commission/Executive's role in regulation of industrial risks involves determining whether a risk is so great as to be unacceptable; whether the risk is so small that no further precautions are necessary; or, if the risks falls between these two states, whether it has to be reduced as low as reasonably practicable (ALARP). This framework is illustrated in Figure 22.

Figure 22 : Levels of risk and ALARP



The framework provides a mixture of cost benefit based and equity based criteria. The horizontal line at the top represents an upper limit defined by the HSE, above which a particular risk for practical purposes is regarded as intolerable, whatever the benefit, although this may be over-ridden in the wider national interest by a Government decision. Existing risks above this line require some remedial action.

The bottom line, conversely, represents a lower limit or cut-off point where risks are considered broadly acceptable because they are typical of small risks which do not worry people or cause them to alter their behaviour in any way. When they are incurred, they only slightly increase the background level of risks to which everyone is exposed in their lifetime. In between the two lines is the "Tolerability region" where a balance needs to be struck to accommodate society's and an individual's willingness to live with a particular risk to secure social and economic benefits.

This concept implies that existing control measures require periodic review to ensure that they are being properly applied and take into account of changes over time, for example to assess the availability of new options for reducing or eliminating risks due to technical progress.

For this framework to be useful, it is vital that risks can be quantified and compared in a way that enables people and regulators to make informed decisions about them. The HSE suggests that a risk of death for workers of 1 in 1000 per year should be the dividing line between what is tolerable for any substantial category for any large part of a working life, and what is unacceptable for any but exceptional groups. For members of the public who have risks imposed upon them in "the wider interest" HSE would set the limit at 1 in 10,000. At the other end of the spectrum, an individual risk of death of 1 in 1,000,000 for the public (including workers) corresponds to a very low level of risk, and should be considered to be broadly acceptable.

Between these values, within the tolerability region, existing standards, good practice guides, and cost benefit analyses (CBAs) are used to decide the levels to which risks to individuals should be controlled. There are instances where the potential impact extends seriously beyond those immediately affected, e.g. in large catastrophes where there may be loss of life, property and political costs, or loss of public confidence. Equally, there are hazards which give rise to risks where there is no escape or no warning. In these cases, HSE proposes a "rule of thumb", that an acceptable risk cannot sensibly be less than 3x the amount of life attributed to individual risks.

Where there is a high degree of uncertainty, the ALARP calculation should be biased in favour of greater safety, and the legal concept of "reasonable practicability" should apply, paying more attention to avert the risk than would otherwise apply. Where the risk is <u>both</u> considerable and uncertain it may actually beyond the tolerable level.

5.3 Product Safety Techniques of Risk Assessment

Hazard Analysis and Critical Control Point (HACCP) as previously mentioned by Fairman and Parkinson (1992), is a similar technique to the HAZAN system of hazard analysis. It was developed as a tool within the food industry for managing food safety and to reduce dependence on finished product sampling and testing. First presented in 1971, initially for microbiological hazards and risks associated with the manufacture, distribution and use of foodstuffs, it is equally applicable for identifying and controlling chemical and foreign body hazards, or indeed for identifying risks for non-food products outside the food industry.

There are six steps entailed within HACCP (ICMSF 1988):

- ◊ Identification of hazards and assessment of their severity and risk - **Hazard analysis**
- ◊ Determination of **critical control points** (CCPs) required to control identified hazards
- ◊ **Specification** of criteria that indicate whether an operation is under control at a particular CCP
- ◊ Establishment and implementation of **monitoring** systems
- ◊ Execution of **corrective actions** when criteria are not met and **verification** of the system
- ◊ Establishment of **documentation** concerning the above points and their application

Progress in applying the technique throughout the food industry in the UK and Europe has been relatively slow. However, reference to HACCP principles in recently introduced EC Hygiene Directives has increased this momentum and is likely to accelerate their application in the food industry. Like HAZOP and HAZAN, HACCP principles are concerned with the efficient working of the manufacturing system to build in the necessary safeguards. HACCP emphasises implementing control as far upstream in the processing system as possible, by utilising operator control and/or continuous monitoring techniques, through anticipation and prevention.

Although primarily aimed at controlling food processing activities, within manufacturing, the technique also considers the effects of downstream activities such as actual and probable conditions during storage, distribution, sales and foreseeable use. Its principles could be equally applied for manufacturing, distribution and foreseeable use of non food products.

Schothorst and Jongeneel (1992) examine how HACCP principles can demonstrate a defence to a product liability action on the basis of a defective product, or to rebut criminal liability for a food product which does not satisfy the General Food Safety Requirement. They conclude that using HACCP principles can improve product quality and reduce the possibility of contravening safety legislation, as well as providing objective evidence of the exercise of reasonable precautions and due diligence in the event of a problem. Data collected through process monitoring will demonstrate that production is working properly. Verification data obtained through examination of end products, feedback from customers and enforcement agencies and from consumer complaints will also demonstrate the usual capability to produce a safe product.

A further hazard analytical technique, suggested in draft proposals for risk assessment of the safety of machinery CEN/TC114 (1990), is the construction of fault trees to set down events leading to a hazardous occurrence in a logical way. The method enables illustration of various combinations of events and the various ways in which the chains of events can be broken.

Fault tree analysis FTA is primarily a means of analysing (not identifying) hazards, which may follow procedures such as HAZOP to identify hazardous or top events. Fault trees can be constructed top down or from left to right, leading back from the hazardous event to the next level of probable causes. Each level in the tree identifies probable causes for the events described at the previous level above or to the left. Analysis continues until it is not possible to identify any further probable causes. The terminal node of the tree provides potential issues for design solution. Fault tree analysis also permits the calculation of the probability of a hazardous event from other known probabilities. Where a product has various different safety hazards FTA can be carried out for each type of hazard.

There are two types of fault tree, those with AND gates where probabilities in each branch are multiplied, and those with OR gates where the probabilities in each branch are added. FTA makes it possible to investigate the impact of alternative preventive measures, and has been found useful in determining the cause of accidents.

Cushman and Rosenberg (1991) provide an example of a hypothetical fault tree analysis of possible cause of chemical burn from a drain cleaner as shown in Figure 23.

Figure 23 : Hypothetical Fault Tree Analysis : Drain Cleaner

CHEMICAL

TOO SHAPE

SMALL

Cushman & Rosenberg (1991) p 318

Errors in FTA typically result from errors in drawing the fault tree, or in failures to foresee all of the ways in which a hazard could arise. It is as important to address contributing human factors in the fault tree as the contribution of product and/or packaging construction or design.

These hazard analysis techniques are concerned with identifying hazards and introducing upstream process and production controls, or designing out the safety hazards associated with the product. Even in the application of risk assessment methodologies in occupational safety as discussed earlier, the emphasis is on introducing remedial programmes concerning the nature of the task, exposure to safety hazards through introduction of additional safeguards, and by design or process changes or operator training.

Cushman and Rosenberg (1991) discuss another qualitative structure technique for product safety analysis which is used to determine probable causes for potential product-related injuries. This hazard assessment technique analyses hazards into four levels:

Level I : INJURIES	A type of injury which could occur during product use
Level II : CIRCUMSTANCES	Circumstances that might be associated with injury identified in Level I
Level III: CAUSES	Lists of probable causes for the circumstances (Level I) leading to the injuries (Level II)
Level IV : HAZARDS	Hazards that may be responsible for an accident having one of the causes listed at Level III

The process of assessment entails working back from the likely injury, at each successive level providing a more detailed consideration of potential accidents to identify hazards. As such it may be more appropriate for appraising consumer goods which are on the market, than the process-oriented techniques previously discussed.

Cushman and Rosenberg demonstrate this method of hazard assessment as shown in Table 11 which takes the hypothetical drain cleaning product used in the fault tree analysis previously shown in Figure 23. They explain that by addressing the potential hazards identified at level IV, the probability of an accident can be reduced.

Although the technique does not provide design solutions, it is possible to take each potential hazard and suggest ways of elimination through design modification, and through user instruction, use of protective equipment and warning labels. Taking each of the hazards identified at level IV, Cushman and Rosenberg propose solutions as illustrated in Table 12.

Table 11 : Hazard Assessment for Hypothetical Drain Cleaning Product

Aston University

Content has been removed for copyright reasons

Cushman & Rosenberg (1991) p 319

Table 12 : Showing Solutions for Hazards Identified in Table 11

Aston University

Content has been removed for copyright reasons

Cushman & Rosenberg (1991) p 320

As discussed in Chapter 1, a classification system for injury has been developed for the purposes of Home and Leisure Accident Research. The current system of 12 generic injury categories illustrated in Table 13, has superseded the more specific system of 18 injury categories as used up until 1994. These injury classification systems were incorporated by the author in developing the model for retrospective analysis of accident statistics as previously shown in Figure 2, and also provide a useful checklist for identifying injuries when conducting an assessment of hazards as part of a safety appraisal of a consumer product.

Table 13 : Generic Injury Categories Currently Used in Accident Analysis

Source : Home and Leisure Accident Research : 19th Annual Report 1995 data (1997)

Bass (1986) proposes a taxonomy of eight types of hazard:

- ◊ kinetic
- ◊ mechanical
- ◊ chemical
- ◊ electrical
- ◊ thermal
- ◊ pressure
- ◊ radiation
- ◊ noise & vibration

His taxonomy has been adapted by Cushman & Rosenberg (1991) to present a summary of the hazard types, giving examples and the associated potential injuries as shown in Table 14.

After Bass (1986)

This Table also includes various hazards associated with machinery safety taken from CEN/TC114 (1990) / BS EN 292 Part 1 and potential injuries.

Cushman and Rosenberg have also prepared various guidelines for designers to enhance product safety addressing mechanical, electrical, thermal hazards, together with guidelines for packaging safety. A summary of the relevant issues which need to be addressed is given in Table 15.

Table 15 : Guidelines on assessing potential hazards in consumer products

	is it properly earthed
	fingers or hands

After Cushman & Rosenberg (1991)

Although these guidelines are primarily prepared for designers, they can also be used as the basis of a product safety appraisal, to determine whether adequate safeguards are present to reduce the potential for injury to the minimum. Many of these guidelines address aspects included in current UK safety standards and regulations, covering for example electrical appliances, pan handles on cookware, and packaging for toys.

Cushman and Rosenberg also cite useful statistics for surface temperatures for pain threshold and for first degree burns adapted from work by Faulkner (1976) as set out in Table 16, and specify surface temperatures for different materials adapted from work by the US Government (1973) as set out in Table 17. The values in Table 16 assume one second duration contact, a high initial skin temperature and a high product mass.

Table 16 : Guidelines on pain thresholds for surface temperatures

Material	Pain threshold	Threshold for 1st degree burns
Aluminium	45°C (113 °F)	60°C (140 °F)
Pyrex glass	54°C (129 °F)	82°C (180 °F)
Phenolics	61°C (142 °F)	99°C (210 °F)
Polystyrene	77°C (171 °F)	138°C (280 °F)

After Faulkner (1976)

Table 17 : Guidelines on maximum surface temperatures for different materials

Surface Use	metals	glass	plastics
handles	50°C (122°F)	55°C (131°F)	60°C (140°F)
surface near handles	55°C (131°F)	65°C (149°F)	75°C (167°F)
other surface (No warning)	65°C (149°F)	750°C (167°F)	85°C (185°F)
other surface (+ warning)	70°C (158°F)	90°C (194°F)	110°C (230°F)

After US Government (1973)

Although various values are given in these tables, ideally, surface temperatures would be kept below 35°C (95°F). The varying temperatures for different materials and different uses show how the thermal properties of a material and its thermal conductivity can vary.

Other important variables which can contribute to the extent of injury ranging from discomfort through pain to burns, are the thickness of the epidermis at the point of contact and the duration of contact.

Kjos (1990) emphasises that the key to controlling a hazard is identifying it. She also notes however, that it is difficult to be knowledgeable in all of the necessary fields to make an adequate risk assessment of the system. For example, she comments that the radio-active coating of optics is a feature which may not be known by an engineer carrying out a risk assessment, who would therefore not investigate this potential hazard. Although checklists as detailed in Table 15 above are commonly used to aid the process of identifying hazards, and are well suited to checking for compliance with specific standards and Regulations, she comments that they have inherent faults.

In describing the use of checklists and guidelines to make sure that the full range of ergonomics issues have been considered, Stanton and Young (1998) suggest that this approach can suffer from lack of situational sensitivity, requiring the expertise of the analyst to discriminate an appropriate item from an inappropriate one. Kjos (1990) comments that checklists need to be designed to ask rigorous questions, i.e. rather than querying "Are suspect carcinogens used?" a more searching question would be to ask "Are beryllium compounds used? Is dimethylamine used... etc.?".

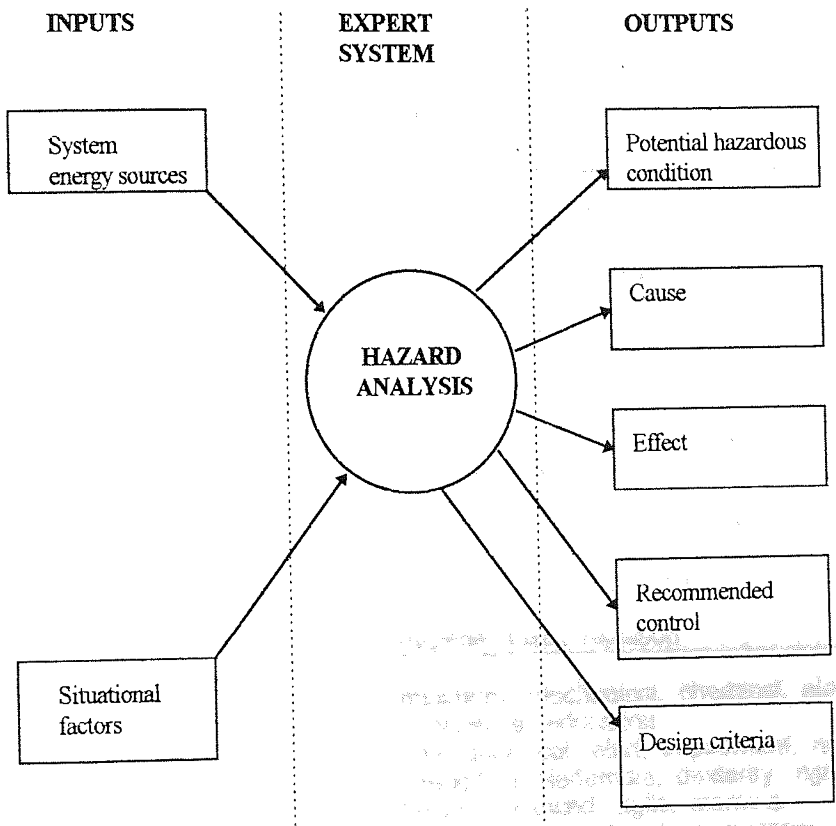
She suggests it may be more constructive approach to ask open questions, e.g. "What compounds are used for the bases of circuit boards?" and then determine whether that compound is toxic or has compatibility problems. Kjos discusses the development of a computer based expert system as shown in Figure 24 to aid in identifying, quantifying and recommending control for hazards, which would also be used for training engineers in identifying and quantifying hazards.

The expert system incorporates two different approaches to safety system analysis:

◊ **energy/hazard** based - i.e. energies that can cause hazard - acting as a hazard checklist for engineers;

◊ **system based** - coupling epidemiological analysis with experience of a given system.

Figure 24 : Generic Inputs and Outputs of Expert System for Safety



Kjos (1990) p 337

Utilising the former approach, Kjos breaks down her five main hazard types into categories as shown in Table 18.

Table 18 : Hazard Types

After Kjos (1990)

CHEMICAL	- carcinogen - compatibility - corrosion - explosiveness - flammability - toxicity
ELECTRICAL	- arcing/sparking - loss of function - radiation - shock - temperature
HUMAN ERROR	- capture errors - misperception - mode errors
MECHANICAL	- ejected parts - kinetic energy - pinch points - structure - weight/strain
SOFTWARE	- failure in safety critical software - inadvertent activation

She also proposes inclusion of information on specific systems, for example a hierarchical structure of information about features of a laser system, or other specific product.

Ryan (1987) has devised his own checklist of product hazards and user characteristics as shown in Table 19.

Table 19 : Checklist of Hazards

PRODUCT	energy level	◊ pressure, force, temperature, explosive, flammable, mass, stability
	surface	◊ rough, irregular, sharp, hard, soft, slippery, floppy, hot, cold, unstable
	geometry	◊ edges, bulky, grabbing, holding, small, too large, unwieldy
	motion	◊ static, dynamic, rotation, reciprocating, intermittent, continuous
	safeguards	◊ guards, presence sensing devices, emergency stop, fail-safe, personal protective equipment
	warnings	◊ labels, signs, instructions, operator manual, spare parts, assembly/disassembly, clarity
INJURY	limb	◊ cutting, crushing, pinching, burning, abrasive, sharp, tearing
	health	◊ hygiene, toxic, radiation
USER	skill	◊ minimum, mechanical, chemical, electrical, prior experience, education
	mental	◊ age, analytical, alert, impairment, nature
	physical	◊ strength, male/female, dexterity, right/left handed, height, balanced, agile, stamina
	cognitive processes	◊ perceptual, long/short term memory, risk taking, comprehension, decision
	psychological	◊ behaviour, emotional, calm, panic, impulsive, deliberate, cautious

The emphasis on identifying **critical** factors in causing an accident has much in common with the approaches of HAZOP/HAZAN and HACCP described earlier in this section.

Table 20 illustrates the factors which Schoone-Harmsen identified as **critical** and proposes general strategies to be used to address these factors, through product design. All of these methodologies share in common a focus on preventative measures to be considered by designers, or during production or manufacturing.

Table 20 : Schoone Harmsen's Critical Factors

- **product factors**
  - ◊ select a different working principle
  - ◊ deactivate before use
  - ◊ separate user from source of danger
- **user actions**
  - ◊ influence user actions through product
  - ◊ select user through anthropometric/cognitive characteristics
- **environmental conditions**
  - ◊ influence where used through product

As shown in Table 21, Jaycock and Gad propose preparing a hazard and toxicity profile for chemical products, by asking pertinent questions to understand the way a product is made and how it is to be used. Their toxicology hazard matrix includes assessment of various properties to classify and simplify the volume of data to enable variables to be identified, differences to be established and to attach weightings to them.

Table 21 : Toxicology Hazard Matrix

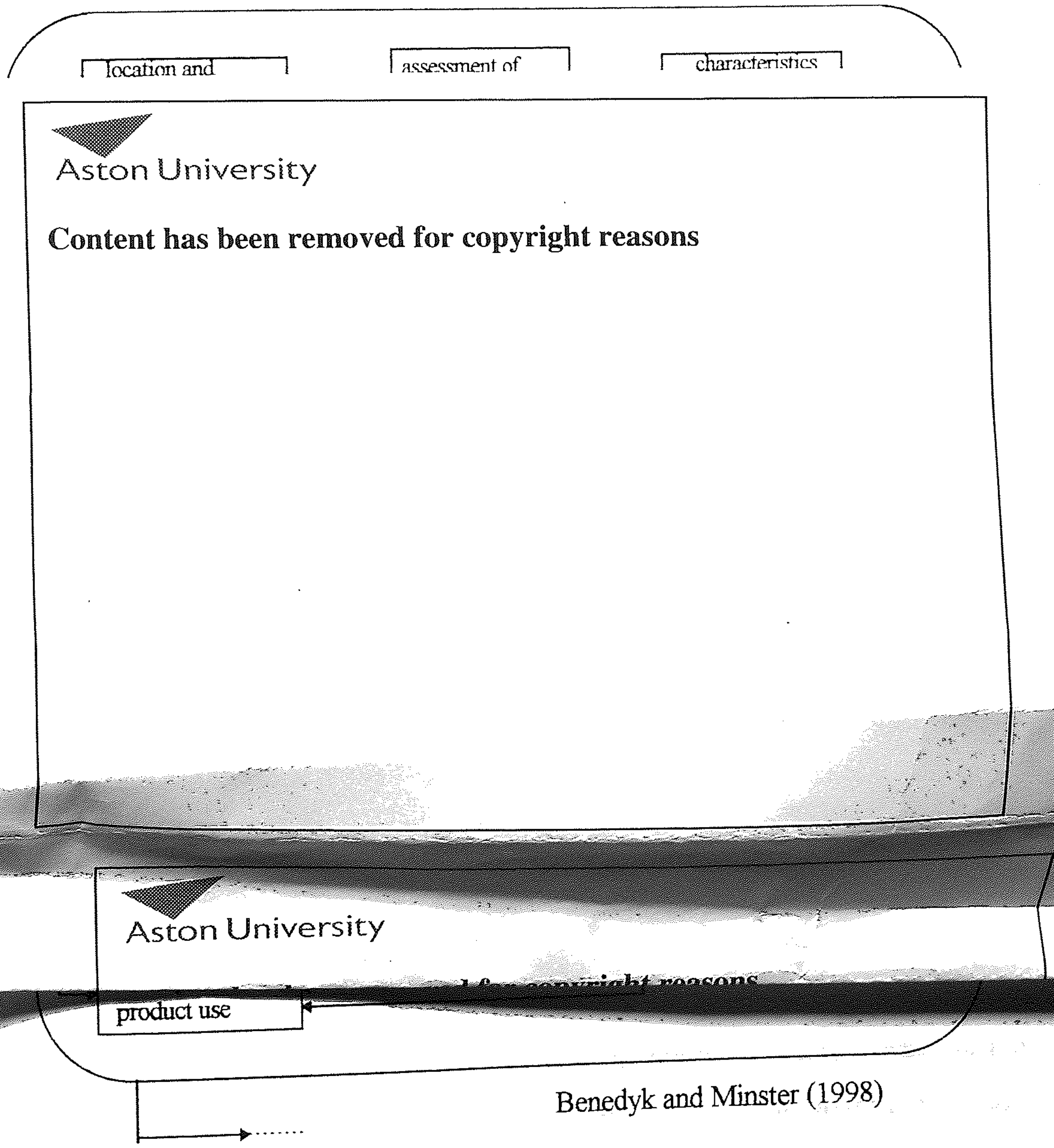
Physicochemical properties

After Jaycock & Gad (1988)

In recognising legislative pressures concerning product safety and workplace safety, Benedyk and Minster (1998) identify the requirement to assess safety and the safe usage of products. They also recognise the overlap between this type of safety assessment of the product as used in normal conditions, and an ergonomics evaluation of product use - centred on the user in the use environment - to evaluate product safety. They describe BeSafe (Behavioural Safety) techniques which were developed by ergonomists for use in the mining industry to reduce accidents attributed to human error.

Figure 25: BeSafe Scenario Approach to Workplace and Product Safety

WORKPLACE SCENARIO



Benedyk and Minster (1998)

This is essentially an integrated set of ergonomics based procedures, including analysis techniques, checklists and questionnaires designed to enable an auditor to identify systematically potential for human error in a specified job, operation or system. The technique has been designed for use by non-ergonomists to identify potential human errors likely to cause accidents (active failures) and organisational factors which might predispose active failures, i.e. the latent failings in the system. Analysis of accident statistics is a fundamental element of the process.

Benedyk and Minster adapt the workplace scenario framework for use in product safety evaluation, in evaluating the product instead of the job, as shown in Figure 25. This requires additional information regarding the target population of users, age, anthropometry, experience and the physical and societal environments of use.

Benedyk and Minster recognise the violations of safety mechanisms which occur in use of consumer products, where users disobey instructions and warnings or override safety devices. As well as the ergonomics of the human/product system, they propose that product safety evaluation must consider the basis of the original design decisions, the reality of the use environment and the nature of the user's risk perception of measures taken by users.

They comment, however, that the BeSafe method has some limitations. In the consumer product environment scenarios are more wide ranging and uncertain, users are variable, the use environment is variable/unknown, product use is variable and many factors are diffuse or impractical to measure. Because of this it is necessary to "over-design" the ergonomics of the product.

5.4 Developing a Single Model as the Basis of a European Protocol

Thus far, a wealth of approaches have been identified which emphasise classifying hazards and associated injuries. In order to develop a working model for hazard analysis, these techniques require synthesis into a cohesive approach. In practice, when such models are applied to a **finished product**, unless the product safety risks to the user are so great as to require removal of the product from the market, such strategies addressing critical factors will necessarily be limited to post hoc measures of improving safety instructions and warnings.

Jaycock and Gad (1988) describe the need to select and utilise methods to minimise uncertainty in the entire risk assessment process, and illustrate the risk management zone in Figure 26. They identify the role of the scientist or safety engineer to be to reduce the extent of the zone to minimise the uncertainty. Equally, risk managers and regulators have a role to determine or set the limits of acceptable risk.

Figure 26 : The Risk Management Zone

Jaycock & Gad (1988) p 579

In Chapter 1, Schoone-Harmsen's (1990) "Product Safety Method" was discussed as a useful tool for predicting possible situations which occur during a product's use. It provides a useful framework for a synthesis of the approaches discussed. If the elements of the hazard analytical process are taken sequentially, initially a task analysis must be carried out, addressing how the product is used/may reasonably expected to be used, in all of its phases of use, and breaking tasks into sub-tasks as appropriate. This follows the HTA approach discussed by Stammers (1996). Checklists for product hazards, of user related factors and situational factors as discussed by Stanton & Young (1998) can then be used to complete the matrix.

This type of product safety appraisal is not intended to provide solutions for design, production or marketing defects, the aim being primarily to diagnose their existence, and to establish whether safety risks have been reduced to the minimum. However, it may be possible that the potential hazards identified can be addressed through improved user instructions and warnings. Where the hazards cannot, the appraisal should be capable of identifying those products which should not be on the marketplace without additional safeguards or re-design.

As mentioned in Chapter 3, a professional body of enforcement practitioners - PROSAFE - has been seeking a protocol for risk assessment procedures within Europe. Safety enforcement practitioners in the individual Member States are applying their own informal systems for identifying unsafe products, in order to determine the appropriate enforcement response in response to their "local" enacting legislation, and their structures and mechanisms of enforcement.

However, there is a recognition that greater "transparency" of the mainly informal hazard analytical techniques in use in different Member States would assist in achieving greater uniformity of safety standards and compliance. There is also a view that there would be greater consistency if a common protocol were agreed, in responding to complaints about unsafe products, and in identifying potentially unsafe products.

The **RAPEX** system for notifying other Member States within the European Community of unsafe products, i.e. products likely to cause a serious and immediate danger to consumers, was discussed in Chapter 2. This system depends upon local arrangements for identifying and responding to unsafe products through the enactment of the requirements of Directives into domestic legislation, and Member States to relay this information to other Members. In the UK, Trading Standards Officers notify the DTI Consumer Safety Unit (CSU), and the DTI relays this information within the Community. This information is not published throughout the UK in a single source.

An analysis has been carried out by the author of the notifications received by the Consumer Safety Unit from other Member States from May 1992 to June 1996, as published through the "TS Link" confidential enforcement bulletin, as shown in Table 22.

The author has also analysed the number of UK notifications received by the Consumer Safety Unit on the basis of safety concerns raised by UK enforcement officers during the same period as detailed in Table 23.

Table 22 : Summary of RAPEX Notifications May 1992 to June 1996

Country	Details of products notified	
Austria (2)	steam cleaning device	steam cleaning device
Portugal (2)	plastic toy	skin tattoo/transfer
Eire (1)	high back toddler swing	
FDR (3)	wooden swing portable halogen lamp	Pinocchio figure
Finland (2)	Barbie Hair mist	children's bath seat
Greece (3)	power antenna hair dyer	hair dyer
Spain (4)	table lamp candles in plastic holder	electronic bug killer hot glue gun
Sweden (12)	drill/paint stripper mini soother (dummy) plastic walkalong dog toy mobile telephone ceiling fixture light 7 arm candle holder	digital pacifier thermometer Santa suit Micky babylek rattle children's rucksack timer baby soother
Netherlands (19)	ceiling fan teddy bear 7 light window stand Christmas lights (50) sensor outdoor light fitting Christmas lights (35) time switch + plug beer keg cartridge holder tulip decorative lights Christmas lights	catapult darts air pistol Christmas lights (100 + music box) refillable gas lighter Christmas lights (140) Christmas lights (10 + 5 village houses) hand held lamp high pressure cleaner sunbed canopy
Germany (37)	wall lamp table lamp travel sport hair drier galaxy table lamp optical fibre light/clock halogen lamp steam iron universal multiple socket ice crusher halogen standard light running light controller imitation sandwich pump for indoor fountain eccentric grinding machine submersible pump drill stripper hand lamp toy lights table lamp	fireworks lamp electrical steam freshener/iron Tiffany table lamp toy aeroplane steam press transformer halogen lamp steam iron electric bug killer ceiling floodlight imitation potato chips indoor fountain/pump portable halogen bulb halogen table lamp triple pendant light/burner rice cooker battery charger desk fans
Denmark (36)	bench drilling machine amplifier echo unit glue gun nipple clinical thermometer folding chair water steriliser adaptor toy crane & hook wooden pre-amplifier wooden blocks with animals magnifying glass cuddly bear tow metal swimming duck wooden toy abacus cuddly toy pig wooden rocking horse tool set	fluorescent tube fitting limit value meter hand held fluorescent tube lamp fire truck baby walker microwave egg boiler bench grinders wooden blocks swimming mask wooden windmill wooden jumping jack swimming goggles wooden train wooden balls & hammer toy metal police car tin tractor & lorry wooden toy lorry & bricks cuddly toy rabbit wooden toy train telephone

Table 23 : Summary of UK RAPEX Notifications May 1992 to June 1996

Details of products notified (17)	
Imitation Dummy	Paint set
Plastic toy	Make-up
Necklace	Pump for aquarium
Christmas Santa lights	Illuminated bathroom mirror
Smoke machine	Child's cycle seat
Puzzle	Kettle
Glass candy ornament	Pencil
Soft toy	Ball point pen
Colour pen	

The clear variation in the number and type of products notified by Member States within Europe poses a number of questions:

◊ whether the "absolute" safety of consumer products differs within European Member States,

◊ whether there are cultural differences in safety perception and risk assessment,

◊ whether the process of hazard analysis is different,

◊ or whether there is a subtle combination of these contributing factors.

Agreeing a common procedure for use by all Member States in identifying and analysing hazards, provides an objective basis for applying a "transparent" protocol which may be less susceptible to subjective or cultural bias.

Following a PROSAFE conference in Stockholm in May 1995, the PROSAFE group has been considering models developed in the USA and New Zealand for assessing consumer safety risks, in order to select or develop a single model for adoption by Member States. These models share some similarities with the occupational safety methods of risk assessment and product safety assessment techniques discussed earlier in this chapter. However, no practical work has been carried out to evaluate the suitability of either method for this purpose. The author was invited to evaluate the American and New Zealand models for risk assessment as part of the research process, and to assist in developing a single method for use by PROSAFE members.

5.5 Reviewing the American Model

It is interesting to trace the development of the American approach to risk assessment in seeking safety compliance, in context of their legal framework as discussed in Chapter 2. Schmelzter (1995) describes the system implemented in the USA by the US Product Safety Commission's (CPSC) Office of Compliance, to determine whether a product warrants further investigation, and if a substantial hazard exists, what remedy to seek. Their model extends beyond the process of hazard identification and analysis, to consider the appropriate corrective action, on a scale from product recall, repair, replacement, refund, or prospective design change, as directed via the Corrective Actions Division.

This offers a much wider scope of governmental controls than provided via the UK safety legislative framework, which is primarily concerned with criminal safety enforcement. The American approach also embraces civil law remedies such as repair, replacement and refund. It also appears to exercise a greater control over imported product, and associated detention shipments, which is wider than the joint working arrangements between the Trading Standards Service and Customs and Excise officers set out in UK legislation.

The US Regulatory Management Division appears to be the most direct equivalent of the role of UK Trading Standards Service, having responsibility to ensure that industry comply with all applicable regulations under the Consumer Product Safety Act. However, the US Regulatory Management Division exerts a central influence rather than the local enforcement role of Trading Standards' enforcers in the UK. The DTI Consumer Safety Unit would appear to be the most direct equivalent of the CPSC Office of Compliance. There is no statutory equivalent to the Corrective Actions Division, although the Office of Fair of Fair Trading maintains a general watching brief over trading activities extending into the civil domain.

The American model provides a useful set of criteria to consider in receiving consumer safety complaints to determine those to follow up as shown in Table 24. In each instance in determining whether to assign a follow up, the sample availability, extent of consumer exposure and specialised population group affected are <u>always</u> considered.

Table 24 : Criteria To Screen and Follow Up Complaints

♦ Fatality or grievous injury attributable to (potential) defective product
♦ Identify or suggest product defect could present substantial hazard. Initially assess likelihood and severity of injury that could occur dependent upon available information
♦ Information not sufficient to identify product defect - does indicate a new product complaint or new complaint previously not recognised with the product. A pattern defect may or may not be known.
♦ Identifies a safety related or injury/accident associated with a product which the firm refuses to recall at staff's request
♦ Identifies a possible failure to report under s15(b) of the Consumer Product Safety Act

Three hazard priority categories A-C are used to invoke the appropriate level and intensity of corrective action programmes to be identified by manufacturers and suppliers to protect the public from undue risk of injury associated with that product.

Statutory criteria are then applied to consider:

◊ the pattern of defect

◊ the number of products distributed and the severity of risk including likelihood of injury

to form the basis of a substantial product hazard determination for the preliminary determination panel. The risk is assigned a hazard classification of A-D based on the Hazard Priority System detailed in Table 25.

Table 25 : CPSC Hazard Priority System

Class A	Exists when the risk of death or grievous injury or illness is likely, or very likely, or serious injury or illness is very likely
Class B	Exists when the risk of death or grievous injury or illness is not likely to occur, but is possible, or when serious injury or illness is likely, or moderate injury or illness is very likely
Class C	Exists when the risk of serious injury or illness is not likely to occur, but is possible, or when moderate injury or illness is not likely but possible
Class D	Exists when a defect is present and while some risk of injury is presented, it does not rise to the level of a substantial product hazard. The staff supports a firm's efforts to correct the problem in the interest of public health and safety.

When classifying a product two general criteria will also be considered to distinguish the importance of product hazards known to the Commission:

◊ **the severity of the most likely injury** resulting from the hazard, prioritised into three priorities :

- ● *death or grievous injury or illness* - e.g. amputation, severe burns, loss or impairment of vision or hearing, cancer and genetic damage
- ◓ *serious injury or illness* - e.g. disability, disfigurement resulting from bone fractures, serious lacerations, concussions and strong allergic reactions
- ⊖ *moderate injury or illness* - e.g. where there is no disability or disfigurement resulting from cuts, scratches, irritation or moderate to strong allergic reactions.

◊ **the likelihood of death, injury or illness** resulting from the hazard, prioritised into three priorities of:

- ● very likely,
- ◓ likely,
- ⊖ not very likely but possible,

The following factors are taken into account to prepare a summation or a hazard pattern.:

- ◊ *the number of hazardous products* in use
- ◊ *the extent of consumer exposure per unit* (i.e. a few times per year, a few times per week, or constantly)
- ◊ *the proportion of units* representing risk of injury
- ◊ *the likelihood of all conditions* which must occur before the product causes injury in normal use
- ◊ *the latency of hazard*, i.e. hidden hazard or harm unforeseeable

For example, the matrix shown in Table 26 distinguishes hazards in terms of the four lettered classes of priority.

Table 26 : CPSC Hazard Priority Matrix

	Hazard Priority Classification								
Hazard Priority	A	A	A	B	B	B	C	C	D
Severity	●	●	◓	●	◓	⊖	◓	⊖	⊖
Likelihood	●	◓	◓	⊖	◓	●	⊖	◓	⊖

5.6 The New Zealand Model

In setting the legislative context for the New Zealand technique of risk assessment, Hooker (1995) describes the introduction of the Fair Trading Act 1987 in New Zealand, and how their domestic framework for consumer safety enforcement has evolved in a similar way to the UK framework described in Chapter 2. Their Fair Trading Act addresses misleading and deceptive trading practices as well as promoting consumer safety, by providing the power to make mandatory safety standards and to order a recall of unsafe goods.

In New Zealand, as in the UK, there is no co-ordinated approach to product safety matters and safety complaints are dealt with under a variety of legislation and by a range of Government agencies who are concerned with electrical safety, food safety and road safety issues. The New Zealand Ministry of Consumer Affairs has powers to make mandatory standards and to order a recall or ban unsafe goods. Not unlike the UK Department of Trade and Industry Consumer Safety Unit, or the United States Product Safety Commission, the Ministry of Consumer Affairs monitors and records incidents involving alleged hazardous products, and consideration of these incidents provides an opportunity to exercise these powers.

However, Hooker comments that most incidents are resolved voluntarily, avoiding the need to exercise these powers. He also adds that resource limitations prevent full investigation of reports concerning all alleged hazardous products. Accordingly, a system has been developed for establishing an order of priority for products selected for investigation. Hooker discusses the risk assessment technique currently used which combines the work of Fine (1973) and Kinney and Wirith (1976) from the United States Navy, as developed by the New Zealand Accident Compensation Corporation (ACC) (1983) and a risk analysis technique developed in Australia.

The ACC method assumes that an assessment of the risk can be determined from three factors:

- ◊ the severity of the consequence that might result from an incident involving the product, i.e. the degree of injury or financial cost of resultant damage;
- ◊ the time for which the user is exposed to the product;
- ◊ the probability of an incident occurring.

These factors were each assigned a range of numeric values on a logarithmic scale. For example, the severity of consequence of an incident ranged from a value of 1, if minor first aid was necessary and/or $100 damage was caused, to a value of 100, if there were many fatalities and/or $10,000,000 damage was caused. The three values obtained by scoring in this way were multiplied together to obtain a risk score for the product.

However, the majority of consumer product incidents under investigation, in practice appeared to cluster at the lower end of the severity scale, and exposure times fell into a relatively narrow range, by comparison with the wider range of values obtained in US Naval investigations. This limited the usefulness of the method for incidents involving consumer products, as risk scores tended to be tightly clustered, making it difficult to use the method for priority setting.

A technique was developed for risk rating components used in particular products, to indicate which parts of the product presented unacceptable hazards and therefore needing corrective action. Three assessment factors were used:

- ◊ potential hazard severity;
- ◊ probability of occurrence
- ◊ likelihood of hazard recognition.

Each of the factors was assigned 5 possible numeric levels ranging from 1 to 10, and a risk rating was calculated by multiplying the three values obtained together. Hooker comments that the assessment factors were more relevant for application to consumer products, and therefore more suitable for the Ministry's purposes . In their trials, the Ministry found the method to be satisfactory for priority setting. However, there was an element of subjective judgement involved in rating the severity of an injury, and it was inconvenient to do the necessary multiplication to determine the risk rating. This method also resulted in clusters of risk ratings around a few values, a limitation common to the previous method.

The two methods were combined with the assistance of a product safety consultant, to produce an approach to meet the Ministry's needs. The technique developed had to be simple to use, to be as non-subjective as possible, in order to enable a numerical risk rating to be used for deciding whether a product should be investigated, and prioritising these investigations, using risk factors of injury potential, probability of hazard, likelihood of hazard and product availability.

For example:

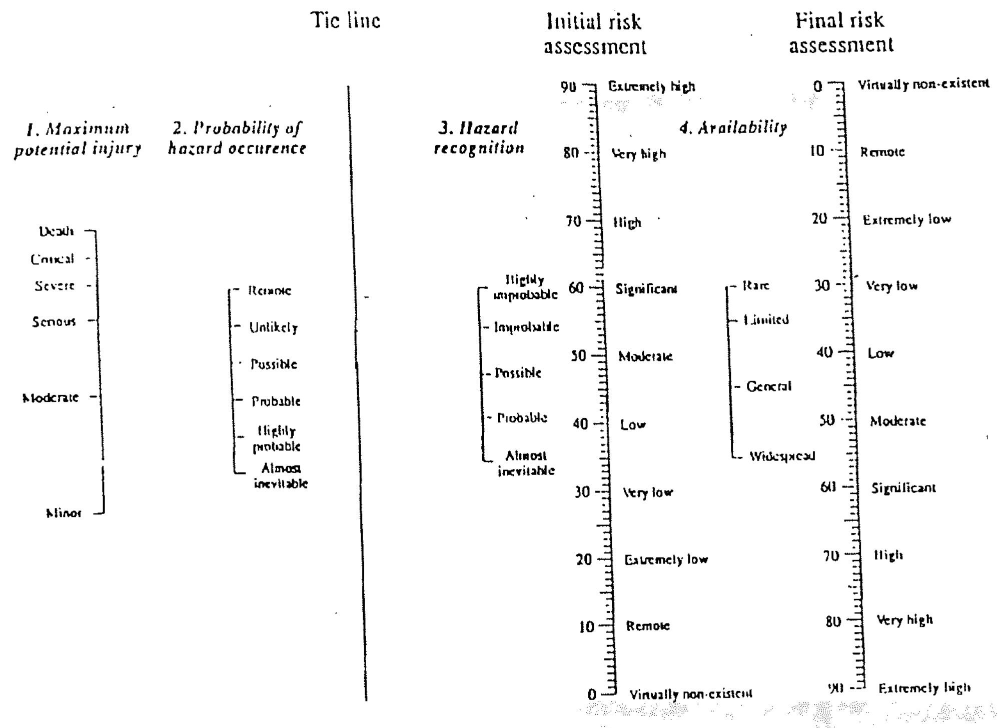
- ◊ **maximum potential injury** - given the highest weighting;
- ◊ **probability of the hazard occurring** - a greater number of users are likely to get injured where the probability of the hazard occurring is high;
- ◊ **likelihood of the hazard being recognised** - the ability to recognise a hazard is likely to reduce the possibility of injury, e.g. an unexpected sharp edge on a kitchen appliance is likely to result in more injuries than from a sharper kitchen knife;
- ◊ **the availability of the product** - a product in widespread use which develops a safety problem warrants more consideration than a product used by only a few people.

As an alternative to multiplying numerical values, a graphical method - the Nomograph - was developed, where the four factors are represented by 4 vertical lines with benchmark positions for values of each factor. Other elements were considered but the four depicted were considered to be the most important.

A general example of the Nomograph is given in Figure 27. The two scales at the right side of the Nomograph determine the risk assessment, the extreme right providing the "Final Risk Assessment". Where the assessment is carried out based on all four factors, the value is read from this final value. Where there is insufficient information known about the availability of the product, the risk rating is read from the other scale labelled "Initial Risk Assessment".

As shown in Figure 27 the two scales at the right side of the Nomograph determine the risk assessment, the extreme right providing the "Final Risk Assessment". Where the assessment is carried out based on all four factors, the value is read from this final value. Where there is insufficient information known about the availability of the product, the risk rating is read from the other scale labelled "Initial Risk Assessment".

Figure 27: The Risk Assessment Nomograph

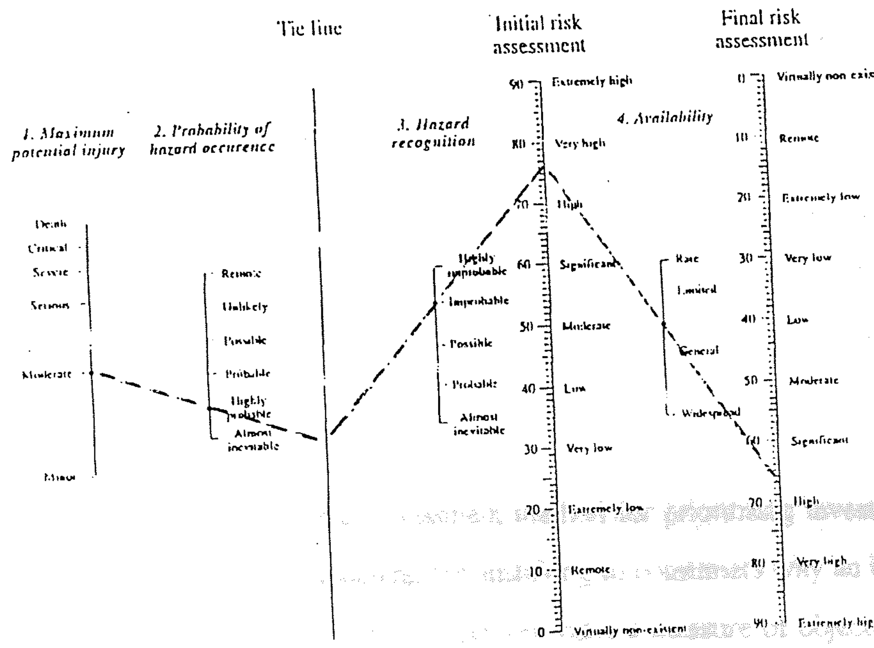


The lengths and spacing of the vertical lines illustrated in the Nomograph were selected to enable the majority of the results could be depicted on a single sheet. The distance between each was chosen to give equal weight to all of the parameters, and the vertical spacing between the points on the maximum potential injury scale were chosen to give more weight to the more serious injuries. The maximum potential injury scale were chosen to give more weight to the more serious injuries.

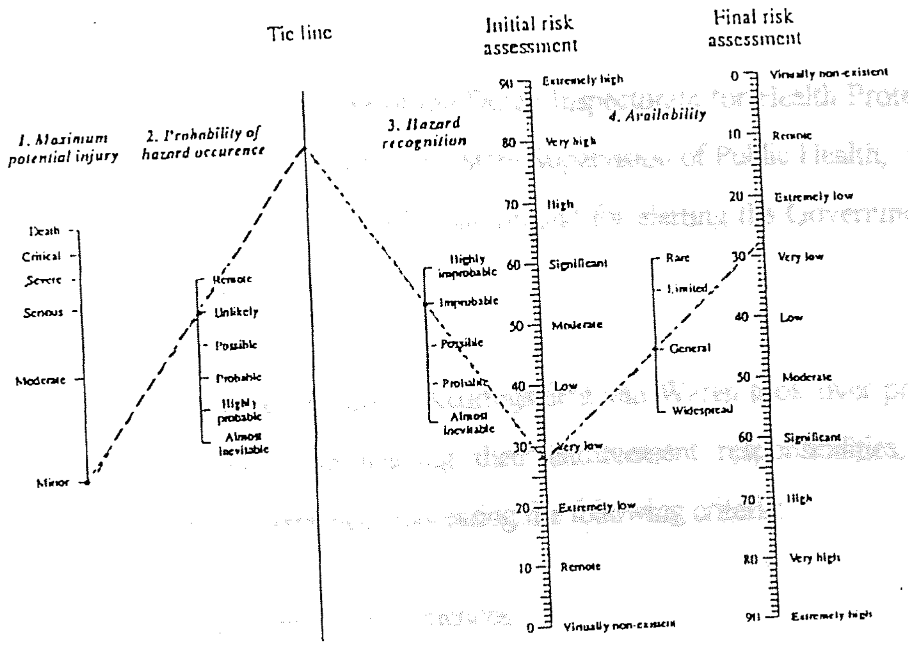
In order to reduce the need for subjective judgement, the Ministry use a simplified Injury Scale, which defines injury severity levels by reference to an internationally accepted rating scale of injury severity, underpinned by full procedural instructions. This offers greater choice for levels of scoring for the risk levels and avoids clustering around a few discrete values helping in decision making and priority setting by spreading the risk ratings in this way.

Trials using the Nomograph for assessing the same product safety complaints by different people were compared to determine consistency of results. It was agreed that the Nomograph was an easy method of doing the safety assessment, and was easier than doing the multiplication that had been necessary previously.

Figure 28 : Risk Assessment Nomographs showing



Faulty pushchair locking device



Explosion of toughened glassware

Hooker provides two examples using the Nomograph method, as shown in Figure 28, which demonstrate that the final risk assessment of an exploding toughened glass plate causing injury by propelled glass is lower than the risk assessment of a pushchair which collapses due to a poorly designed locking device which traps and severs a child's finger. The method indicates that the folding pushchair incident was more serious.

Using this combined method and the Nomograph, the New Zealand Ministry of Consumer Affairs has been routinely carrying out risk assessments since the early 1990s to determine whether to investigate a product safety complaint. Where a score exceeds 60 - corresponding to significant risk - the Ministry will investigate. A product with a score of 80 will take priority over a product with a score of 70. Even if the score is less than 60, details of any alleged injuries connected with a consumer product are stored on the Ministry's database in order to monitor any further reports, and to carry out an investigation at a later date if there is further public concern.

Hooker reports that use of this risk assessment method for prioritising investigations has proved to be a valuable tool in explaining and justifying to consumers why an investigation has not been carried out, particularly as it demonstrates a measure of objectivity, rather than merely subjective judgement.

Van Leent (1995) describes the activities of the Dutch Inspectorate for Health Protection (Keuringsdient van Waren) which is part of the State Supervision of Public Health, and is responsible for enforcement and review of legislation and for alerting the Government of public health or consumer safety issues.

Although initially a food enforcement body, Keuringsdient van Waren took over product safety enforcement from 1988. In meeting their enforcement responsibilities, the Inspectorate carries out risk assessments, addressing the following criteria:

◊ the hazard and potential consequences

◊ the probability of occurrence of the hazard

◊ recognition of the hazard and possibility to avoid the hazard

◊ vulnerability of users

◊ number of products sold

Keuringsdient van Waren apply a similar method of risk assessment as the New Zealand model, with the objective of applying an approach which :

◊ is equally acceptable to consumers and businesses
◊ is easy to use;
◊ provides a speedy result;
◊ provides sufficient discrimination within and between categories to enable risks and appropriate outcomes to be compared.

Van Leent agrees that it would be beneficial to adopt a single model for risk assessment for use as a reference system. He also welcomes further research to investigate an adequate system for risk communication to deal with circumstances where there is a difference in the perception of risk between experts and consumers.

5.7 Developing the safety appraisal protocol

Clearly, the literature provides a number of examples of approaches towards hazard identification, and analysis, establishing links with potential injuries, and techniques of risk assessment in the fields of product safety and workplace safety. Ergonomics approaches have much to offer in strategies intervention and accident prevention. The increasing legislative reference to risk assessment has fostered a concomitant increase in research into the complex interaction between users and products, at work, or in home and leisure activities. The interest in this complex interaction is world-wide. There is, therefore, a need for a robust approach to product safety issues, which might increase enforcement transparency and consistency. In response to this challenge, and specifically to inform European safety enforcement practitioners, the author has developed a model for safety appraisal, drawing upon a number of the techniques examined.

In Chapter 1, a systems approach was proposed as a model for activities which occur when a consumer product is used, including four interacting components within the system: the user; the product; the task or activity; and the context or location where the activity takes place. The interaction between the hazards associated with each system component may give rise to desirable or undesirable outcomes, contingent on the way in which information about hazards is processed, through risk assessment. A protocol for consumer product safety appraisal seeks to assess all of the interacting components in the system and associated hazards. This will include an appraisal of the product, its packaging, associated hazards and any risks of injury in use.

In deriving a consumer product safety appraisal protocol bringing together human factors influences through an ergonomics approach, the relevant legal requirements must be also addressed having regard to the safety which consumers may reasonably expect, any prescriptive legal requirements for health and safety, or in their absence published European technical specifications and standards, codes of good practice on health and safety for that product sector; and state of the art technology.

To provide a framework to record the process of task analysis Schoone Harmsen's (1990) Product Safety Matrix was introduced in Chapter 1 which identified phases in use connected with:

◊ the product,
◊ the actions of the user; and
◊ situations of use

and thus to predict situations which may occur during use of the product which may give rise to injury.

The ability for the process of consumer product safety appraisal to be carried out by non-expert evaluators, is an important requirement, if it is to be used widely by safety enforcement practitioners. However, we have seen that there are psychological biases in the perception of third parties or "experts" judging events, who may be prone to exaggerate what was foreseeable and what could have been anticipated and prevented by the consumer product manufacturer. For this reason, the author has endeavoured to establish proforma documentation as a "DIY tool kit" to lead the safety practitioner through the safety evaluation process. Although Schoone Harmsen stressed the importance of training and familiarity in use of the Product Safety method for it to be applied successfully. The proposed tool kit approach seeks to avoid these subjective biases, and recognises that there is no opportunity in practice to provide widespread training in the use of the method.

In order for it to be controlled, a hazard must be identified. Kjos (1990) notes that it is difficult to be knowledgeable in all of the necessary fields to make an adequate risk assessment of the system, and proposes use of checklists to aid the process of identifying hazards, particularly in checking for compliance with specific standards and Regulations. However, she cautions that checklists also have inherent faults. Stanton and Young (1998) also propose the use of checklists and guidelines to ensure consideration of the full range of ergonomics issues, but caution that this approach can suffer from lack of situational sensitivity, requiring the expertise of the analyst to discriminate an appropriate item from an inappropriate one.

Kjos (1990) comments that checklists need to be designed to ask rigorous questions which challenge as wide a range of issues as possible, opening up the process to identifying latent or less obvious hazards, rather than being confined to the issues included in the checklist. To address Kjos's criticisms about the restrictive nature of a checklist approach, the proposed appraisal process includes a combination of open and closed questions to make the process of enquiry as rigorous as possible.

5.8 Outline of the Safety Appraisal Model

The safety appraisal protocol proposed consists of qualitative and quantitative techniques applied in two key stages:

- ◊ **product appraisal and hazard identification**
- ◊ **task analysis and assessment of risks of injury**

The process of product appraisal and hazard identification is a qualitative product appraisal technique, led by a systematic sequence of questions to identify hazards associated with product use to complete an **Initial Product Safety Matrix**.

The process of task analysis to assess risks of injury is a qualitative process of hierarchical task analysis (HTA) as proposed by Stammers (1996) prompted from an overall general task description documented via a **Task Analysis Matrix.** This matrix considers the product's life cycle from "cradle to grave", and provides the opportunity for more detailed descriptions through a process of progressive re-description through each operation and sub-operation of product use, exploring potential injuries associated with each hazard identified at the operation/sub-operation within the HTA process, to apply a quantitative process of risk assessment of likelihood of potential injuries identified.

5.9 Documentation

The documentation of the safety appraisal process has been developed by the author to be relatively self explanatory in its purpose and the manner of completion. As to be discussed in Chapters 7 and 8, brief instructions only were provided with the documentation to explain the appraisal process and details of document completion to the participating Trading Standards Authorities who evaluated the safety appraisal process. In order to consider each of the four interacting components within the system, i.e. product/ user/ location/ task, the process examines each in turn, in order to identify all potential hazards. Although the potential interactions are complex and multi-dimensional, for the purpose of the experimental phase of research, each component is necessarily considered separately in the initial phase of hazard identification, and the potential interactions are considered through the systematic sequence of questions.

For this purpose, a detailed **Initial Product Safety Matrix** has been developed for use by enforcement personnel to carry out the preliminary process of hazard identification in response to a series of questions addressing factors concerning the product, its marketing factors, safety information, and then users factors, the location of activity and task factors. Table 27 illustrates the outline of major categories of questions posed, where the questions included are based on the literature review and the author's experience. The outcome of the Product Safety Matrix study is discussed in further detail in Chapter 7.

Table 27 : Initial Product Safety Appraisal

1. PRODUCT: a) Description b) Size / dimensions c) Whether portable / hand held / fixed? d) Assembly/ installation e) Materials : Describe its principal materials: f) Motion : Does it have moving parts? g) Electrical hazards h) Thermal hazards i) Chemical hazards j) Packaging k) Deterioration l) Maintenance m) Disposal n) Cognitive o) Foreseeable Misuse
2. MARKETING a) Target user group : b) Age labelling given? c) Whether product's intended use clearly conveyed
3. WARNINGS / SAFETY INSTRUCTIONS a) Use of signal words, e.g. " Lethal, Danger, Warning, Caution, Notice " present? b) Location, Visibility, Durability, Comprehension : c) Message section : d) Pictorial section : e) Maintenance f) What PPE is required? g) Cross references to other sections
4. USER a) Sex b) Age c) Skill
5. LOCATION a) List of all likely locations of use and any associated potential hazards
6. TASK a) Intended use b) Misuse

Depending upon the nature of the product, for example whether it is intended to be portable or fixed, and whether assembled for use or whether assembly and/or installation is necessary before use etc., a number of potential hazards will be identified. These questions also seek to identify whether there are any patterns of use and associated hazards resulting from the nature of the user, i.e. male/female, or their age and physical characteristics, or resulting from the location of usage i.e. indoors/outdoors etc. The process is intended to be re-iterative, in that responses to questions in subsequent categories might prompt a further review of responses to questions in previous sections.

To assist the participating Trading Standards Authorities in completing the Product Safety Appraisal Matrix, a worked example of a sample product was enclosed with their experimental pack, together with the sample. An excerpt of this worked example, indicative of how the Matrix is to be completed is illustrated in Table 28.

Table 28 : Excerpt from Initial Product Safety Appraisal of Tefal Freeline Jug Kettle

1.2 **Size / dimensions** ☐ Is it heavy, bulky ? ☐ Geometry : awkwardly shaped, unwieldy	*The handle at the side of the kettle is towards the top of the container. It is quite heavy to lift when full. There is a T shaped plastic stop device on the inner surface of the top of the handle, which prevents the trigger for releasing the base from opening too far. When the kettle is full, this moulding digs into the forefinger.*
1.3 ☐ Is it portable / hand held / fixed? ☐ Are there any slipping / tripping/ falling or other hazards : ☐ in moving the product towards its place of use? ☐ in handling /holding the product? ☐ in its fixed location of use?	*The kettle is designed to be portable, and detachable from the base unit which is the source of power. This has the benefit of the kettle being moved from the power supply to the place where it is required to be used, e.g. for filling with water. It has the disadvantage that a kettle full of recently boiled water may be moved to a location where it will be emptied, en route there may be potential tripping/ slipping hazards and thus spillage of boiling water. The short flex between the power supply and base unit reduces the possibility of the kettle being reached by a child and pulling the boiling contents over themselves.* *It is hard to lift the kettle when full without the grip squeezing the trigger, tending to release the kettle from the power base unit. This may be a useful safety feature to ensure that the kettle is separated from the base (and thus the power supply) for filling*

Having completed the initial product appraisal, the next analytical phase entails preparing a detailed list of the tasks and sub tasks associated with all potential phases of reasonably foreseeable use and reasonably foreseeable misuse of the product in question, for each of the different types of user and differing locations. An outline framework listing the general task descriptions used as the basis of the detailed hierarchical task analytical process is illustrated in Table 29

The documentation is designed to enable Trading Standards staff to complete a number of **Task Analysis Matrix** forms successively, for each of the types of potential users identified in the preliminary product appraisal process. Thus, a product which may have one set of uses/misuses when used by children, and another when used by adults, would require the task analysis matrix to be completed twice. Equally, if the nature of use differs substantially for different locations, a separate task analysis matrix would be completed for each location. Having identified all of the primary tasks and sub-tasks within each matrix, it is then completed by linking the potential hazards identified in the first phase with potential injuries for each potential usage scenario. . The outcome of the Task Analysis study is discussed in further detail in Chapter 8.

Table 29 : General Framework of Task Analysis Process

PHASE IN USE **List in the column below every phase of use of the product from "cradle to grave" using the sub headings as a guide**
Manufacture
Distribute product
Display product
Purchase product/ transport home for use
Unwrap product
Bring product to place of use
Make product ready for use
Install/ assemble product
Use product
Interrupt task
Adjust product
Refill product
Clean product
Dismantle product
Store product

The taxonomy of hazards adapted by Cushman & Rosenberg (1991) summarising hazard types and potential injuries has been further developed by the author into a **Summary of Hazard Guidelines** which also cross references published standards and guidelines to widen the consideration of potential hazards and associated injuries. This matrix, has been prepared for reference in order to assist in completion of the Task Analysis Matrix, to assist in associating hazards and potential injuries, cross referencing other sources of reference, including European and British standards which specify relevant criteria for avoiding injury. The matrix considers potential injuries associated with thermal, pressure, radiation, mechanical, kinetic, noise/vibration, chemical and electrical hazards in turn. An excerpt from this summary is detailed in Table 30.

Table 30 : Excerpt from Summary of Hazard Guidelines

HAZARDS	POTENTIAL INJURIES	CONSIDERATIONS	GUIDELINES
Kinetic Moving parts Ejected parts/fragments Impacts Falling parts	- Cuts & punctures - Bruises - Broken bones - Eye damage - Severing - Entangling/trapping - Abrasion - Dislocation - Tenderness/swelling - Concussion / head injuries	- Rotation, reciprocating, intermittent, continuous? - Are there hazards from: - entanglement? - drawing in or trapping hazards? - crushing ? - shearing? - cutting or severing hazards? - stabbing or puncture? - impact? - ejection of parts? - loss of stability? - Safeguards : emergency stop, fail-safe, guards, presence sensing devices?	BS EN 418 Safety of machinery/ emergency stops BS EN 349 Minimum gaps in machinery to avoid crushing BS 4139 relating to prams, BS 4972 relating to pushchairs, BS 4648 relating baby walkers BS 3785 child restraining devices prams & chairs, BS 6684 walking reins BS 5665/ EN71 relating to toys, BS 5715 relating to skateboards BS 7409, BS EN 747 relating to bunk beds BS 7646 relating to shopping trolleys Shear testing BS EN 205, Shear testing of adhesives BS EN 29653, of plastics BS 2782, of structural fixings BS 5080 BS 5776 domestic stairlifts

Once the full list of potential injuries associated with each task/operation/sub operation has been identified, they are recorded in the third column of the Task Analysis Matrix as shown in Table 31.

Table 31 : Task Analysis Process To Record Hazards and Potential Injuries

(1)PHASE IN USE List in the column below every phase of use of the product from "cradle to grave" using the sub headings as a guide	**(2) HAZARD** List in the column below, all hazards associated with use of the product by the user, for each phase of use identified in column (1), which might result in injury to the user	**(3) POTENTIAL INJURY** List in the column below any potential injuries associated with hazard identified in column (2), for each phase of product use detailed in column (1)
Manufacture		
Distribute product		
Display product		
Purchase product/ transport home for use		
Unwrap product		
Bring product to place of use		
Make product ready for use		
Install/ assemble product		
Use product		
Interrupt task		
Adjust product		
Refill product		
Clean product		
Dismantle product		
Store product		

In order to meet the aspirations of the PROSAFE group of European safety enforcement practitioners to identify a common approach towards risk assessment, and to evaluate alternative methods available, two systems for assessing the risk of potential injury were identified for use by the participating enforcement authorities, based on the literature review. This enabled a comparison of the comparative benefits and usability of a numerical scoring method as compared with the graphical Nomograph method. As a result, two formats of the Task Analysis Matrix were developed for use in determining a final risk assessment based on the numerical and the Nomograph method:

◊ a numerical system developed by the author based on the system proposed by Steel (1992) as included in EN 292. The principal elements for scoring risk are incorporated into columns 4 - 8 of the Task Analysis Matrix, as illustrated in Table 32.

Table 32 : Principal Elements of Risk Assessment Process : Numerical Method

(4) Probability of exposure to hazard - PE	(5) Frequency of exposure to hazard - FE	(6) No of persons at risk - NP	(7) Maximum probable loss - MPL	8) Risk rating HRN
0 **Impossible** -cannot happen under any circumstances 1 **Unlikely** - but conceivable 2 **Possible** -but unusual 5 **Even chance** - could happen 8 **Probable** - not surprised 10 **Likely** - only to be expected 15 **Certain** - no doubt	0.1 **Infrequently** 0.2 **Annually** 1.0 **Monthly** 1.5 **Weekly** 2.5 **Daily** 4 **Hourly** 5 **Constantly**	1 **1 - 2 persons** 2 **3 - 7 persons** 4 **8 - 15 persons** 8 **16 - 50 persons** 12 **not < 50 persons**	15 **Fatality** 8 **Loss 2 limbs/eyes/ serious permanent illness** 4 **Loss 1 limb/eye/ serious temporary illness** 2 **Break bone/minor permanent illness** 1 **Break bone/minor temporary illness** 0.5 **Laceration/mild ill health effect** 0.1 **Scratch/bruise**	

◊ and a graphical method, the Nomograph as proposed by Hooker (1995). The principal elements for determining risk are incorporated into columns 4 - 9 of the Task Analysis Matrix, as illustrated in Table 33.

Table 33 : Principal Elements of Risk Assessment Process : Nomograph Method

(4) Maximum potential injury	(5) Probability of the hazard occurring	(6) Likelihood of the hazard being recognised	(7) Initial risk assessment	(8) The availability of the product	(9) Final Risk Assessment
Death Critical Severe Serious Moderate Minor	Remote - cannot happen under any circumstances Unlikely - but conceivable Possible -but unusual Probable - not surprised Highly probable- likely/ only to be expected Almost inevitable / Certain - no doubt	Highly improbable Improbable Possible Probable Almost inevitable		Rare Limited General Widespread	

Inevitably, these techniques include elements of subjectivity. However, it is considered that the discipline introduced through following the systematic process previously described introduces an element of objectivity which is missing from existing methods of assessment of consumer products currently carried out by enforcement agencies.

Each of the two alternative methods is intended to provide a single numerical score, or a single risk assessment via the Nomograph for the product being evaluated. However, the way in which the Task Analysis Matrix has been structured to consider all phases of use provides a number of scores, i.e. a score for <u>each</u> phase of use identified in the matrix. In order to determine a single final numerical score volunteers were asked to select the highest numerical score/ Hazard Rating Number identified in the phases of use considered. Similarly, in order to determine a final risk assessment for the product, volunteers were asked to select the most extreme combination of :

◊ Maximum potential injury,
◊ Probability of the hazard occurring,
◊ Likelihood of the hazard being identified, and
◊ Availability of the product,

to calculate a final value to plot on the Nomograph.

In addition, where several matrices are completed successively for each different user and/or different locations, it is entirely foreseeable that there will be a number of different hazard analysis evaluations carried out for each product. The method identifies all potential hazard analysis scenarios arising from use of the product, in a similar manner to the hazard patterns proposed by Drury and Brill (1983) for retrospective analysis of accident scenarios. Although this might inevitably provide a range of values for risk assessment for different phases of use, or for different user/location combinations, it provides an attempt to address the complicated interactions of the various factors which exist in reality. The highest numerical score/ Hazard Rating Number identified in the phases of use identified, or the most extreme injury combination plotted on the Nomograph must be determined for each Task Analysis Matrix completed, to consider all of the potential hazard analysis scenarios.

This brief outline of the actual safety appraisal model developed by the author belies the extensive considerations which have underpinned the development, format and content of the documentation used in the proposed safety appraisal process, and how the concepts considered within the literature reviewed in the earlier chapters have been synthesised within this process. It is encouraging that the author's drive to develop a pragmatic approach to the task of undertaking product safety appraisal has found support within the literature, and that recent ergonomics work in the field of consumer safety is developing a recognition of the importance of such practical techniques.

Chapter 6 : Experimental Design

6.1 Introduction

Essentially, three separate studies have been carried out in order to evaluate the safety appraisal method outlined at the end of Chapter 5. This Chapter describes an overview of the three studies and describes and evaluates the initial survey of responses from local authority Trading Standards Departments. It also considers briefly a number of related issues addressed in the responses of the representatives of the six participating authorities to the Pre-Appraisal questionnaire. Subsequently, chapters 7 and 8 describe the Product Safety Appraisal study and the study of the comparative risk assessment outcomes using the Nomograph and Numerical scoring systems.

The thrust of the empirical work carried out combines use of a number of questionnaires together with performance evaluation of the proposed safety appraisal method:

◊ to establish the level of understanding and application of objective risk assessment techniques within local authorities through a preliminary questionnaire;

◊ to identify local authorities to apply the safety appraisal method based on analysis of their responses to the preliminary questionnaire;

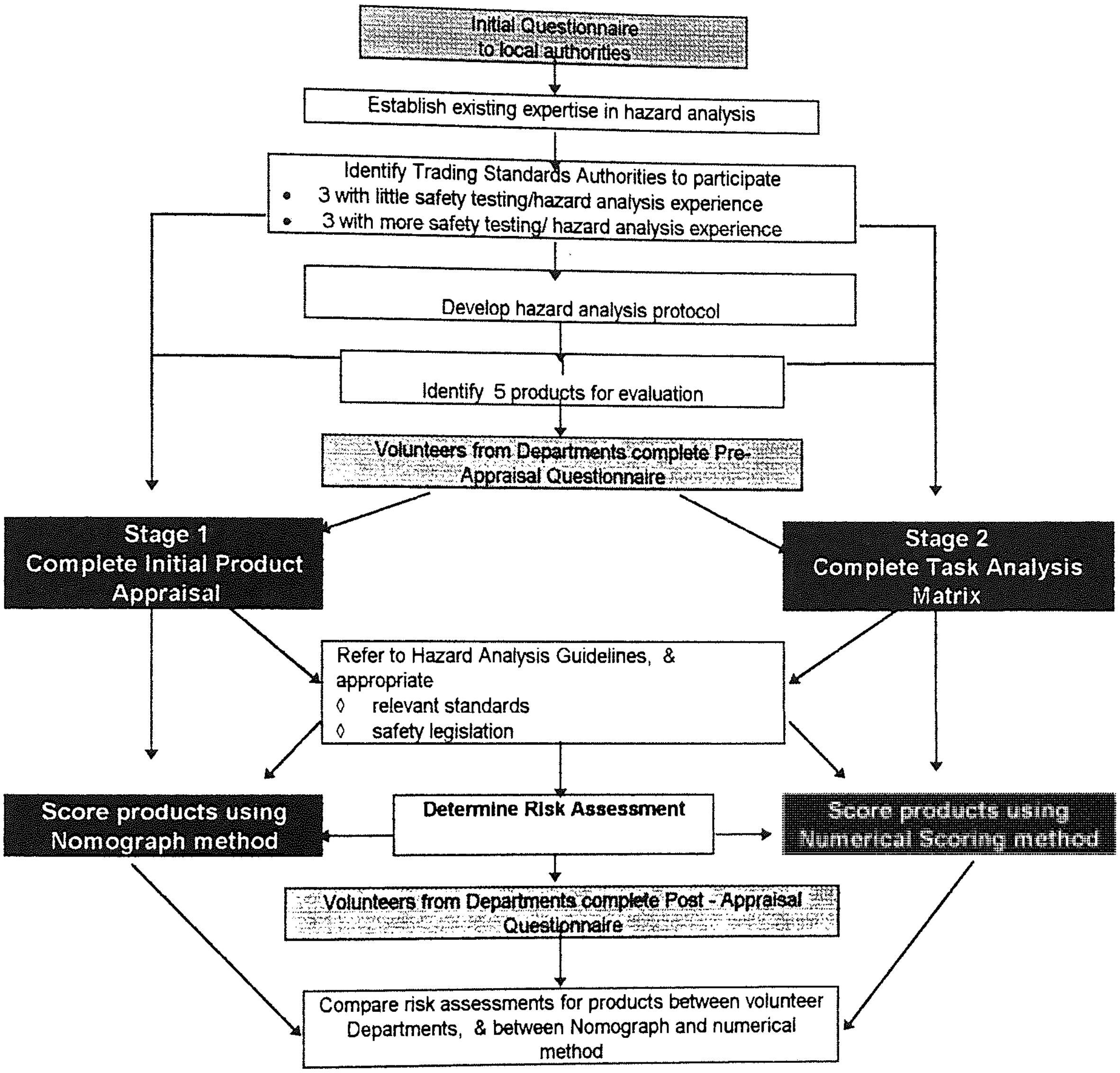
◊ for local authorities to evaluate the method, the documentation, its usability through performance evaluation and their responses to the post appraisal questionnaire;

◊ to comment on the influence of human factors and subjective influences on the risk assessment using the method, based on pre-appraisal and post-appraisal questionnaire responses;

◊ to establish and compare consistency of outcomes of risk assessment using the method.

An outline of the stages of the empirical work is detailed in Figure 29.

Figure 29 : Outline of Empirical Work



In considering the results from each stage of the research a number of broad questions, are addressed i.e. :-

◊ what do the results of the preliminary questionnaire indicate about the ***level of understanding and application of objective risk assessment techniques*** within local authorities;

◊ from the sample of six authority responses, what does the research indicate about the ***personnel*** who were involved in evaluating the sample products, and the safety appraisal method;

◊ what ***product safety factors*** were identified by the personnel, before, during and after applying the safety appraisal method

◊ how ***useful and reliable were the two different methods*** in identifying the "key" hazards identified by the author, and assessing safety risks;

◊ what ***subjective influences*** might have affected the risk assessment outcome.

◊ how might the safety appraisal method be developed to improve consistency in outcomes of risk assessment and its usability;

6.2 Initial Questionnaire Survey of Local Authority Trading Standards Departments

The nature of safety testing carried out by some local authority Trading Standards Departments, for example in response to a consumer complaint or where potential unsafe products are identified through officer initiative as being worthy of investigation, was discussed in Chapter 3. Trading Standards personnel may use their "expert" knowledge and experience to select items to purchase for safety testing as part of their safety sampling programmes, or actually carry out screen tests to select those items for testing by external test houses, or where a testing programme can be readily developed in-house, they may carry out their own in-depth safety testing.

A questionnaire was designed for completion by enforcement authorities in England, Scotland and Wales, and Ireland, to establish the current level of involvement of Trading Standards personnel in hazard analysis and risk assessment techniques in considering consumer safety complaints, and in carrying out safety sampling programmes. The questionnaire was made up of 39 primarily multiple choice questions. 15 questions sought a Yes/No tick box response, 15 questions sought responses to rating scales of strongly agree/possibly agree/disagree or very useful/possibly useful/not useful, or regularly/occasionally/never. 5 questions offered a range of tick box responses, and there were 4 open ended questions. Prior to the distribution of the questionnaire, the draft questions were evaluated by the UK Secretary of PROSAFE.

This "initial" questionnaire was designed to identify from respondents the range of expertise and experience in hazard analysis, and to identify those authorities who were willing to participate in the research project. The questionnaire particularly sought to identify any authorities with experience in risk assessment or hazard analytical procedures who might share their experiences and participate in the research. The willingness or ability for local authority Trading Standards Departments to participate in this research is subject to the influence of a range of external factors:

◊ their willingness to participate in any research when facing increasing pressures to provide a high level of service within decreasing or constrained budgetary resources;

◊ the priority attached by the Department to safety enforcement in context of the competing demands of other Trading Standards legislation;

◊ the opportunity within their respective local authority organisation structures to enable personnel to specialise in safety enforcement - each participating department was asked to provide an indication of the number of officers who specialise in safety enforcement.

In addition, local government has been the subject of organisational change as a result of the introduction of a number of "Unitary" authorities in Scotland, Wales and England during 1996-98. Not only has this increased a number of the organisational tensions detailed above, it has also increased the need for greater enforcement consistency and the need to adopt more objective measures for hazard analysis and risk assessment. At the time of distribution of the preliminary questionnaire in 1997, many of the local authorities were newly established, still recruiting staff, or were facing re-organisation the following year.

In order to improve the level of response by authorities in completing the questionnaire, following discussions with UK representatives of PROSAFE and the Local Authorities Co-ordinating Body on Trading Standards (LACOTS), it was suggested that the questionnaires be circulated by LACOTS' safety communication network to the local authorities for completion. The questionnaire was therefore circulated by post to the 13 Secretaries of LACOTS' Regional Management Groups, for distribution via the secretaries of their Regional Liaison Safety Sub-Groups to each authority's safety representative for completion. In all 170 questionnaires were distributed to local authorities in England, Scotland Wales and Ireland in this way, and respondents were requested to return the completed questionnaire as soon as possible.

6.3 Analysis of preliminary questionnaire

Of the 170 preliminary questionnaires distributed to local authorities, 63 were returned by fax or post. This section analyses the responses of the 63 respondents to establish the level of understanding and application of objective risk assessment techniques within local authorities and to explore other relevant issues, concluding with a summary of key findings. Based on these results six local authorities were identified to apply the safety appraisal method discussed in Chapters 7 and 8.

An analysis of the source of the completed questionnaires received by the type of local authority, i.e. County Councils, Metropolitan District Councils, London Boroughs and Unitary authorities is shown in Table 34.

Table 34: Showing breakdown of Responding Authorities

	Number of Authorities contacted	Number of Authorities responding	% of authorities contacted who responded	Proportion of 63 respondents in each category
London Boroughs	35	12	54%	19%
Metropolitan Borough/District	27	15	56%	24%
Unitary English	19	8	42%	13%
Unitary Scottish/Irish	31	4	13%	6%
Unitary Welsh	22	8	36%	13%
County	36	16	44%	25%
	170	63	37%	

The higher level of response shown by the London Boroughs, Metropolitan Borough/District Councils and County Councils, was expected, as these authorities were not subject to the ongoing organisational influences affecting the new unitary authorities in Wales, Scotland and England. However, despite these organisational pressures, the level of responses from English unitary authorities of 42% was almost as high as the level of response of 44% from the Counties. In the following analysis and commentary, responses are grouped into the proportion of local authorities in the above six local authority categories responding to each alternative.

Extent of utilisation of objective protocols for risk assessment and investigating safety complaints

As shown in Table 35, only 6% of respondents, (4 authorities), replied that they regularly used any objective risk assessment protocol to evaluate the safety of consumer products following a consumer product safety complaint. Similarly, only 11% of respondents, (7 authorities), regularly used any objective risk assessment protocol as part of surveys or sampling programmes, and only 8%, (5 authorities), regularly used any objective risk assessment protocol during enforcement visits.

Table 35 : Does your authority use any objective risk assessment protocol or hazard analytical criteria to evaluate the safety of consumer products?

Following a consumer product safety complaint?	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	0	0%	2	17%	10	83%	0	0%	
Metropolitan Borough/District	1	7%	4	27%	10	67%	0	0%	
Unitary English	0	0%	2	25%	6	75%	0	0%	
Unitary Scottish/Irish	0	0%	0	0%	4	100%	0	0%	
Unitary Welsh	0	0%	3	38%	3	38%	2	25%	
County	3	19%	3	19%	10	63%	0	0%	
	4	**6%**	**14**	**22%**	**43**	**68%**	**2**	**3%**	**100%**

As part of surveys /sampling programmes?	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	1	8%	2	17%	8	67%	1	8%	
Metropolitan Borough/District	2	13%	4	27%	9	60%	0	0%	
Unitary English	0	0%	2	25%	6	75%	0	0%	
Unitary Scottish/Irish	0	0%	0	0%	4	100%	0	0%	
Unitary Welsh	1	13%	4	50%	2	25%	1	13%	
County	3	19%	3	19%	10	63%	0	0%	
	7	**11%**	**15**	**24%**	**39**	**62%**	**2**	**3%**	**100%**

During enforcement visits?	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	1	8%	2	17%	9	75%	0	0%	
Metropolitan Borough/District	0	0%	6	40%	8	53%	1	7%	
Unitary English	0	0%	2	25%	6	75%	0	0%	
Unitary Scottish/Irish	0	0%	0	0%	4	100%	0	0%	
Unitary Welsh	1	13%	3	38%	2	25%	2	25%	
County	3	19%	3	19%	10	63%	0	0%	
	5	**8%**	**16**	**25%**	**39**	**62%**	**3**	**5%**	**100%**

As shown in Table 36, only 3% (2 authorities) had documented their protocols for hazard analysis/risk assessment, whereas 90% (57 authorities) had not.

Table 36 : Are these protocols for risk assessment/hazard analysis documented?

	Yes	%	No	%	NA	%	
London Borough	1	8%	9	75%	2	17%	
Metropolitan Borough/District	0	0%	15	100%	0	0%	
Unitary English	0	0%	7	88%	1	13%	
Unitary Scottish/Irish	0	0%	4	100%	0	0%	
Unitary Welsh	0	0%	7	88%	1	13%	
County	1	6%	15	94%	0	0%	
	2	**3%**	**57**	**90%**	**4**	**6%**	**100%**

This contrasts with the high proportion of respondents 90%, (57 authorities), who indicated that they would be interested in using a protocol for evaluating the safety of consumer products, and the 83% of respondents, (52 authorities), who indicated that they would use a method for evaluating the hazards in consumer products and the risk of injury if one were to be published, as shown in Tables 37 and 38.

Table 37 : Would your authority be interested in using a protocol for evaluating the safety of consumer products?

	Yes	%	No	%	NA	%	
London Borough	10	83%	2	17%	0	0%	
Metropolitan Borough/District	15	100%	0	0%	0	0%	
Unitary English	7	88%	0	0%	1	13%	
Unitary Scottish/Irish	4	100%	0	0%	0	0%	
Unitary Welsh	8	100%	0	0%	0	0%	
County	13	81%	0	0%	3	19%	
	57	**90%**	**2**	**3%**	**4**	**6%**	**100%**

Table 38 : If a published method existed for evaluating consumer products and the risk of injury, would your authority use it?

	Yes	%	No	%	Possibly	%	
London Borough	7	58%	0	0%	5	42%	
Metropolitan Borough/District	12	80%	1	7%	2	13%	
Unitary English	7	88%	0	0%	1	13%	
Unitary Scottish/Irish	4	100%	0	0%	0	0%	
Unitary Welsh	8	100%	0	0%	0	0%	
County	14	88%	0	0%	2	13%	
	52	**83%**	**1**	**2%**	**10**	**16%**	**100%**

Table 39 : Does your authority employ a system of rating or weighting of potential severity to determine the extent of investigation to undertake concerning a consumer product safety complaint?

	Regularly	%	Occasionally	%	Never	%	
London Borough	3	25%	4	33%	5	42%	
Metropolitan Borough/District	3	20%	3	20%	9	60%	
Unitary English	0	0%	2	25%	6	75%	
Unitary Scottish/Irish	0	0%	2	50%	2	50%	
Unitary Welsh	3	38%	0	0%	5	63%	
County	6	38%	3	19%	7	44%	
	15	**24%**	**14**	**22%**	**34**	**54%**	**100%**

As shown in Table 39, 24% of respondents, (15 authorities), replied that they employed a system of rating or weighting of potential severity to determine the extent of investigation to undertake concerning a consumer product safety complaint.

However, as shown in Table 40, only 3% of respondents, (2 authorities), had documented the rating system, whereas 79% of respondents (50 authorities) had not.

Table 40 : Is this rating system documented?

	Yes	%	No	%	NA	%	
London Borough	1	8%	9	75%	2	17%	
Metropolitan Borough/District	0	0%	11	73%	4	27%	
Unitary English	0	0%	5	63%	3	38%	
Unitary Scottish/Irish	0	0%	4	100%	0	0%	
Unitary Welsh	0	0%	6	75%	2	25%	
County	1	6%	15	94%	0	0%	
	2	**3%**	**50**	**79%**	**11**	**17%**	**100%**

As shown in Tables 41 and 42, 75% of respondents, (47 authorities), stated that they would be interested in using a rating system to assist in allocating resources towards consumer safety enforcement, and 65% of respondents, (41 authorities), indicated that they would use a method for determining the extent of investigation of consumer safety complaints if such a published method existed.

Table 41 : Would your authority be interested in using a rating system to determine the extent of investigation of consumer safety complaints in allocating appropriate resources towards consumer safety enforcement?

	Yes	%	No	%	Possibly	%	
London Borough	7	58%	5	42%	0	0%	
Metropolitan Borough/District	9	60%	3	20%	3	20%	
Unitary English	6	75%	1	13%	1	0%	
Unitary Scottish/Irish	3	75%	0	0%	1	25%	
Unitary Welsh	6	75%	2	25%	0	0%	
County	16	100%	0	0%	0	0%	
	47	**75%**	**11**	**17%**	**5**	**8%**	**100%**

Table 42 : If a published method existed for determining the extent of investigation of consumer safety complaints would your authority use it?

	Yes	%	No	%	Possibly	%	
London Borough	5	42%	3	25%	4	33%	
Metropolitan Borough/District	9	60%	2	13%	4	27%	
Unitary English	6	75%	1	13%	1	13%	
Unitary Scottish/Irish	3	75%	0	0%	1	25%	
Unitary Welsh	7	88%	1	13%	0	0%	
County	11	69%	0	0%	5	31%	
	41	**65%**	**7**	**11%**	**15**	**24%**	**100%**

Selecting the pool of volunteers to participate in the evaluation trial

In total, thirty six authorities indicated a willingness to participate in the experimental trial to evaluate a protocol under development for appraising the safety of consumer products, as shown in Table 43.

Table 43 : Would your authority be prepared to participate in a trial to evaluate a protocol which is under development for evaluating the safety of consumer products?

	Yes	%	No	%	Unsure	%	
London Borough	7	58%	5	42%	0	0%	
Metropolitan Borough/District	10	67%	5	33%	0	0%	
Unitary English	4	50%	4	50%	0	0%	
Unitary Scottish/Irish	2	50%	2	50%	0	0%	
Unitary Welsh	5	63%	3	37%	0	0%	
County	8	50%	4	25%	4	25%	
	36	**57%**	**23**	**37%**	**4**	**6%**	**100%**

Based on their replies to questions 10 -13 and questions 21 - 24, six authorities were identified as having experience in using systems for hazard analysis/risk assessment either informally or formally, and they were contacted to obtain further details of their formal or informal systems. Three of these authorities had also expressed a willingness to participate in the experimental phase, i.e. Solihull MBC, Suffolk CC, and London Borough of Redbridge. Therefore, when seeking the additional information about their current experience, they were also contacted requesting their involvement in the experimental phase.

In order to identify a group of authorities who potentially possessed less experience in hazard analysis or risk assessment techniques to balance the relative experience in these skills expected of the first group, negative responses to questions 2 , 3, 5 and 10 were considered. Authorities were identified who had indicated that they did not operate a sampling programme for testing consumer products, did not carry out safety screen testing, who indicated that they had no safety specialists, or who had officers employed in consumer safety less than 50% of the time, and who were willing to participate in the experimental phase were identified.

Quite a high proportion of respondents in this expected "lower experience" group had indicated that they were not willing to participate in the experimental phase. However, it was possible to identify Stockport MBC, London Borough of Barking and Perth and Kinross Council who were subsequently contacted as appropriate potential subjects from this second group of authorities, and they agreed to participate in the research. Thus it was possible to obtain a potential pool of six participating authorities spanning the expected range of expertise in use of objective techniques for hazard analysis.

Approaches to safety enforcement

90% of the respondents, (57 authorities) described themselves as operating a combined approach to safety enforcement, utilising both proactive and reactive enforcement techniques. It is difficult to draw meaningful conclusions about the extent of specialisation in consumer safety enforcement, from an analysis of their responses to question 2, i.e. whether using safety specialists who concentrated on safety enforcement 100%, 75-100%, 50 - 75%, less than 50% of the time, or having no safety specialists due to the diversity of their responses. Authorities indicated in their responses that they employed a range of officers, whether fully qualified Trading Standards Officers, Enforcement Officers, or Technical Assistants, with a range of specialism in product safety. For example, a single authority might have a number of staff of each type, who each might specialise from 100% through the alternative categories to no specialism.

The analysis of responses shown in Table 44, considers the type of authority who responded to the choices in question 2. 33% (21 authorities) responded that they employed a combination of staff with varying time spent specialising in consumer safety enforcement. 24% (15 authorities) responded that they employed staff who spent less than 50% of their time on safety enforcement, and 21% (13 authorities) responded that they employed no safety specialists. Only four of the Counties, plus one London Borough responded that they employed staff who specialised in safety enforcement all of the time.

Table 44: Authorities employing staff who specialise in consumer safety

	100%	%	75 - 100%	%	50 - 75%	%	< 50%	%	None	%	Mixture	%
London Borough	1	8%	1	8%	1	8%	3	25%	2	17%	4	33%
Metropolitan Borough/District	0	0%	2	13%	1	7%	1	7%	4	27%	7	47%
Unitary English	0	0%	0	0%	1	13%	3	38%	3	38%	1	13%
Unitary Scottish	0	0%	0	0%	0	0%	1	25%	3	75%	0	0%
Unitary Welsh	0	0%	1	13%	1	13%	3	38%	1	13%	2	25%
County	4	25%	0	0%	1	6%	4	25%	0	0%	7	0%
	5	8%	4	6%	5	8%	15	24%	13	21%	21	33%

Table 45 attempts to summarise the pattern of responses indicating the number of officers available in the categories : Trading Standards Officer, Enforcement Officer and Technical Officer. This analysis is problematic, as the response matrix provided did not enable adequate definition of the total number of enforcement staff, or of each types of officer employed, and the analysis in table 45 is both inconclusive and is at odds with Table 44.

Table 45 : Authorities employing staff who specialise in consumer safety

Specialise 100% of the time	T S O(s)	%	Enf Officers	%	Tech Officers	%	
London Borough	0	0%	1	8%	0	0%	
Metropolitan Borough/District	1	7%	3	20%	0	0%	
Unitary English	0	0%	0	0%	0	0%	
Unitary Scottish	0	0%	0	0%	0	0%	
Unitary Welsh	0	0%	1	13%	0	0%	
County	4	25%	4	25%	0	0%	
	5	**8%**	**9**	**14%**	**0**	**0%**	**22%**
Specialise 75 - 100% of the time	**T S O(s)**	**%**	**Enf Officers**	**%**	**Tech Officers**	**%**	
London Borough	0	0%	1	8%	0	0%	
Metropolitan Borough/District	1	7%	1	7%	0	0%	
Unitary English	0	0%	0	0%	0	0%	
Unitary Scottish	0	0%	0	0%	0	0%	
Unitary Welsh	1	13%	0	0%	0	0%	
County	1	6%	0	0%	0	0%	
	3	**5%**	**2**	**3%**	**0**	**0%**	**8%**
Specialise 50 - 75% of the time	**T S O(s)**	**%**	**Enf Officers**	**%**	**Tech Officers**	**%**	
London Borough	5	42%	2	17%	0	0%	
Metropolitan Borough/District	7	47%	4	27%	1	7%	
Unitary English	2	25%	2	25%	0	0%	
Unitary Scottish	0	0%	0	0%	0	0%	
Unitary Welsh	1	13%	2	25%	0	0%	
County	14	88%	1	6%	1	6%	
	29	**46%**	**11**	**17%**	**2**	**3%**	**67%**
Specialise 50% of the time	**T S O(s)**	**%**	**Enf Officers**	**%**	**Tech Officers**	**%**	
London Borough	5	42%	4	33%	1	8%	
Metropolitan Borough/District	3	20%	4	27%	0	0%	
Unitary English	3	38%	1	13%	0	0%	
Unitary Scottish(Irish)	1	25%	0	0%	0	0%	
Unitary Welsh	2	25%	3	38%	0	0%	
County	13	81%	6	38%	2	13%	
	27	**43%**	**18**	**29%**	**3**	**5%**	**76%**
No specialists	**T S O(s)**	**%**	**Enf Officers**	**%**	**Tech Officers**	**%**	
London Borough	2	17%	2	17%	1	8%	
Metropolitan Borough/District	3	20%	3	20%	1	7%	
Unitary English	3	38%	2	25%	2	25%	
Unitary Scottish/Irish	4	100%	0	0%	0	0%	
Unitary Welsh	0	0%	0	0%	1	13%	
County	0	0%	3	19%	3	19%	
	12	**19%**	**10**	**16%**	**8**	**13%**	**48%**

Experience in Safety Sampling and Testing

76% of authorities, as shown in Table 46, operate a sampling programme for testing consumer products. As discussed in Chapters 2 and 3, sampling programmes enable authorities to purchase consumer products and to test for their compliance with prescriptive safety legislation, or with the General Safety Requirement. Ordinarily, authorities will submit the samples to external agencies to test for compliance with legislation or standards. However, some authorities have their own screen testing facilities and equipment to carry out some preliminary testing prior to sending samples to external test houses. Others may operate more comprehensive testing facilities and thus can carry out more extensive testing.

Table 46 : Does your authority operate a sampling programme for testing consumer products?

	Yes	%	No	%	NA	%	
London Borough	6	50%	6	50%	0	0%	
Metropolitan Borough/District	12	80%	3	20%	0	0%	
Unitary English	5	63%	2	25%	1	13%	
Unitary Scottish/Irish	2	50%	2	50%	0	0%	
Unitary Welsh	8	100%	0	0%	0	0%	
County	15	94%	0	0%	1	6%	
	48	**76%**	**13**	**21%**	**2**	**3%**	**100%**

The authorities were asked about the types of safety testing services used as a matter of routine, and their responses are summarised in Table 47, indicating those used regularly, occasionally or never used.

The most regularly used external agency, the Public Analyst, was used regularly by 60% of authorities, (38 respondents), followed by "accredited" test houses used regularly by 43% of the authorities. Internal screen test facilities were used regularly by 37% of authorities. There was a broader spread of replies indicating occasional use of safety testing services, with Product Safety Experts being used occasionally by 59% of authorities, followed by "accredited" test houses used occasionally by 56% of authorities, Ergonomics experts used occasionally by 51% of authorities, and internal screen test facilities used occasionally by 46% of authorities.

Table 47 : Which of the following safety testing services does your authority use as a matter of routine :-

Public analysts	Regularly	%	Occasionally	%	Never	%	
London Borough	5	42%	6	50%	1	8%	
Metropolitan Borough/District	6	40%	6	40%	3	20%	
Unitary English	6	75%	2	25%	0	0%	
Unitary Scottish/Irish	2	50%	1	25%	1	25%	
Unitary Welsh	7	88%	1	13%	0	0%	
County	12	75%	2	13%	2	13%	
	38	**60%**	**18**	**29%**	**7**	**11%**	**100%**

"Accredited" Test houses	Regularly	%	Occasionally	%	Never	%	
London Borough	5	42%	7	58%	1	8%	
Metropolitan Borough/District	6	40%	9	60%	0	0%	
Unitary English	1	13%	7	88%	0	0%	
Unitary Scottish/Irish (1)	0	0%	3	75%	0	0%	
Unitary Welsh	3	38%	5	63%	0	0%	
County	12	75%	4	25%	0	0%	
	27	**43%**	**35**	**56%**	**1**	**2%**	**100%**

Product Safety experts	Regularly	%	Occasionally	%	Never	%	
London Borough	1	8%	7	58%	1	8%	
Metropolitan Borough/District	2	13%	5	33%	2	13%	
Unitary English	1	13%	6	75%	0	0%	
Unitary Scottish/Irish	0	0%	2	50%	1	25%	
Unitary Welsh	1	13%	6	75%	0	0%	
County	3	19%	11	69%	0	0%	
	8	**13%**	**37**	**59%**	**4**	**6%**	**78%**

Ergonomics experts	Regularly	%	Occasionally	%	Never	%	
London Borough	1	8%	7	58%	3	25%	
Metropolitan Borough/District	0	0%	7	47%	3	20%	
Unitary English	0	0%	2	25%	4	50%	
Unitary Scottish/Irish	0	0%	0	0%	3	75%	
Unitary Welsh	0	0%	3	38%	2	25%	
County	0	0%	13	81%	1	6%	
	1	**2%**	**32**	**51%**	**16**	**25%**	**78%**

Internal screen test facilities	Regularly	%	Occasionally	%	Never	%	
London Borough	4	33%	6	50%	1	8%	
Metropolitan Borough/District	9	60%	4	27%	0	0%	
Unitary English	3	38%	4	50%	1	13%	
Unitary Scottish/Irish	0	0%	2	50%	1	25%	
Unitary Welsh	2	25%	5	63%	0	0%	
County	5	31%	8	50%	1	6%	
	23	**37%**	**29**	**46%**	**4**	**6%**	**89%**

Other :-specify	Regularly	%	Occasionally	%	Never	%	
London Borough	0	0%	0	0%	1	8%	
Metropolitan Borough/District	0	0%	2(*1)	25%	0	0%	
Unitary English	0	0%	0	0%	2	25%	
Unitary Scottish	0	0%	0	0%	0	0%	
Unitary Welsh	0	0%	0	0%	0	0%	
County	0	0%	2(*2)	13%	2	13%	
	0	**0%**	**4**	**6%**	**5**	**8%**	**14%**

Key (*1) = Paediatrician / Doctors
(*2) = EMC /Surveyor

Interestingly, 25% of authorities indicated that they had never used Ergonomics experts and 11% of authorities had never used Public Analysts for safety testing. Where authorities responded that they occasionally used other safety testing services, responses about other services used given by two Metropolitan Borough/District Councils included a Paediatrician and a Doctor, and responses given by two County authorities included an expert in Electromagnetic Compatibility (EMC) and a Surveyor.

Experience of screen testing

The authorities were asked about their experience in screen testing, i.e. the process of carrying out various preliminary safety tests on samples of consumer products, which is typically preparatory to carrying out further more comprehensive safety investigations. Table 48 shows that 90% of respondents, (57 authorities), carried out screen testing to evaluate compliance with safety legislation.

Table 48 : Does your authority carry out safety screen testing to evaluate compliance with safety legislation?

	Yes	%	No	%	
London Borough	11	92%	1	8%	
Metropolitan Borough/District	14	93%	1	7%	
Unitary English	7	88%	1	13%	
Unitary Scottish/Irish	3	75%	1	25%	
Unitary Welsh	7	88%	1	13%	
County	15	94%	1	6%	
	57	**90%**	**6**	**10%**	**100%**

As discussed in Chapter 3, because some of the formal tests carried out by safety test houses and experts can be very costly, some authorities carry out a variety of safety screen tests to determine whether a consumer product is considered to be safe, and whether to require further expert testing. This may include some of the more straightforward tests specified in British Standard specifications or safety legislation or may include more extensive testing in certain circumstances. Some local authorities have also equipped test laboratories to enable more detailed and comprehensive testing to be carried out.

In their response to the open question 38, one authority commented:

> "We only have a small sampling budget - which is used for internal testing"

Where authorities carry out screen testing as a preliminary to testing carried out by other "experts" and where their own results will not be used for evidential purposes, this screen testing is **informal**. Where the test results may subsequently be used as part of legal proceedings, without recourse to an external expert or test house, the testing is considered to be **formal**.

Only 6 authorities replied that they did not carry out screen testing. However, there were many incomplete responses to questions 6 - 9 about screen testing, and thus a "Not Applicable" category of response was recorded in relevant tables. The level of incomplete response varied depending upon which of the three questions was asked. Twelve authorities did not reply to question 6 about use of results formally, and ten authorities did not reply about use of results informally. Seven authorities did not reply to question 7 about using results of external screen testing, and twenty authorities did not reply about using internal screen testing. Eight authorities did not reply when questioned about carrying out screen testing for other local authority enforcement departments in response to question 8, and there were varying responses to question 9 asking who carries out screen testing.

Table 49 shows that 57% of respondents, (36 authorities) never carry out formal screen testing, i.e. where their results might be used in evidence. Only one authority indicated that the results of screen testing were regularly used formally, and only 14 authorities replied that they occasionally used screen test results formally. In contrast, 52% of respondents, (33 authorities) regularly used results of screen testing informally and 30% of respondents (19 authorities) occasionally used results of screen testing informally. Only one authority replied that they never used results of screen testing informally.

Table 49 : Are the results of screen testing/examination of consumer product safety formal or informal ?

Formal - officers opinion used as evidence?	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	0	0%	1	8%	11	92%	0	0%	
Metropolitan Borough/District	0	0%	3	20%	6	40%	6	40%	
Unitary English	1	13%	2	25%	3	38%	2	25%	
Unitary Scottish/Irish	0	0%	1	25%	2	50%	1	25%	
Unitary Welsh	0	0%	1	13%	6	75%	1	13%	
County	0	0%	6	38%	8	50%	2	13%	
	1	2%	14	22%	36	57%	12	19%	100%

Informal - i.e. will not be used as evidence?	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	6	50%	6	50%		0%		0%	
Metropolitan Borough/District	8	53%	3	20%		0%	4	27%	
Unitary English	3	38%	2	25%	1	13%	2	25%	
Unitary Scottish/Irish	2	50%	1	25%		0%	1	25%	
Unitary Welsh	7	88%		0%		0%	1	13%	
County	7	44%	7	44%		0%	2	13%	
	33	52%	19	30%	1	2%	10	16%	100%

Table 50 shows that 56% of respondents, (35 authorities), indicated that they regularly use screen testing to target resources towards identifying likely failures for further external testing.

Table 50 : Is screen testing used to target resources towards identifying likely failures for further:-

External testing?	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	6	50%	3	25%	1	8%	2	17%	
Metropolitan Borough/District	8	53%	6	40%		0%	1	7%	
Unitary English	4	50%	2	25%	1	13%	1	13%	
Unitary Scottish/Irish	2	50%	1	25%		0%	1	25%	
Unitary Welsh	5	63%	2	25%		0%	1	13%	
County	10	63%	5	31%		0%	1	6%	
	35	56%	19	30%	2	3%	7	11%	100%

Internal testing?	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough		0%	2	17%	6	50%	4	33%	
Metropolitan Borough/District	2	13%	4	27%	2	13%	7	47%	
Unitary English	0	0%	5	63%	1	13%	2	25%	
Unitary Scottish/Irish	2	50%	0	0%	1	25%	1	25%	
Unitary Welsh	0	0%	4	50%	2	25%	2	25%	
County	2	13%	5	31%	5	31%	4	25%	
	6	10%	20	32%	17	27%	20	32%	100%

30% of respondents, (19 authorities) indicated that they occasionally use screen testing to target resources towards identifying likely failures for further external testing, and only 3% of respondents, (2 authorities), never use screen testing to target resources towards identifying likely failures for further external testing.

In contrast, 27% of respondents, (17 authorities), indicated that they never use screen testing to target resources towards identifying likely failures for further internal testing, 32% of respondents, (20 authorities) occasionally use screen testing to target resources towards identifying likely failures for further internal testing, and only 10% of respondents (6 authorities) regularly use screen testing to target resources towards identifying likely failures for further internal testing. Almost a third of respondents did not answer the question about internal screen testing, and 11% of respondents did not answer the question about external screen testing as a means of targeting resources.

Table 51 shows the relatively low extent that authorities who reported that they carried out screen testing for other enforcement Departments.

Table 51 : Does your authority carry out screen testing for other enforcement Departments?

	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	0	0%	2	17%	8	67%	2	17%	
Metropolitan Borough/District	1	7%	1	7%	12	80%	1	7%	
Unitary English	0	0%	1	13%	5	63%	2	25%	
Unitary Scottish/Irish	0	0%	0	0%	3	75%	1	25%	
Unitary Welsh	0	0%	2	25%	5	63%	1	13%	
County	0	0%	1	6%	14	88%	1	6%	
	1	**2%**	**7**	**11%**	**47**	**75%**	**8**	**13%**	**100%**

Only one authority indicated that it regularly carries out screen testing for other authority enforcement Departments, only 7 authorities indicated that they occasionally carry out screen testing for other authority enforcement Departments, and 47 authorities, (75% of respondents), indicated that they never carry out screen testing for other authority enforcement Departments. As commented when examining the diversity of responses reported indicating the extent of specialisation in consumer safety enforcement, an equally diverse range of responses was given indicating the range of staff used by authorities in carrying out screen testing.

Therefore, it is difficult to draw meaningful conclusions from an analysis of staff used, i.e. whether using Trading Standards Officers (TSOs), enforcement officers with authority to investigate offences under the Consumer Protection Act 1987 (i.e. CPA warranted), Technical Assistants who do not have authority to investigate offences under the Consumer Protection Act 1987 (i.e. not CPA warranted), Advice staff, Technical/Lab staff, or other personnel. Authorities indicated in their responses that they utilised a range of officers for this task. Each Authority potentially employed a number of staff of each type, who then might or might not carry out screen testing.

As shown in Table 52, many of the authorities who replied did not select one of the three options provided, and the "Not Applicable" responses in many instances represented the largest response type. Based on the replies given, TSOs were most likely to be involved in screen testing. 51% of respondents, (32 authorities), reported that TSOs occasionally carried out screen testing, and 24% of respondents, (15 authorities), reported that TSOs regularly carried out screen testing. Only 2 authorities reported that TSOs never carried out screen testing, and 14 authorities did not reply.

Enforcement Officers were the next most likely category of employee reported to be involved in screen testing. 43% of respondents (27 authorities) reported that enforcement officers occasionally carried out screen testing, and 24% of respondents, (15 authorities), reported that enforcement officers regularly carried out screen testing. Only 5 authorities reported that enforcement officers never carried out screen testing, and 16 authorities did not reply.

Technical Assistants were reported to carry out screen testing occasionally by 17% of authorities, and were reported to do so regularly by only 8% of responding authorities. 13% of respondents reported that Technical Assistants never carried out screen testing. 39 authorities did not reply to this section. Technical or lab staff were reported to carry out screen testing regularly by 13% of respondents, (8 authorities), and to carry out screen testing occasionally by 6% of respondents, (4 authorities). 19 authorities reported that Technical or lab staff never carried out screen testing. 34 authorities did not reply to this section.

Table 52 : Who carries out screen testing?

Trading Standards Officers	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	4	33%	8	67%	0	0%	0	0%	
Metropolitan Borough/District	1	7%	8	53%	1	7%	5	33%	
Unitary English	3	38%	3	38%	0	0%	2	25%	
Unitary Scottish/Irish	2	50%	1	25%	1	25%	0	0%	
Unitary Welsh	2	25%	4	50%	0	0%	2	25%	
County	3	19%	8	50%	0	0%	5	31%	
	15	**24%**	**32**	**51%**	**2**	**3%**	**14**	**22%**	**100%**

Enforcement officers (i.e. CPA warranted)	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	3	25%	5	42%	1	8%	3	25%	
Metropolitan Borough/District	4	27%	8	53%	1	7%	2	13%	
Unitary English	3	38%	2	25%	1	13%	2	25%	
Unitary Scottish/Irish	0	0%	1	25%	1	25%	2	50%	
Unitary Welsh	4	50%	2	25%	0	0%	2	25%	
County	1	6%	9	56%	1	6%	5	31%	
	15	**24%**	**27**	**43%**	**5**	**8%**	**16**	**25%**	**100%**

Technical assistants (i.e. not CPA warranted)	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	3	25%	2	17%	3	25%	4	33%	
Metropolitan Borough/District	0	0%	1	7%	5	33%	9	60%	
Unitary English	0	0%	1	13%	3	38%	4	50%	
Unitary Scottish/Irish	0	0%	1	25%	1	25%	2	50%	
Unitary Welsh	0	0%	2	25%	1	13%	5	63%	
County	2	13%	4	25%		0%	10	63%	
	5	**8%**	**11**	**17%**	**13**	**21%**	**34**	**54%**	**100%**

Advice staff	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	0	0%	0	0%	5	42%	7	58%	
Metropolitan Borough/District	0	0%	1	7%	6	40%	8	53%	
Unitary English	0	0%	0	0%	4	50%	4	50%	
Unitary Scottish/Irish	0	0%	0	0%	1	25%	3	75%	
Unitary Welsh	0	0%	0	0%	3	38%	5	63%	
County	0	0%	0	0%	4	25%	12	75%	
	0	**0%**	**1**	**2%**	**23**	**37%**	**39**	**62%**	**100%**

Technical/Lab staff	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	1	8%		0%	3	25%	8	67%	
Metropolitan Borough/District	6	40%	1	7%	2	13%	6	40%	
Unitary English	1	13%	1	13%	2	25%	4	50%	
Unitary Scottish/Irish		0%		0%	1	25%	3	75%	
Unitary Welsh		0%		0%	3	38%	5	63%	
County		0%	2	13%	1	6%	13	81%	
	8	**13%**	**4**	**6%**	**12**	**19%**	**39**	**62%**	**100%**

Other (specify)	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough		0%	1(*1)	0%	11	92%		0%	
Metropolitan Borough/District		0%	1(*2)	0%	1	7%	13	87%	
Unitary English		0%	1(*2)	0%	2	25%	5	63%	
Unitary Scottish		0%		0%		0%	4	100%	
Unitary Welsh	1	13%		0%	2	25%	5	63%	
County	2(*3)	13%	1	6%		0%	13	81%	
	3	**5%**	**4**	**6%**	**16**	**25%**	**40**	**63%**	**100%**

Key
(*1) = Consultants
(*2) = Trainees
(*3) = EMC/Electrical contractor

Advice staff were least likely to carry out screen testing, as only one authority reported occasionally using them to carry out screen tests. 23 authorities reported that Advice staff never carried out screen testing. 39 authorities did not reply did not reply to this section.

Three of the four authorities who reported that other personnel occasionally carried out screen testing provided details in their responses. Two reported using trainees for screen testing, and one reported using an external consultant. Two of the three authorities who reported that other personnel regularly carried out screen testing provided details in their responses, referring to Electrical contractors and experts in Electromagnetic Compatibility (EMC). 16 authorities reported that other personnel never carried out screen testing. 40 authorities did not reply did not reply to this section.

Future Use of Objective Protocols for Hazard Analysis and Risk Assessment

Responses to this sequence of questions are at the crux of the research, to establish the status of development and use of any hazard analysis protocols. As previously discussed, and shown in Table 36, only 3% of authorities had documented either protocols for hazard analysis/ risk assessment of consumer products. Question 12 queried whether the documented protocols formed part of the Department's quality management system. Only 2 authorities had documented a protocol for hazard analysis/ risk assessment, and only 1 authority included this within their Department's quality management system. Most authorities responded negatively to these questions, or not at all.

Despite the current low level of use and documentation of protocols of this nature, as shown in Table 53, in response to question 14, a high level of authorities, i.e. 90% of respondents, (57 authorities) indicated that they would be interested in using a protocol for evaluating the safety of consumer products.

Table 53 : Would your authority be interested in using a protocol for evaluating the safety of consumer products?

	Yes	%	No	%	NA	%	
London Borough	10	83%	2	17%	0	0%	
Metropolitan Borough/District	15	100%	0	0%	0	0%	
Unitary English	7	88%	0	0%	1	13%	
Unitary Scottish/Irish	4	100%	0	0%	0	0%	
Unitary Welsh	8	100%	0	0%	0	0%	
County	13	81%	0	0%	3	19%	
	57	**90%**	**2**	**3%**	**4**	**6%**	**100%**

As shown in Table 54, all authorities indicated that they agreed that enforcement consistency would be improved by following a more systematic method of evaluating the hazards in consumer products and the risk of injury, but only 33% of respondents, (21 authorities), strongly agreed.

Table 54 : Do you think enforcement consistency would be improved by following a more systematic method of evaluating the hazards in consumer products and the risk of injury?

	Strongly Agree	%	Possibly Agree	%	Disagree	%	
London Borough	5	42%	7	58%		0%	
Metropolitan Borough/District	6	40%	9	60%		0%	
Unitary English	1	13%	7	88%		0%	
Unitary Scottish/Irish	2	50%	2	50%		0%	
Unitary Welsh	4	50%	4	50%		0%	
County	3	19%	13	81%		0%	
	21	**33%**	**42**	**67%**	**0**	**0%**	**100%**

As shown in Table 55, 83% of respondents, (52 authorities), indicated that if a published method existed for evaluating the hazards in consumer products they would use it. Although no "mid " option was given, 10 authorities indicated that they were unsure and possibly may use such a published method. One authority indicated that they would not use such a method. Most authorities replied that they felt that following a systematic method of evaluating the hazards in consumer products would be useful in allocating resources towards consumer safety enforcement.

Table 55 : If a published method existed for evaluating the hazards in consumer products and the risk of injury would your authority use it?

	Yes	%	No	%	Possibly	%	
London Borough	7	58%		0%	5	42%	
Metropolitan Borough/District	12	80%	1	7%	2	13%	
Unitary English	7	88%		0%	1	13%	
Unitary Scottish/Irish	4	100%		0%		0%	
Unitary Welsh	8	100%		0%		0%	
County	14	88%		0%	2	13%	
	52	**83%**	**1**	**2%**	**10**	**16%**	**100%**

As shown in Table 56, 60% of respondents, (38 authorities), indicated that following such a method was possibly useful, and 40% of respondents, (25 authorities), indicated that following such a method was very useful. No authorities indicated that following a systematic method would not be useful. Most authorities also agreed that additional guidance would be helpful in establishing a protocol for hazard analysis and risk assessment.

Table 56 : Do you think following a systematic method of evaluating the hazards in consumer products would be useful in allocating resources towards consumer safety enforcement?

	Very Useful	%	Possibly Useful	%	Not Useful	%	
London Borough	4	33%	8	67%	0	0%	
Metropolitan Borough/District	5	33%	10	67%	0	0%	
Unitary English	3	38%	5	63%	0	0%	
Unitary Scottish/Irish	3	75%	1	25%	0	0%	
Unitary Welsh	3	38%	5	63%	0	0%	
County	7	44%	9	56%	0	0%	
	25	**40%**	**38**	**60%**	**0**	**0%**	**100%**

As shown in Table 57, 48% of respondents, (30 authorities), possibly agreed with this statement, and 51% of respondents, (32 authorities), strongly agreed. Only one authority disagreed.

Table 57 : Does your authority consider that additional guidance would be helpful in establishing a protocol for hazard analysis and risk assessment?

	Strongly Agree	%	Possibly Agree	%	Disagree	%	
London Borough	6	50%	6	50%	0	0%	
Metropolitan Borough /District	8	53%	6	40%	1	7%	
Unitary English	3	38%	5	63%	0	0%	
Unitary Scottish/Irish	3	75%	1	25%	0	0%	
Unitary Welsh	4	50%	4	50%	0	0%	
County	8	50%	8	50%	0	0%	
	32	**51%**	**30**	**48%**	**1**	**2%**	**100%**

For those authorities who agreed that additional guidance would be helpful in establishing a protocol for hazard analysis and risk assessment as shown in Table 58, the most popular answer was LACOTS as a potential provider of advice, selected by 48 authorities, or 78% of respondents. The next most popular choice was the Consumer Safety Unit (CSU) identified by 26 authorities, or 41% of respondents. PROSAFE was chosen by 9 authorities, BSI by 6 authorities, RoSPA by 5 authorities, and 5 authorities suggested a combination of all of the bodies mentioned.

Table 58 : Who do think should provide that additional guidance in establishing a protocol for hazard analysis and risk assessment?

	C S U	%	LACOTS	%	PROSAFE	%	BSI	%	RoSPA	%	All	%
London Borough	5	42%	10	83%	2	17%	1	8%		0%	1	8%
Metropolitan Borough/District	5	33%	10	67%	2	13%	1	7%	2	13%	2	13%
Unitary English	4	50%	7	88%	1	13%		0%		0%		0%
Unitary Scottish/Irish	3	75%	3	75%	1	25%	1	25%		0%		0%
Unitary Welsh	4	50%	6	75%	1	13%	1	13%	2	25%	1	13%
County	5	31%	12	75%	2	13%	2	13%	1	6%	1	6%
	26	**41%**	**48**	**76%**	**9**	**14%**	**6**	**10%**	**5**	**8%**	**5**	**8%**

This emphasises a comment given in the general open ended responses to question 38 of the questionnaire, where two authorities indicated that they would:

> "..use LACOTS guidelines for risk assessment of visits as a basis for a risk assessment schemes for determining the safety of consumer products .."

In addition, one authority indicated that :

> "It would be helpful if a national system was in operation"

As shown in Table 59, 71% of respondents, (45 authorities), indicated that a Code of Practice similar to those statutory Codes of Practice employed within Food Safety or Health and Safety enforcement would assist in risk assessment of consumer products. However, 22% of respondents, (14 authorities), did not think that such a Code of Practice would assist, and 6% of respondents, (4 authorities), indicated that they were unsure.

Table 60 : Would your authority be interested in using a rating system to determine the extent of investigation of consumer safety complaints in allocating appropriate resources towards consumer safety enforcement?

	Yes	%	No	%	Possibly	%	
London Borough	7	58%	5	42%	0	0%	
Metropolitan Borough/District	9	60%	3	20%	3	20%	
Unitary English	6	75%	1	13%	1	0%	
Unitary Scottish/Irish	3	75%	0	0%	1	25%	
Unitary Welsh	6	75%	2	25%	0	0%	
County	16	100%	0	0%	0	0%	
	47	75%	11	17%	5	8%	100%

As shown in Table 61, 33% of respondents, (21 authorities), felt it would be very useful, and 54% of respondents, (34 authorities), felt it would possibly be useful to use this type of system in allocating resources towards consumer safety enforcement. 7 authorities disagreed and 1 authority gave no response.

Table 61 : Do you think following a system of rating or weighting of potential severity to determine the extent of investigation of consumer safety complaints would be useful in allocating appropriate resources towards consumer safety enforcement?

	Very Useful	%	Possibly Useful	%	Not Useful	%	NA	%	
London Borough	4	33%	4	33%	4	33%	0	0%	
Metropolitan Borough/District	5	33%	7	47%	3	20%	0	0%	
Unitary English	0	0%	7	88%	0	0%	1	13%	
Unitary Scottish/Irish	3	75%	1	25%	0	0%	0	0%	
Unitary Welsh	2	25%	6	75%	0	0%	0	0%	
County	7	44%	9	56%	0	0%	0	0%	
	21	33%	34	54%	7	11%	1	2%	100%

As shown in Table 62, 29% of respondents, (18 authorities) strongly agreed that following a system of rating or weighting of potential severity to determine the extent of investigation of consumer safety complaints would improve enforcement consistency and 59% of respondents, (37 authorities), possibly agreed. Only 7 authorities disagreed that following such a system would improve enforcement consistency, and 1 authority did not respond.

Table 62 : Do you think following a system of rating or weighting of potential severity to determine the extent of investigation of consumer safety complaints would improve enforcement consistency?

	Strongly Agree	%	Possibly Agree	%	Disagree	%	NA	%	
London Borough	4	33%	3	25%	5	42%	0	0%	
Metropolitan Borough/District	5	33%	8	53%	2	13%	0	0%	
Unitary English	0	0%	7	88%	0	0%	1	13%	
Unitary Scottish/Irish	2	50%	2	50%	0	0%	0	0%	
Unitary Welsh	2	25%	6	75%	0	0%	0	0%	
County	5	31%	11	69%	0	0%	0	0%	
	18	**29%**	**37**	**59%**	**7**	**11%**	**1**	**2%**	**100%**

As shown in Table 63, 65% of respondents, (41 authorities), indicated that if a published method existed for determining the extent of investigation of consumer safety complaints they would use it. Although no "mid " option was given, 15 authorities indicated that they were unsure and possibly may use such a published method. 7 authorities indicated that they would not use such a method.

Table 63 : If a published method existed for determining the extent of investigation of consumer safety complaints would your authority use it?

	Yes	%	No	%	Possibly	%	
London Borough	5	42%	3	25%	4	33%	
Metropolitan Borough/District	9	60%	2	13%	4	27%	
Unitary English	6	75%	1	13%	1	13%	
Unitary Scottish/Irish	3	75%	0	0%	1	25%	
Unitary Welsh	7	88%	1	13%	0	0%	
County	11	69%	0	0%	5	31%	
	41	**65%**	**7**	**11%**	**15**	**24%**	**100%**

The open responses to question 38 expressed by some authorities illuminate some of the concerns and limitations expressed by authorities in adopting a formal rating system:

> "Any protocol would be too wide to be of practical value"
> " Schemes need to include subjective judgement"
> " A decision making matrix would be useful"

In addition, two authorities commented that systematic methods for rating the potential severity of a consumer safety complaint to determine the extent of investigation were...:

> "OK as long as not too rigid - any system needs to be able to respond to local resources & enforcement policies"

When asked whether they had an enforcement policy addressing issues relating to the investigation of safety complaints, 62% of respondents, (39 authorities) indicated that they had, and 38% of respondents, (24 authorities) indicated that they did not, as shown in Table 64.

Table 64 : Does your authority have a consumer safety enforcement policy addressing issues relating to the investigation of safety complaints?

	Yes	%	No	%	
London Borough	6	50%	6	50%	
Metropolitan Borough/District	9	60%	6	40%	
Unitary English	3	38%	5	63%	
Unitary Scottish/Irish	1	25%	3	75%	
Unitary Welsh	4	50%	4	50%	
County	16	100%		0%	
	39	**62%**	**24**	**38%**	**100%**

Some of the general open responses at the end of the questionnaire provide an insight into their approaches in determining the priority for safety complaints:

> "We place priority where there is likely to be the most harm"
> "All consumer safety complaints are high priority"
> " All safety complaints are investigated"
> " Risk assessment is based on likelihood of injury"

which emphasise the importance of injury or potential injury in consumer safety investigations.

As shown in Table 65, 98% of respondents, i.e. all but one authority, indicated that they always investigate consumer safety complaints where an injury is alleged. From the author's own experience, consumer complaints involving injury are rarely referred to the "Home Authority" of the importer/manufacturer for investigation, although the Home Authority is contacted for advice and assistance. Any potential offences are usually investigated by the authority in whose area the complainant lives, and where any supply offences were committed.

Table 65 : Does your authority always investigate consumer safety complaints where an injury is alleged?

	Yes	%	No	%	
London Borough	12	100%	0	0%	
Metropolitan Borough/District	15	100%	0	0%	
Unitary English	8	100%	0	0%	
Unitary Scottish/Irish	3	75%	1	25%	
Unitary Welsh	8	100%	0	0%	
County	16	100%	0	0%	
	62	**98%**	**1**	**2%**	**100%**

To test this perception, authorities were asked whether complaints were referred to the UK Home Authority of the importer/manufacturer if an injury to a local resident had occurred. As shown in Table 66, 63% of respondents, (40 authorities) indicated that they regularly refer complaints to the UK Home Authority for investigation, and 32% of respondents, (20 authorities) indicated that they occasionally refer complaints to the UK Home Authority for investigation.

Table 66 : Does your authority refer consumer product safety complaints to the UK "Home Authority" of the importer/manufacturer for investigation if an injury to a local resident has occurred?

	Regularly	%	Occasionally	%	Never	%	
London Borough	5	42%	7	58%		0%	
Metropolitan Borough/District	10	67%	4	27%	1	7%	
Unitary English	6	75%	1	13%	1	13%	
Unitary Scottish/Irish	3	75%	1	25%		0%	
Unitary Welsh	6	75%	2	25%		0%	
County	10	63%	5	31%	1	6%	
	40	**63%**	**20**	**32%**	**3**	**5%**	**100%**

Only 3 authorities indicated that they never refer complaints on this basis. It would seem, therefore, that the author's experience of Home Authority referrals has not been the experience of the responding authorities.

When asked the open ended question 32 to identify what circumstances would be relevant in deciding **<u>not</u>** to refer the complaint to the Home Authority, and to investigate the complaint locally, for example, whether referrals were handled differently where products are produced, or imported into the EU outside the UK, a range of open responses was received.

The most common response, by 18 authorities was that authorities...:

"...would take local prosecution if could"

which partly bears out the author's previous views. However, 17 authorities indicated that they:

" ... would always notify or advise the Home Authority"

Eight authorities indicated they would always refer to the Home Authority. Four authorities indicated that they would not refer a complaint if it was about a serious injury. Two authorities said that a decision to refer would depend on the likelihood of a successful prosecution, two authorities commented that they would refer to the Home Authority if they could take no action locally, and two authorities commented that they would always seek Home Authority comments.

These responses indicated the different interpretation held by many authorities about the appropriate level of involvement of the Home Authority or delegation of responsibility for dealing with the complaint to the Home Authority, i.e. regarding seeking comments, advising or notifying, or actual referral. A number of other comments were made by other respondents as summarised below:

" We would only refer if there was a problem"
" Refer technical defects to Home Authority"
" Refer to Home Authority where problem best dealt with by advice"
" Refer to Home Authority where contributory negligence by consumer"
" Depends if injury caused"
" Refer if no injury"
" May not refer to Home Authority if have previously been unhelpful"
" May not refer to Home Authority if they have insufficient resources"
" Refer where nation-wide action is necessary"
" Would notify LACOTS if no recognised importer"
" Won't refer if importer outside UK"
" Contact Home Authority where is a UK importer"
" Always contact Home Authority for importer"
" Depends on history of importer/manufacturer as advised by Home Authority"
" More likely to refer if BEAB or kitemarked"
" Would depend on Home Authority policy."

These varying responses identify an area for future research, to establish the practical implementation of Home Authority principles for safety complaints, and the influence of resource availability on decisions to act locally at the point of detection of injury or at the point the product came onto the market.

RAPEX referrals

The differing level of reporting by UK countries via RAPEX compared with other EC Member States was previously discussed in Chapter 5 and this was considered to be another area for research. As shown in Table 68, most of the respondents reported referring very few products for a RAPEX notification. 76% of respondents, (48 authorities) indicated that they had referred no products to the CSU in context of the RAPEX notification system in the last 3 years. 17% of respondents, (11 authorities), had referred less than 3 products to the CSU for RAPEX notification, and only 4 County authorities had referred more than 3 products for RAPEX notification in the last 3 years. However, as many of the unitary authorities recently established could not have had any track record prior to 1st April 1996, a low level of reporting was expected.

Table 67 : How many consumer products has your authority referred to the CSU in context of the RAPEX notifications system in the last 3 years?

	0?	%	< 3?	%	4 -10?	%	
London Borough	10	83%	2	17%	0	0%	
Metropolitan Borough/District	13	87%	2	13%	0	0%	
Unitary English	7	88%	1	13%	0	0%	
Unitary Scottish/Irish	3	75%	1	25%	0	0%	
Unitary Welsh	6	75%	2	25%	0	0%	
County	9	56%	3	19%	4	25%	
	48	**76%**	**11**	**17%**	**4**	**6%**	**100%**

Respondents were asked to list the types of consumer products which they had referred to the CSU in relation to a possible RAPEX notification in the last 3 years. 10 authorities cited toys, 4 cited electrical goods, and examples of electrical goods were individually listed by 3 authorities, i.e. Christmas tree lights, Electric lamps, and Electric fans. Other products listed were a Terrarium, a Pram, Fireworks, a Corkscrew, an Oil lamp and a retractable dog lead. 56% of respondents, (35 authorities) indicated that they had never applied any objective criteria in deciding which consumer products to refer to the CSU via the RAPEX system.

As shown in Table 68, 11% of respondents, (7 authorities) indicated that they regularly applied objective criteria and 14% of respondents, (9 authorities) indicated that they occasionally applied objective criteria in deciding which consumer products to refer to the CSU via the RAPEX system. 12 authorities indicated that the response choices given were not applicable.

Table 68 : Does your authority apply any objective criteria in deciding which consumer products to refer to the CSU via the RAPEX system?

	Regularly	%	Occasionally	%	Never	%	NA	%	
London Borough	0	0%	2	17%	9	75%	1	8%	
Metropolitan Borough/ District	0	0%	2	13%	8	53%	5	33%	
Unitary English	0	0%	1	13%	5	63%	2	25%	
Unitary Scottish/Irish	1	25%	1	25%	1	25%	1	25%	
Unitary Welsh	1	13%	1	13%	5	63%	1	13%	
County	5	31%	2	13%	7	44%	2	13%	
	7	11%	9	14%	35	56%	12	19%	100%

Authorities were asked to specify the circumstances when they would notify LACOTS, and the most common open-ended answer was given by six authorities was :

"Where national significance or a uniform approach is needed"

The next most common response reported by 4 respondents was that authorities would notify LACOTS when there was a serious problem. A number of other responses were given by 2 respondents, i.e. :

" We always notify LACOTS "
" It depends on the circumstances"
" It hasn't arisen"
" For toys or electrical goods"
" Whenever there are grey areas"

The remaining responses circumstances when authorities would notify LACOTS given by individual respondents are listed :

" When we institute an investigation"
" When we issue suspension notice"
" When we can't establish manufacturer/importer"
" Where there are other EC countries marketing the product"
" Where EC legislation breached"
" LACOTS will receive notification via BT Gold/Enforcement Bulletin"
" On all RAPEX referrals"
" When there is sufficient time"
" When assistance is required"

The response given referring to BT Gold/Enforcement Bulletins notifications highlights an important aspect of safety notifications, which was also picked up in the general comments, namely that:

" ..the main concern is about domestic notifications"

The computer information system known as "BT Gold" is primarily used by authorities to provide details of matters under investigation, as an "early warning" system, and the information is read by enforcement officers on a daily basis. For this reason, the majority of safety notifications are made domestically via this medium.

It is contended that authorities are not as familiar with the mechanics of making RAPEX and safeguard notifications as their European counterparts. A different mechanism is needed to trigger the formal RAPEX and Safeguard notifications discussed in Chapters 2 and 5, but at least one authority, as reported above, considered that LACOTS was notified via the general BT Gold system of exchanging enforcement information.

Other authorities commented that:

"To be honest our main concern is to alert UK authorities, CSU, LACOTS via BT Gold, ITSA Enforcement Bulletin. As RAPEX is time consuming and requires all sorts of details which are not always available, it can become an afterthought.."
"CSU do not accept RAPEX details unless a prosecution is in progress"

6.4 Analysis of Local Authority responses to the Pre-Appraisal Questionnaire

On the basis of their responses to the initial questionnaire, six local authorities were subsequently selected to participate in the performance evaluation trial of the Product Safety Appraisal method, as shown in Table 69 three being allocated to Group A - authorities who had reported some experience in objective measures for hazard analysis and risk assessment, and three in Group B - authorities expressing little or no experience in these objective measures.

Table 69: Performance Evaluation Participating Local Authorities

Group A	Solihull Metropolitan Borough Council Suffolk County Council London Borough of Redbridge
Group B	Stockport Metropolitan Borough Council Perth & Kinross Council London Borough of Barking

Representatives from the six participating authorities were asked to complete questionnaires administered before and after carrying out the "DIY" product safety appraisal, task analysis and risk assessment processes. In analysing and discussing responses to the Pre-appraisal questionnaire, rather than identifying individual authority responses, to preserve confidentiality, their responses are compared by the letter A-C for Group A authorities and D-F for Group B authorities. The small number of respondents within each group necessarily limits the reliability of extrapolating their comments as fully representative of other local authority views.

Local authority safety enforcement role

No instructions were provided to specify any level of safety expertise required for the personnel completing the experimental work, and associated documentation. Thus, each authority had a free choice in the selection of the member of staff to carry out the safety appraisal. From the responses to the pre-appraisal questionnaire it was apparent that only one authority in each group chose a Trading Standards Officer for the task of participating in the research, and the remaining authorities chose Enforcement officers. None of the Authorities selected a Technical Officer for this task.

The respondents were asked to indicate their safety enforcement role by selecting from the options of response provided. As shown in Table 70, none of the respondents identified themselves as safety specialists, i.e. involved in safety enforcement all of the time. Group A included more respondents who indicated that they specialised in safety for more than 50% of their time. This may reflect a policy in Group B authorities to employ officers required to enforce a broad range of legislation, to provide greater flexibility.

Table 70 : Role in Safety Enforcement

	Grp A	Grp B	
Trading Standards Officer	1	1	2
Enforcement Officer	2	2	4
Technical Officer			
Involved in safety Enforcement 75-100 % of the time			
Involved in safety Enforcement 50-75% of the time	2	1	3
Involved in safety Enforcement <50% of the time	1	1	2
No safety specialists		1	1

Safety Knowledge & Experience

From their responses to the post appraisal questionnaire, it was established that there were two male respondents and one female respondent in each group. There were 2 respondents aged 22-30 yrs, three aged 31-40 yrs and one respondent was aged over 50. The indicated range of experience within Trading Standards spanned from 7 to 23 years in Group A and 10 to 15 years in Group B.

Table 71 : Knowledge of safety standards and legislation

	Grp A	Grp B	
I have never specialised in safety enforcement		1	1
I only have a basic knowledge of safety legislation			0
I have a good general background in safety legislation but would not call myself an expert	2	1	3
I have developed an interest in safety legislation and tend to involved in safety investigations	1		1
I am considered to be the Department's expert in safety legislation		1	1
I consider myself to be an expert in safety legislation			0
I only have a basic knowledge of safety standards		1	1
I have a good general background in safety standards but would not call myself an expert	2	1	3
I have developed an interest in safety standards and tend to involved in safety investigations	2	1	3
I am considered to be the Department's expert in safety standards		1	1
I consider myself to be an expert in safety standards			0

Table 73 : Characterisation of Respondents

A	A male enforcement officer aged 31-40 yrs with 13.5 years of experience in Trading Standards who is involved in safety enforcement between 50-75% of the time, who has carried out informal safety testing, and has designed informal GSR tests. He responded that he had a general background in safety legislation and safety standards but was not an expert.
B	A male Trading Standards Officer aged 31-40 yrs with 23 years of experience in Trading Standards, who is involved in safety enforcement between 50-75% of the time, and has carried out visual safety evaluations related to safety sampling and investigation of complaints, informal safety testing, and has designed informal GSR tests. He responded that he had a general background in safety legislation but was not an expert, who had an interest in safety investigations.
C	A female enforcement officer aged 22-30 yrs with 7 years of experience in Trading Standards who is involved in safety enforcement less than 50% of the time, and has carried out visual safety evaluations related to safety sampling and investigation of complaints. She responded that she had a general background of safety legislation and standards but was not an expert.
D	A female Trading Standards Officer aged 22-30 yrs with 10 years of experience in Trading Standards whose authority has no safety specialists, who has carried out visual safety evaluations related to safety sampling and investigation of complaints and has carried out informal safety testing. She responded that she had never specialised in safety legislation and only had a basic knowledge of safety standards.
E	A male enforcement officer aged over 50 yrs with 11.5 years of experience in Trading Standards who is involved in safety enforcement less than 50% of the time, has carried out visual safety evaluations related to safety sampling and investigation of complaints, informal safety testing, and has designed informal GSR tests. He responded that he was considered to be the department's expert in safety legislation and standards.
F	A male enforcement officer aged 31-40 yrs with 15 years of experience in Trading Standards who is involved in safety enforcement between 50-75% of the time, has carried out visual safety evaluations related to safety sampling and investigation of complaints, and informal safety testing. He responded that he had a general background in safety legislation and safety standards but was not an expert.

On this basis, Trading Standards Officer B appeared to provide the most extensive enforcement experience, and the most extensive knowledge and experience in safety matters. However, he did not describe himself as a safety expert. It is interesting that Group A also included the officer with least enforcement experience, Enforcement Officer C, who was involved in safety for less than half of the time. She also described herself as having a good background in safety matters.

The range of enforcement experience was more similar in Group B, although the age range was much wider. Enforcement Officer E, the oldest participant, indicated a wide range of involvement in safety issues, and although being involved in safety for less than half of the time, he indicated that he was considered to be the department's expert on safety. Trading Standards Officer D appeared to provide the least involvement in safety enforcement and described herself as having never specialised in safety legislation with only a basic knowledge of safety standards.

The final question in the pre-appraisal questionnaire sought to establish whether any of the respondents had been involved in any product safety referrals to the Consumer Safety Unit (CSU) for a RAPEX notification. As shown in Table 74, half of the respondents had been involved in a RAPEX product safety referral, 2 of which were from Group A and 1 from Group B.

Table 74 : Experience in RAPEX Referrals	**Group A**	**Group B**	
I have been involved in RAPEX referrals	2	1	3
I have not been involved in RAPEX referrals	1	2	3

Respondent E from Group B, with experience of a RAPEX product safety referral was also the Group B respondent who had provided the most information regarding obvious hazards at first sight for each product and in identifying serious hazards.

6.5 Discussion of the Questionnaire Results

The initial questionnaire was designed to identify from respondents the range of expertise and experience in hazard analysis, and to identify any authorities with experience in risk assessment or hazard analytical procedures who might share their experiences and who would be prepared to participate in the research project. It is clear from their responses to the initial questionnaire that Trading Standards authorities were generally interested in using objective systems for risk assessment and for determining which safety complaints to investigate. However, experience both in these objective systems, and in safety testing was more limited.

Although the proportion of authorities indicating that they utilised objective risk assessments was low (6%), the majority of respondents (90%) indicated that they would be interested in such a protocol, and 83% indicated that they would use it if published. Similarly, although the proportion of authorities using a system of rating of severity of complaints to determine the extent of investigation to carry out was also low (24%), there was significant interest in this type of system (75% of authorities), and 65% of authorities indicated that they would use a method if published.

LACOTS was chosen by most respondents (78%) in the Initial questionnaire as the source of guidance on protocols for hazard analysis and risk assessment. However, there were concerns expressed about how subjective judgement could be incorporated into any objective protocols, and to enable flexibility in relation to local enforcement pressures.

In determining safety complaints to be investigated, most authorities reported that they investigated complaints involving injury, some reporting that they investigated all complaints. There were a number of considerations for local authorities in the involvement of the Home Authority in their safety investigation, which was linked to whether a prosecution was to be undertaken by the local authority where the injury occurred, rather than at the point of manufacture or import.

Responding authorities did not have much experience of reporting safety products by the RAPEX system, and there were indications that authorities were more concerned with notifying their UK than their European colleagues about product safety issues.

In considering the types of safety testing utilised, 25% of respondents had never used Ergonomics experts, and only 51% indicated using ergonomics experts occasionally. Most of the respondents (90%) had carried out screen testing, but more than half of the authorities (57%) had never used their screen testing as the basis of prosecution evidence. 50% of authorities reported using screen testing to target their resources towards identifying likely failures for external testing.

Based on the responses of the 63 authorities, the intention was to select three authorities with some experience in objective measures for hazard analysis and risk assessment, and three authorities with little or no experience in these objective measures. However, it was apparent that the representatives from each of the six authorities who were nominated to complete the safety appraisal did not fully match these selection criteria.

In fact, in their responses to the Pre-Appraisal questionnaire, fewer of the individual respondents from Group A authorities had experience in visual safety evaluations and informal safety testing, although more of this group had designed their own informal safety tests. There was also a wide range of individual experience in safety legislation and testing amongst respondents which did not reflect the expected demarcation between the two groups. The involvement of individual respondents in product safety referrals to the Consumer Safety Unit also did not fully reflect the expected demarcation of experience, although more respondents from Group A than Group B had been involved in a RAPEX referral. In later chapters, then, it would appear that the comparison of responses based on the Group A and B may be less meaningful than the author would have expected.

Chapter 7 : The Product Safety Appraisal Study

7.1 Introduction

Six of the 63 local authorities who responded to the Initial questionnaire, were selected to participate in the research to apply the proposed Product Safety Appraisal method as described in Chapter 6. In this chapter, the responses of the representatives from each authority who completed questionnaires before and after carrying out the safety appraisal are discussed, evaluating the proposed safety appraisal method, and any factors identified including product familiarity, complexity of operation, obviousness of hazards and potential severity of injury, which may have influenced the outcome of the safety appraisal process. The outcome of the process of safety appraisal using the method is considered, comparing the consistency of risk assessment outcomes determined by the participating enforcement authorities for the sample products selected, and considering their comments regarding the usability of the method.

Subsequently, chapter 8 examines the risk assessment outcomes achieved in using the between the Nomograph and Numerical scoring methods, and any comments regarding the relative usability of either scoring method.

In the context of usability evaluation, Stanton and Baber (1996) comment that usability means different things to different people, and different people measure different aspects of product use. They cite an earlier review they had undertaken of the factors which define the concepts of usability and scope, and list a number of constituent ingredients:

◊ **Learnability** : a system should allow users to reach acceptable performance levels within a specified period of time

◊ **Effectiveness** : acceptable performance should be achieved by a defined proportion of the user population, over a specified range of tasks, in a specified range of environments

◊ **Attitude** : acceptable performance should be achieved within acceptable human costs, in terms of stress, frustration, discomfort and satisfaction

◊ **Flexibility** : the product should be able to deal with a range of tasks beyond those first specified.

As they comment that a product may score highly on the first four of these, LEAF precepts, and yet the product may simply not be used, they have therefore identified the additional precepts:

◊ the **perceived usefulness or utility** of the product

◊ **task match** to ensure that there is a match between the functions provided by the system and the needs and requirements of the user

◊ **task characteristics** : the frequency with which a task can be performed and the degree to which the task can be modified

◊ **user characteristics** : the knowledge, skills and motivation of the user population.

Although these ingredients of usability are discussed by Stanton and Baber (1996), as they relate to product evaluation, they may also be applicable concepts for evaluating the usability of the safety appraisal protocol which is the focus of this research. The framework of constituents would appear to be equally applicable to evaluating the usability of process of consumer product appraisal as developed in this chapter, although the safety appraisal method is an outline rather than finished format.

Stanton and Baber (1994) suggest that a number of methods and techniques may be employed in usability evaluation, proposing that the stage in the life cycle of the "product" to be evaluated determines which is the most appropriate. Their heuristic chart as shown in Figure 30, suggests that performance evaluation is an appropriate method for evaluating prototypes, where access is available to user groups, and where time pressures are relaxed. As part of this research, the approach used to evaluate the consumer product appraisal process relies upon performance evaluation by a limited but structured sample of enforcement authority personnel, utilising questionnaire analysis to identify pertinent user characteristics.

Figure 30 : Selection of Methods and Techniques - Usability Evaluation

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evaluation

Error identification

Stanton & Barber (1996) p 46

Botman (1996) proposes a Do-it-yourself method of usability evaluation consisting of six steps:

◊ orientation of the users and their environment - understanding the users everyday issues and problems
◊ expert view - seek the views of experts to address issues of consistency, language, style etc.,
◊ user view - consider the views of different users
◊ user testing - test the product using "real" users
◊ evaluation report
◊ recommendations for improvement.

Although Botman's approach is primarily intended for evaluating software applications, his approach is helpful in structuring the approach to the "user testing" of the safety appraisal process.

The Product Safety Appraisal study discussed in this chapter addresses:

◊ *how* the products to be appraised were selected

◊ what ***product safety factors*** were identified by the personnel, before, during and after applying the safety appraisal method,

◊ how ***useful and reliable were the two different methods*** in identifying the "key" hazards identified by the author, and assessing safety risks; and

◊ what ***subjective influences*** might have affected the risk assessment outcome.

7.2 Selection of products for appraisal

Five consumer products were selected by the author for use in user testing the safety appraisal method, for the hypothetical scenario identified, specifying user and location. This process of selection proved to be a challenge, as the products to be used within the trial, by necessity, had to be generally available on the market. Therefore, by definition, they should already comply with legal requirements regarding safety for supply. In addition, the original intention was to provide a selection of consumer products which would be capable of representing the subjective and physical dimensions of:

◊ familiarity / unfamiliarity;

◊ simple / complicated manner of operation;

◊ obviousness / uncertainty of safety hazards;

◊ gravity or seriousness of hazard.

Ideally, the products chosen would also include one or more of the hazard categories identified in the hazard identification checklist, i.e. thermal, mechanical, electrical, chemical, noise/vibration hazards etc.

In practice, however, it proved to be almost impossible to find products which fulfilled all of these criteria. As shown in Table 75, however, a number of items were selected to provide varying combinations of these hazards.

Table 75: Consumer products selected for performance evaluation

Product	Simple/ complicated	Familiarity	Potential Hazard type	Obviousness of Hazards	Seriousness of Injury
Diabolo juggling toy/novelty ***(New)***	Simple	Low	Combination: Rotation/ ejecting parts, points, strangulation	Medium	Medium
Power Ranger Die cast Turbo launcher ***(New)***	Simple	Medium	Rotation/ ejecting small parts	Medium	High
Lacin' & beadin' ***(New)***	Simple	High	Small items resembling fruit posing choking hazard	High	Medium
Electric Kettle ***(Used)***	Medium	High	Electrical, Heat - Surface temperature, Scald from vented steam)	High for electrical and surface temperature, low for steam vents	Medium
Toy ball ***(Used/ complaint)***	Simple	High	Small latent item posing choking hazard	Low - impossible to predict	High

As indicated in the table, some of the items selected were purchased as new products. This enabled two of each item to be purchased, to enable one item to be examined with intact packaging by all volunteers, and to enable an examination of the other in use.

From the author's experience, as many of the products which prompt consumer complaints are "used" rather than "new" products have safety problems which occur after a period of usage, the range of samples included an electric kettle purchased from a local car boot sale, to represent this type of "complaint" item. As "used" products, complaint samples do not have their original packaging or the safety instructions as supplied with the product when new, and therefore the appraisal process can only consider the impact of any "on-product" warnings. The final product, the toy ball, was the subject of an actual complaint received by Wolverhampton Trading Standards Division, and as a result of seizure of a number of these toys, it was possible to provide a "new" or unused comparison toy as well as the complaint ball.

The Diabolo juggling toy

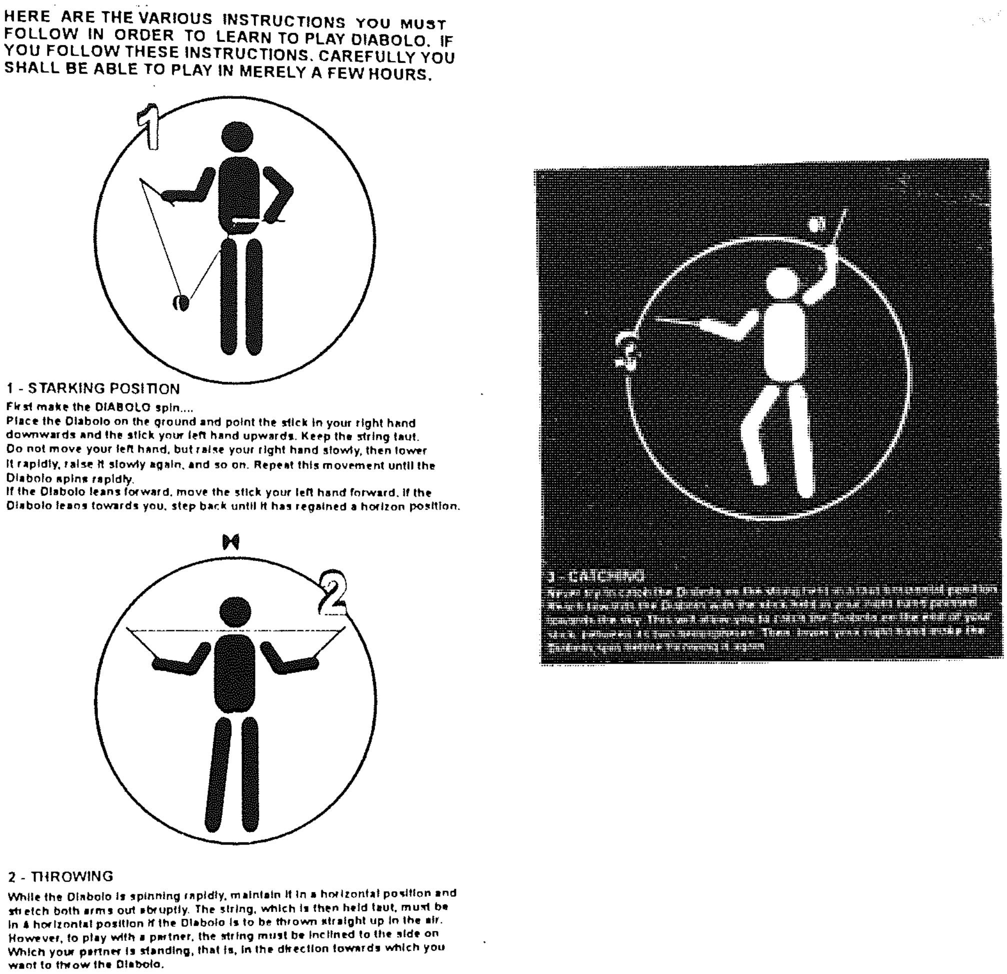
The Diabolo juggling toy consisted of two sticks and a plastic two colour Diabolo. Attached to one end of each stick was a length of cord of approximately one metre which tied the two sticks together. The Diabolo which was made of two plastic cup shapes, attached together by a bolt and washer through the base of the cup to make a narrow waist. In order to use the toy, a stick is held in either hand, like drum sticks with the corded end furthest away from the body. The user then places the Diabolo "waist" onto the cord, and juggles the Diabolo along the cord, by moving the sticks up and down as if drumming, to make the Diabolo rotate and spin. The Diabolo could then be tossed into the air, and then caught.

The toy was described as a "Pro-Diabolo" and on the pack front bore a pictorial symbol of a male and female user with an indication "1+ player" and an age indication of 8 years. The reverse of the pack bore a CE mark and a warning :

> CAUTION
> NOT SUITABLE FOR CHILDREN UNDER 36 MONTHS DUE TO SMALL PARTS.
> TO BE USED UNDER DIRECT SUPERVISION OF AN ADULT
> TO BE KEPT OUT OF REACH OF VERY YOUNG CHILDREN

In fact, there were no parts accessible to children without use of tools likely to cause a choking hazard. However, the cord was capable of causing a strangulation hazard. The ends of the sticks could poke a child in the eye, and there was the likelihood that the spinning toy might be ejected and cause injury. As shown in Figure 31, only brief three step pictorial and text instructions were given in how to play with the toy.

Figure 31: Three step instructions : Diabolo Juggling Toy



In addition, as shown in Figure 32, adjacent to the toy safety warning there was a cartoon illustration indicating a user losing control of the Diabolo, striking the head and causing a bump, labelled "Don't get mad-Practise makes perfect".

Figure 32 : Cartoon : Diabolo Juggling Toy

As previously indicated in Table 75, the Diabolo toy was considered by the author to be simple in operation, was potentially low in familiarity of operation, possessed a combination of hazards which were considered of medium obviousness and seriousness of injury. The scenario for evaluation by the Trading Standards staff was use of the Diabolo Juggling toy by a child aged 9-11 years in a small garden.

The Power Ranger Die Cast Turbo Launcher

The Power Ranger Die Cast Turbo Launcher consisted of a hand held device into which the small weighted top/projectile was inserted into a ratchet like mechanism. By running the a black toothed wheel of the hand held device along the ground the device was "wound up", storing kinetic energy into a hidden spring. When the gold trigger was operated, the kinetic energy was released, launching the top from the toy, causing it to spin. As such this toy was also considered to be simple in operation.

The toy was described as an "Exclusive die-cast metal Power Rangers spin fighter" and on the pack front bore an age indication of 4+. The reverse of the pack bore a CE mark and a warning in five languages :

GB - WARNING NOT SUITABLE FOR CHILDREN UNDER 36 MONTHS - CONTAINS SMALL PARTS COLOURS AND DECORATION OF CONTENTS MAY VARY. RETAIN DISTRIBUTOR'S ADDRESS FOR FUTURE REFERENCE.

The spinning projectile was small enough to cause a choking hazard and there was the possibility that when the spinning projectile was ejected it might cause injury, particularly if ejected into a child's eye. As shown in Figure 33, brief four step operating instructions were provided in five languages, and three stage pictorial instructions were given on how to play with the toy.

As indicated in Table 75, the Turbo Launcher toy was considered by the author to be simple in operation, was potentially medium in familiarity of operation, possessed a combination of hazards which were considered of medium obviousness and high seriousness of injury. The scenario for evaluation by the Trading Standards staff was use of the Turbo Launcher toy by a child aged 6-9 years in a living room.

Figure 33: Four step instructions : Power Ranger Die cast Turbo Launcher

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The Lacin' and Beadin' toy

The Lacin' and Beadin' toy consisted of two clear plastics drums containing coloured plastics beads and shapes to be threaded onto a coloured length of plastics thread or lace. One of the drums contained small coloured round beads, and the other contained small plastic fruit shapes coloured blue, yellow, green and red and the "thread". The toy was described as "Lacin' Beadin'" on a coloured paper band preventing the plastic drums from being opened, and on this band bore the new 0-3 toy safety warning pictogram approximately 5 mm in diameter.

The band also bore a CE mark and a warning :

CAUTION : "SMALL PART" NOT SUITABLE FOR CHILDREN UNDER 36 MONTHS

An additional label was attached to the side of the drum bearing a larger CE mark, displaying the distributor's address in London, and the instruction given in six languages "please retain this address for future reference", and an additional warning given in six languages "Not suitable for children under 3 years because of small part".

The beads and fruit shapes were capable of being contained in a child's mouth and potentially causing a choking hazard. The small beads being 5-8 mm in diameter were capable of being inhaled into the lungs, but the presence of the hole for threading would maintain an air flow. The larger fruit shapes being up to 20 mm could also be fully contained within an child's mouth, and are considered to create a choking hazard. Although, it is unlikely that they would be inhaled into the lungs the shapes did not have a central hole to enable air flow. In addition, their direct resemblance to miniature fruits would increase the likelihood of being placed in the mouth. No instructions were given on how to play with the toy/ thread the beads, however, due to the familiarity of the task it is considered that they would be unnecessary.

As previously indicated in Table 75, the Lacin Beadin toy was considered by the author to be simple in operation, and was high in the familiarity of operation. The potential choking hazard was considered to be high in terms of obviousness and medium in terms of seriousness of injury. The scenario for evaluation by the Trading Standards staff was use of the Lacin Beadin toy by a child aged 4-6 years in a bedroom.

The Haden Autojug kettle

The Haden Autojug plastics kettle was purchased from a car boot sale as an example of a "used" product for safety appraisal. The author had previously received a consumer complaint about this model during 1989, following a scalding injury to a user of this model of kettle, allegedly caused by steam escaping from the vent at the top of the handle, at the point where unwitting users would be likely to place a thumb. The user also dropped the kettle spilling boiling water, but fortunately escaped more serious injury.

As a result of this injury this model of kettle was subjected to a test by the author for compliance with the General Safety Requirement. Under test, the body of the kettle reached temperatures of up to 78°C which might cause a burn or scald within 0.4 seconds contact time, the area around the vent became very hot, and steam capable of scalding the user was emitted from the vent within 30 seconds of operation from a vent at the top of the handle near to the on/off switch.

In 1989, when this model would have been purchased as new, a photograph on the side of its packaging depicted the kettle being held in precisely the position likely to cause an injury in use. In this context, an ergonomics appraisal (un-reported 1989) by ICE had also considered steam emissions from a number of brands of kettle, posing the questions:

- ◊ could the manufacturer, by using and examining the ... kettles, have anticipated problems with steam emission?
- ◊ should the manufacturer have known that steam can endanger the user?
- ◊ could the kettle have been designed in a different way so as to avoid the likelihood of scalds from steam?

The ICE report concluded that simple user test of filling and boiling the kettle by the manufacturer would have identified problems with steam emissions around the handle, the manufacturer should have been aware that steam can endanger the user, and that alternative design measures could have been employed to separate the steam vents from switch positions and improved quality mouldings could also be used.

In 1997, this model of kettle was sold without its box and was therefore circulated for appraisal in this manner. It was supplied with a short flex with a plug fitted. To ensure no exposure to actual injury during testing, however, the kettle was labelled as "element faulty so will not boil" and subjects were asked to appraise it as if it were functional.

The kettle was labelled on its base a warning in four languages:

DO NOT IMMERSE IN ANY LIQUID

As previously indicated in Table 75, the Electric kettle was considered by the author to be of medium complexity in operation, was highly familiar, and possessed a combination of electrical, surface temperature and steam hazards. Although the electrical and surface temperature hazards were considered to be highly obvious, it was considered that the steam vent hazard was less so. It was considered that the seriousness of injury was high. The scenario for evaluation by the Trading Standards staff was use of the Haden jug kettle by an adult aged 65-70 years in the kitchen.

The Disney Toy Ball

The Disney Toy Ball included for safety appraisal was selected as the result of a consumer complaint to Wolverhampton Council's Trading Standards Division. Of relatively simple air filled soft plastics design, the screen printed coloured surface finish of the ball depicted the 101 Dalmatians Disney cartoon characters. The ball was marked with a CE mark, the manufacturer's name in Italy, and the Disney trademark. The complaint concerned a narrowly averted injury by a child of approximately 18 months of age, found to be holding in his mouth a piece of small black plastic, capable of causing a choking hazard, and also small enough to be inhaled into the lungs.

It was established during the investigation, that the black plastic item was actually a closure/plug, approximately 25 mm long which tapered to a rounded point from a diameter of approximately 6 mm. The plug was fitted after inflation of the ball, during manufacture to seal the ball. The plug was designed to be recessed below a moulded shoulder in the aperture for inflation. The manufacturer could not find a satisfactory explanation for how the plug in question had become loose, but this was clearly not an isolated problem as a number of similar balls were identified in the chain of supply with loose plugs. In fact, it appeared that as the balls gradually deflated after manufacture, it was possible to squeeze some of them firmly to eject loose plugs at great speed across a room, which might also cause an eye injury to an unwitting bystander. A number of balls, however, did not demonstrate this defect.

An example of the complaint ball which had been cut in half to show the position of the plug, and enable its removal for examination was also supplied with two other toy balls. One of these balls had the plug sealed by the author to prevent its removal.

As previously indicated in Table 75, the toy ball was considered by the author to be of simple operation, was highly familiar, and possessed a latent hazard of the small part likely to cause a choking hazard. The obviousness of the hazard was low, almost impossible to predict without hindsight, yet the seriousness of injury was high. The scenario for evaluation by the Trading Standards staff was use of the Disney toy ball by a toddler aged 18 months in the living room.

7.3 The Product Safety method

Having developed the safety appraisal process and documentation, as described in the previous chapter, the next stage entailed forwarding the documentation for the safety appraisal process together with a number of sample products for evaluation to the participating Trading Standards Departments. In order to evaluate the proposed method, and to determine the usefulness of a numerical method or risk assessment compared with the Nomograph method of risk assessment, the experimental method utilises four distinct stages :

- ◊ **stage 1** : pre- appraisal questionnaire completion;
- ◊ **stage 2** : initial product safety appraisal using the Product Safety Appraisal Matrix
- ◊ **stage 3** : final risk assessment using either the numerical and Nomograph Task Analysis Matrix documentation provided;
- ◊ **stage 4** : post-appraisal questionnaire completion

The samples and accompanying documentation were posted to the participating authorities, together with brief instructions on how to complete the safety appraisal process. As described in Chapter 5, this was to enable a "DIY" approach to the process of safety appraisal, and the completion of the questionnaires before and after appraisal. For this purpose, the performance documentation for the four stages of the evaluation process was included in a separate numbered envelopes from 1 - 4, each bearing the instructions for the relevant stage. Figure 34 illustrates the instructions for stage 1 as an example of the instructions given for each stage.

Figure 34 : Instructions for Performance Evaluation : Stage One

INSTRUCTIONS

Aston University

Content has been removed for copyright reasons

Please seal the completed questionnaire in envelope 1.

In recognition of the time constraints facing enforcement agencies, the evaluation process was split up into these stages to enable each stage to be "self contained" so that this task could be interspersed by the participating staff between completing their enforcement duties.

In the absence of the opportunity to provide personal instructions on a one to one basis, the instructions provided were as direct as possible and an indication was provided of the estimated time for completion of each section.

In particular, in order to assist in the safety appraisal process required in stage 2 and 3, a worked example on yellow coloured sheets was provided for a sample Tefal Freeline kettle, indicating how to carry out the initial product safety appraisal, and the task analysis process and risk assessment scoring using both of the Nomograph and numerical methods. In addition, the Summary of Hazard Guidelines was prepared on a double sided laminated pink sheet for ease of reference. The use of coloured sheets for different aspects of the documentation was intended to make it easier to cross reference their different purposes within the instructions provided.

Participants in the research were given two alternative formats of the Task Analysis matrix for completion using the numerical scoring method on green sheets or the Nomograph method on blue sheets. The matrices were prepared in advance detailing the product to be considered, and the scenario of usage by the target user and suggested location. The products were allocated for the numerical or Nomograph scoring method to Group A or Group B members as shown in Table 76.

This enabled participating authorities to try both methods and compare their ease of use. Thus Group A had three attempts at the Nomograph method, and two attempts at the Numerical method, and Group A had three attempts at the Numerical method and two attempts at the Nomograph method.

Table 76 : Allocation of methods of risk assessment

Product	Group A	Group B
Diabolo juggling toy/novelty	Nomograph	Numerical
Power Ranger Die cast Turbo launcher	Nomograph	Numerical
Lacin' & beadin'	Numerical	Nomograph
Electric Kettle	Numerical	Nomograph
Toy ball	Nomograph	Numerical

The instructions specified a pre-numbered envelope for use for storing the completed documentation at the end of each stage. When all stages were complete, the instructions explained how to return the samples in the pre-paid parcel to the author. Although participating authorities were also provided with information on how to contact the author for further clarification, none of them took up this offer. Also, despite the request to return the samples as soon as possible after completing the evaluation process, in practice, some authorities took up to 3 months to do so. In practice the response time from receipt of the "DIY" evaluation pack to completion of the evaluation process and return of samples was longer for Group B authorities.

7.4 Pre- and Post-Appraisal Questionnaires

In order to assess the contribution of the subjective factors towards the appraisal process, the pre-appraisal questionnaire was designed to ask questions to establish the subject/tester's perceptions of:

- ◊ their product safety testing expertise and knowledge of relevant legislation and safety standards;
- ◊ the familiarity of the product to be appraised;
- ◊ the seriousness of potential safety hazard;
- ◊ the obviousness or uncertainty of any safety hazards

The way in which the respondents defined the extent of their own expert and non expert knowledge is identified in the analysis of responses to the pre-appraisal questionnaire as discussed in Chapter 6. However, the respondents would not represent truly naive users, as these staff would still have an awareness of potential product safety hazards and their legal context through the nature of their employment in enforcement duties.

After completion of the product safety appraisal, the questions included within the follow up questionnaire were intended to determine the subject/tester's perception of:-

- ◊ familiarity of each test object;
- ◊ seriousness of consequences of potential safety hazards associated with each object;
- ◊ obviousness or uncertainty of hazards of chosen objects.

These factors, thus were considered before and after applying the proposed safety appraisal method. In addition, the Post-appraisal questionnaire also sought to establish:

- ◊ ease of use of the model;
- ◊ any possible association of product brand names with implied safety hazards in use;
- ◊ other subjective biases in hazard analysis;
- ◊ individual differences in the evaluator/tester (i.e. male/female, age, experience etc.);
- ◊ final risk assessment for each product.

7.5 Identification of safety hazards

In the pre-appraisal questionnaire, the respondents were asked to consider a number of questions about each product to test their familiarity with it, if they had seen a product like it before, if they had used this type of product before, and if they felt they could use it without reading instructions or safety information. Respondents were then asked to indicate if there were any obvious safety hazards on first sight of each product, and if so, to list the hazards identified.

The primary purpose of completing the Initial Product Safety Matrix in applying the proposed method of product safety appraisal, was to guide respondents through a systematic series of questions to enable identification of product safety hazards. This was intended to prepare respondents for identifying potential injuries associated with these hazards, and carrying out a risk assessment of the potential for injury when completing this information on the Task Analysis Matrix.

In this section, each of the five consumer products is considered in turn to compare the initial hazards identified via the pre-appraisal questionnaire, the hazards identified by working through the Initial Product Safety Matrix, how these hazards were included within the Task Analysis Matrix to determine the risk assessment score, and relevant comments made in the post-appraisal questionnaire.

Diabolo Juggling Toy

Initial hazards identified

In completing the pre-appraisal questionnaire, all of the respondents in Group A and one respondent in Group B indicated a number of obvious safety hazards recognised at first sight. The potential hazards initially identified included:

- throwing injury (2)
- splinters (1)
- nut and bolt in Diabolo comes undone (1)
- strangulation (3)
- flying object (1)
- misuse (1)
- choking on small parts (1)
- rope burn (1)

When asked to identify any serious hazards only one of the respondents in Group A indicated that the throwing hazard was considered to be serious.

The author would have expected this initial examination to reveal potential throwing/impact and strangulation hazards, either of which might be potentially serious, and which would require some reference in the safety instructions and warnings to avoid potential injury.

A summary of the responses recorded on the Initial Product Safety Matrix about how hazardous the product initially appeared is shown in Table 77

Table 77 : Initial Hazards & Hidden Hazards - Diabolo

	Grp A	Grp B	
Hazardousness			
• Quite	1		1
• Seems less than it probably is		1	1
• Depends on how used		1	1
• not particularly / minimal	1		1
• not	1	1	2
Uncertainty - hidden hazards			
• only if expose small parts		1	1
• supervision needed (spinning etc.)		1	1
• No	3	1	4

Three respondents indicated that the Diabolo initially did not appear hazardous, one indicated it would depend on how used, one indicated that it seemed less hazardous than it probably is, and only one respondent in Group A indicated that it appeared quite hazardous. When respondents were asked to indicate any latent hazards, only Group B respondents reported the hidden hazards which are shown in Table 77.

It would appear that the intended scenario was not uppermost in recording responses to the questions posed in the Initial Product Safety Matrix in terms of the stated location of use, target user and age of user. A number of hazards identified related to use of the product by users outside the proposed age range. All respondents, however, commented that the Diabolo was better used outdoors. One respondent from each group indicated that it would be hazardous to play with the Diabolo indoors, the Group B respondent seeking to avoid breakage of objects and to allow plenty of room. One respondent from each group commented that the Diabolo might be used indoors, the Group A respondent commenting that adequate height would be required indoors, and that care should be taken to avoid it being left where people might trip on it.

Product Hazards

Except one respondent in Group A, who identified the ease of detachment of the Diabolo from the toy in use, all respondents described the properties of the Diabolo in the initial section of the matrix, rather than identifying hazards. In considering the size and dimensions, and ease of handling, one respondent in Group A commented that the toy was fairly awkward to handle, and another commented that the size was appropriate for the target age group of over 8 years. One respondent in Group B indicated that the sticks were smooth but could poke an eye.

Portability, slipping / tripping/ falling hazards

Although tripping hazards had not been initially identified by respondents in the pre-appraisal questionnaire, two of the respondents in Group A made comments about potential tripping hazards, that the user's attention would be concentrating on the item rather than the surrounding environment, and throwing and catching hazards while learning. All respondents in Group B made comments relating to potential slipping/tripping hazards, including tripping over the cord while taking the toy to the place of use, slipping/tripping or bumping into things when playing with the toy while concentrating on the moving Diabolo. One respondent stated the slipping tripping hazards would not occur unless the toy was misused. Tripping hazards were included in the Task Analysis Matrix by two respondents in each group.

Assembly/ installation hazards

Comments concerning assembly were split, two of the respondents in Group A considering that this included placing the Diabolo correctly on the string, and other respondents indicating that no assembly was required. One respondent in Group A indicated that adult supervision was required. One respondent in Group B indicated that the possibility of taking apart the two halves of the Diabolo with the use of a tool. None of the respondents included assembly hazards in the Task Analysis Matrix.

Material hazards

Respondents in both groups had differing views regarding the standard of finish. The only additional hazard identified other than those previously listed in response to the pre-appraisal questionnaire was surface roughness. One respondent in Group A and all of Group B noted roughness in the Diabolo plastic moulding. However, more respondents identified a wider range of surface hazards. One respondent in Group A and two in Group B commented that the nut/bolt could not be removed without use of a tool, but their removal could cause a choking hazard. All of Group A, and one of Group B commented about the potential strangulation hazard posed by the string. One Group A respondent noted splinters on the sticks in one of the samples, and one from Group B commented that the sticks could poke an eye. Only respondent B included a surface roughness hazard in the Task Analysis Matrix, and this was in relation to the splinters identified by respondent B.

Motion hazards

All of the respondents in Group A commented about movement hazards, associated with movement of the toy by the user, the movement of the user and the movement and rotation of the Diabolo. The questions in this section elicited identification of entanglement hazards, the child's instability while playing, and potential stabbing/puncturing hazards not previously identified on the pre-appraisal questionnaire. Two of the respondents in Group B and one in Group A identified an entanglement/strangling hazard posed by the string. Two of the respondents in Group

B also commented on stabbing or puncture hazards if the toy was used in a restricted space or with someone nearby. One respondent in Group B commented about impact caused if the Diabolo flew off the string and hit someone, and another identified ejection of parts if the user lost control of the Diabolo, also remarking that the child may be unstable while using the toy. One of the Group A respondents remarked that the Diabolo is meant to be thrown and caught.

Respondents recorded the motion hazards identified in the Initial Product Safety Matrix within the Task Analysis Matrix as projectile hazards, strangulation and tripping hazards linked to the string, loss of control hazards and misuse hazards.

Chemical Hazards

One respondent in Group A identified the potential toxicity of the plastic material, noting that it gave off a strong smell. This was not initially identified in the pre-appraisal questionnaire. The potential risk of a child chewing the plastic Diabolo was included in the Task Analysis Matrix by the Group A respondent.

Packaging Hazards

One of the Group A respondents mistakenly applied the questions to the product rather than packaging. Other respondents from Group A, and two from Group B identified the potential flammability hazard from cardboard, and one from each group identified that the thin film was unlikely to pose a suffocation hazard as it tore easily. One respondent from each group also queried whether there may be any toxic materials as a result of the printing ink. Two respondents in Group A and one in Group B identified packaging hazards in the Task Analysis Matrix.

Use/ Misuse Hazards

The Product Safety Matrix addressed potential use or misuse in two sections. A set of questions in the first section asked about foreseeable misuse as part of the consideration of cognitive factors, and questions in section 6 required respondents to consider the potential tasks of use and misuse in preparation for completing the Task Analysis Matrix.

All of the respondents identified a number of foreseeable aspects of misuse in the first section, which included throwing the Diabolo, using the sticks as weapons for poking or hitting, dismantling the string and the Diabolo, using the components as a catapult/weapon, and using the Diabolo in a restricted location near to breakable objects. Three of the respondents commented that the instructions for use partly addressed misuse (2 from Group A and 1 from Group B). However, one of these reported that relying on adult supervision would not fully reduce the likelihood of misuse, whereas another felt that this would reduce misuse. One recognised that the cartoon demonstrated an outcome of misuse, but this was a "jokey" way for conveying a safety message.

In response to section 6 of the matrix, only four respondents detailed intended tasks for the Diabolo, as a child's plaything, for juggling and dancing, in play, and possibly rolling or throwing the Diabolo without the sticks. Two respondents from each group also listed potential tasks for reasonably foreseeable misuse, including throwing the Diabolo/using it as a missile, detaching the cord and sticks for use for other purposes, hitting or poking with the sticks, using the sticks like a sword, taking the Diabolo apart (using a tool), wrapping/tying the cord around the neck, tying children up. Two respondents from each group included misuse hazards in the Task Analysis Matrix.

Deterioration and Maintenance hazards

Two respondents from Group B and one from Group A identified that the product may become unsafe if the Diabolo was taken apart. One respondent from Group A referred to splinters on wooden sticks, and one from Group B referred to potential hazards if the sticks were broken or the cord became broken or undone. Five respondents identified potential aspects of maintenance, including damage to the cord, checking that the bolt and nut were intact, and checking that the string stays attached to the sticks.

One respondent from each group commented however, that a tool was required to dismantle the nut and bolt to separate the two parts of the Diabolo. Only one respondent in Group B included the potential choking hazard caused by loosening of the nut and bolt holding the two parts of the Diabolo "spinner" together. None of the other potential hazards identified on the Initial Product Safety Matrix were listed on the Task Analysis Matrix.

Disposal hazards

Although most of the respondents made no comment regarding disposal, one respondent from Group B identified a potential plastic disposal hazard. However, no disposal hazards were recorded on the Task Analysis Matrix.

Marketing

All respondents commented that the target user group was clearly conveyed as being for 8 years and older. Two of the respondents in Group A, however, noted that instructions could have used plainer wording, or actually provide "on product" information. Views were divided about the consistency of the age labelling given. Three respondents (1 in Group A and 2 in Group B) felt that the "8+" indication given on packaging was inconsistent with the small parts warning for children under 36 months. The others indicated that age labelling was consistent with depictions of product use. All respondents commented that the product's intended use was clearly conveyed on the packaging.

User

None of the respondents commented that there was a significant sex for use, or sex difference in use, although one respondent from each group indicated that boys may play "with more gusto" or be "more reckless and less patient". There was broad agreement that the Diabolo was not suitable for play by young children, and that the target age was over 8 years, as marked on the pack. However, the use of the small parts warning (referring to small parts choking hard for under 36 months) led one respondent in each group to include 3+ years in their potential age range of users. Two of the respondents in Group B commented on the conflicting advice on age suitability. Three respondents considered that young children would not be able to use the Diabolo, because it needed patience, or skill and dexterity, and practice to achieve successful play.

In response to questions regarding the skill levels required, all respondents indicated that physical skill was required, listing dexterity, balance, co-ordination, practice, left/right handed ability, fine motor skills and patience. One respondent in Group A indicated that the Diabolo require "gained" skill. Five respondents commented that there were hazards arising from human errors, and two Group B respondents cited examples of eye poking, and throwing the Diabolo about. Three respondents indicated that measures had been taken to ensure the product was only used by appropriate persons citing the instruction for adult supervision.

Warnings and Safety Instructions

In commenting on the warnings and instructions used, views were split regarding whether the warning adequately described the hazards, how to avoid the hazard or injury and what to do if injury occurred.

The warning message was considered to be clear and concise. One respondent from each group considered it described the hazard and one from each group did not. Only one respondent indicated that instructions were given on how to avoid the hazard. Two respondents in Group B commented that there was no pictorial representation of potential hazards. One respondent in Group A referred to the cartoon showing the consequence of ignoring the hazard, but a Group B respondent noted this was "jokey", and also did not represent other hazards of potential eye poking or strangling/entangling.

Five respondents indicated that there were no instructions advising what to do if an injury occurs. One respondent from Group B indicated that the small part warning was unnecessary for the target age group of 8 years and over, and other respondents commenting that instructions concentrated on correct use rather than avoiding injury. Only one respondent cited Home or Leisure Accident reference data as prompted within the matrix. No respondents considered that personal protective equipment was required.

The consensus of views criticised the impact of the warning given, regarding its visibility and location. Two respondents in Group B considered the visibility of the warnings to be adequate, and one Group B respondent did not. The Group A respondents comments criticised the warning as being too small, that it was only on one side of the packaging, and being confined to the packaging rather than the product. Five respondents commented that the warning was not located as close to the peril as possible as it appeared once only on the packaging. As the packaging included an instruction "please keep for future reference" one respondent from Group A and one from Group B considered this guarded against the information being destroyed with the packaging. Two respondents in Group B considered that despite this instruction, the information was likely to be thrown away.

Task Analysis Matrix

The Diabolo was subject to the Nomograph method of risk assessment by authorities A, C and D, and the Numerical method by authorities B, E and F. Tables 78 and 79 summarise the tasks identified, the associated hazards and injuries and risk assessment scores using the Nomograph and Numerical methods, respectively. On the basis of the information determined in response to the questions within the Initial Product Safety Matrix, and particularly as the final sections concerned tasks of *use* and *misuse*, it was expected that this would assist respondents in completing the Task Analysis Matrix.

The two methods demonstrated differences in the phases of use recorded and yielded slightly different outcomes, as shown in the Tables 78 and 79. None of the respondents used the Task Analysis Matrix to record mis-use of the Diabolo indoors, although respondent A did include potentially breaking a glass object in the Task Analysis Matrix for the Diabolo. The Tables show considerable similarity in the types of injuries identified, although the final risk assessment scores differ for similar injuries, and similar circumstances.

Respondents using the Nomograph method identified three hazards considered to have a "moderate" risk of injury:-

- the risk of setting fire to the plastic packaging film (51)
- the risk of impact injury by the "thrown" Diabolo spinner (47)
- the risk of injury by another child hitting others with the sticks (47)

Table 78 : Comparison of risk assessments : Diabolo : Nomograph Method

Task	Hazard	Potential Injury	Maximum Injury	Probability	Likelihood of Recognition	Initial Risk Assessment	Availability	Final risk Assessment
Unwrap	Leave plastic film near heat source (D)	Burn	Minor	Almost Inevitable	Highly improbable	80 Very high	Rare	51 Moderate
Bring to place of use	Trip (C)	Bruising	Minor	Possible	Probable	37 Low	Limited	17 Remote to extremely low
Use	**Projectile** Child or others hit by Diabolo (C)	Bruising Cuts	Minor	Probable	Probable	40 Low	Limited	38 Very low
	Impact (D)	Bruising Cuts	Minor	Possible	Probable	14 Extremely low	Rare	< 0 Virtually non existent
	Impact (A)	Bruising Cuts Shock	Serious	Probable	Possible	64 Significant	Limited	47 Moderate
	String Child trips over string (D)	Bruise	Minor	Unlikely	Probable	5 Virtually non existent	Rare	< 0 Virtually non existent
	Wraps string round neck (A)	Strangulation	Death	Unlikely	Almost Inevitable	45 Low	Limited	27 Extremely low
	Wraps string round neck (D)	Strangulation	Serious	Remote	Almost Inevitable	5 Virtually non existent	Rare	< 0 Virtually non existent
Misuse	Child or others hit by stick (D)	Bruising Cuts	Minor	Possible	Probable	14 Extremely low	Rare	< 0 Virtually non existent
	Child or others hit by stick (A)	Bruising Cuts	Serious	Possible	Probable	64 Significant	Limited	47 Moderate
	Diabolo hits breakable object (A)	Cut from glass	Serious	Possible	Possible	64 Significant	Limited	34 Very low
Interrupt task - leave on floor	Trip/fall over Diabolo on floor (C)	Cut Bruise	Minor	Unlikely	Probable	34 Very Low	Limited	15 Extremely low
	Trip/fall over Diabolo on floor (A)	Cut Bruise (A)	Serious	Possible	Improbable	66 Significant	Limited	44 Low

Respondents using the Numerical method also identified three hazards considered to have a "significant" risk of injury :-

- the risk of strangulation by the string (22.5)
- the risk of impact injury by the "thrown" Diabolo spinner (20)
- the risk of slip/ trip injury due to loss of control (12.5)

Table 79 : Comparison of risk assessments : Diabolo : Numerical Method

Task	Hazard	Potential Injury	Probability of Exposure	Frequency of Exposure	No. of Persons at Risk	Maximum Probable Loss	Hazard Rating
Unwrap	Ingest toxic inks/ packaging (B)	Poisoning	Unlikely 1	Infrequently 0.1	1-2 persons 1	Minor temporary illness 1	0.1 acceptable
Cut plastic film with scissors	Use knife & slip (F)	Cut self	Possible 2	Infrequently 0.1	1-2 persons 1	Laceration 0.5	0.1 acceptable
Use	Splinters from sticks (B)	Splinters	Likely 10	Weekly 1.5	1-2 persons 1	Mild ill health 0.5	7.5 low risk
Projectile	Child or others hit by Diabolo (E)	Bruising	Possible 2	Weekly 1.5	1-2 persons 1	Scratch/bruise 0.1	0.3 acceptable
	Impact (B)	Bruising	Likely 10	Weekly 1.5	1-2 persons 1	Scratch/bruise 0.1	1.5 very low
	Impact 3rd party (F)	Bruise	Possible 2	Infrequently 0.1	1-2 persons 1	Temporary illness 1	0.2 acceptable
	Impact User (F)	Bruise	Likely 10	Hourly 4	1-2 persons 1	Bruise 0.5	20 significant
Loss of control	Wraps string round self/stick (F)	Strangulation	Possible 2	Infrequently 0.1	1-2 persons 1	Temporary illness 1	0.2 acceptable
	String (E)	Strangulation	Unlikely 1	Weekly 1.5	1-2 persons 1	Temporary illness 1	1.5 very low
	String (B)	Strangulation	Unlikely 1	Weekly 1.5	1-2 persons 1	Fatality 15	22.5 significant
	String (F)	Slip/trip	Even chance 5	Daily 2.5	1-2 persons 1	Temporary illness 1	12.5 significant
	String (E)	Slip/trip	Possible 2	Weekly 1.5	1-2 persons 1	Temporary illness 1	3 very low
Misuse	Poke/hit 3rd party (F)	Bruising Cuts	Possible 2	Infrequently 0.1	1-2 persons 1	Bruise 0.5	0.1 acceptable
	Poke/hit 3rd party (E)	Bruising Cuts	Possible 2	Weekly 1.5	1-2 persons 1	Scratch/bruise 0.1	0.3 acceptable
	Strangle 3rd party (F)	Choking	Possible 2	Infrequently 0.1	1-2 persons 1	Serious temporary illness 4	0.8 acceptable
Leave Diabolo on floor	Trip/fall (F)	Cut Bruise	Possible 2	Infrequently 0.1	1-2 persons 1	Bruise 0.5	0.1 acceptable
Chew Diabolo	Flammability or toxicity of plastic (B)	Burns / Poisoning	Possible 2	Weekly 1.5	1-2 persons 1	Temporary illness 1	3 very low
Dismantle Diabolo	Loosen nut & bolt (B)	Choking	Unlikely 1	Weekly 1.5	1-2 persons 1	Temporary illness 1	3 very low

The two methods therefore identified the risk of injury by impact with the thrown Diabolo spinner , but each method then identified two different hazards. The author would not have expected the risk of injury from the potential flammability of plastic film to be more likely than injuries from impact, strangulation, tripping or hitting. In the author's opinion this would appear to be a spurious risk assessment. The likelihood of all of the potential injuries could be reduced by safety information/ warnings emphasising the need for appropriate supervision of a child playing with the toy.

The post appraisal questionnaire asked respondents what their final risk assessment was for each product. By comparison with the risk assessment scores determined via the Nomograph and Numerical method, respondent A identified the hazard of being hit by the Diabolo, and respondent E the loss of control causing bruising or strangling. Other views expressed indicated that the Diabolo was :-

fairly safe for the age intended - accidents can occur in play
reasonably safe if used correctly
unlikely strangulation/projectile hazards
low risk of splinters

The author would concur that the toy is reasonably safe for the intended age if used correctly and under supervision.

Power Ranger

Initial hazards identified

In completing the pre-appraisal questionnaire, most of the respondents in Groups A and B identified similar hazards including:

dangerous projectile (1)
eccentric flight of object (1)
metal projectile (1)
choking (2)
force of projectile (1)
if it breaks sharp edges? (1)
heavy metal content? (1)
small parts (2)

When asked to indicate if any of the hazards are considered to be serious, the respondent in Group B indicated paint and possible sharp edge. The respondents in Group A indicated potential choking, throwing and projectile hazards. The author would have expected the preliminary inspection by respondents to identify potential injuries posed by an ejected spinner, and the risk of possible choking on the spinner to younger children.

A summary of the responses recorded on the Initial Product Safety Matrix about how hazardous the product initially appeared is shown in Table 80. Four respondents indicated that the Power Ranger Turbo Launcher was not particularly hazardous or not hazardous. Two respondents in Group B indicated the speed of release as an potential hazard. When asked if there were any latent hazards, one Group A respondent indicated the possible toxicity of paint and a Group B respondent suggested the flight of the spinner.

Table 80 : Initial Hazards & Hidden Hazards : Power Ranger

	Grp A	Grp B	
Hazardousness			
• Speed of release		2	2
• not particularly / minimal	2		2
• not	1	1	2
Uncertainty - hidden hazards			
• toxicity	1		
• flight		1	1
• No	2	2	4

Initial Product Safety Matrix : Scenario - used in living room by a child of 6-9 years

In relation to the proposed scenario of use, all respondents commented that the Turbo Launcher could be used anywhere, although two respondents from Group A and one from Group B indicated that a flat surface was needed. One respondent from Group A identified a potential tripping hazard if the toy was left on the floor, and one respondent from Group B commented that it would better to avoid glass surfaces for play.

Although all respondents commented that the target user group was clearly conveyed as being for children, two of the respondents in Group A commented that the target age was 4+ years as indicated on the pack, one respondent commented that the 4+ indication was consistent with the age of children watching the TV show, and another indicated that the target group was children who watch the Power Ranger TV programme. One respondent in Group B considered that a more suitable age for play was 9-10 years.

Product Hazards

All of the respondents described the toy rather than the hazards. Two respondents identified the spring powered nature of the toy. Two of the respondents in Group B and one in Group A commented about how the launcher part of the toy fit into the hand, commenting that it fit easily, comfortably and was not awkwardly shaped. One respondent in Group A identified a potential choking hazard for younger children, as the spinner fitted wholly within the truncated cylinder specified within the Toy Safety Standard EN 71 which replicates the size of a child's mouth. As such, the presence of the spinner requires a "Small parts" warning of the potential choking hazard.

Portability, slipping / tripping/ falling hazards

Tripping hazards were not identified by the respondents in their initial inspection, or in completing the Initial Product Safety Matrix. One respondent in Group B indicated a potential handling hazard if the spinner was released at the wrong time and early release of the spinner was identified by respondent D as a hazard in completing the Task Analysis Matrix.

Assembly/ installation hazards

Three of the respondents indicated that assembly/installation was not required, but two of Group A and one of Group B considered the insertion of the spinner into the hand held launcher to be assembly/installation. All noted that the instructions for this task were clear, but only the Group B respondent commented that faulty installation would create a danger through sudden release of an incorrectly inserted spinner. Early release of the spinner was identified by respondent D and the potential pinching of the trigger was identified by respondent A on the Task Analysis Matrix. However, two respondents in Group B commented in completing the Task Analysis Matrix that incorrectly placing the spinner was not a hazard. No respondents indicated that special qualifications were required for this assembly.

Materials hazards

Generally, respondents had similar views regarding the standard of finish, indicating that the product was well constructed with no sharp edges or points. Although one respondent in Group A commented that there were two sharp points on the plastic launcher, no respondents included these hazards on the Task Analysis Matrix.

One respondent in each group queried the potential toxicity hazard of the gold paint on the spinner and the possibility of toxic paint causing a poisoning injury was also identified by one respondent from each group via the Task Analysis Matrix. Three respondents identified the potential of the spinner for creating a choking hazard, and a further two respondents identified the potential of the spinner for creating a swallowing hazard. Subsequently, three respondents identified potential choking hazards as a result of putting the spinner into the mouth on the Task Analysis Matrix. Two respondents also queried flammability, although no flammability hazards were subsequently identified on the Task Analysis Matrix. Two respondents in Group B commented that the launcher might shatter if dropped or stood on, which might cause sharp edges capable of causing injury. Subsequently, one respondent from each group included the potential injury from stepping on the launcher or spinner when completing the Task Analysis Matrix.

Motion hazards

Although only three respondents identified projectile motion hazards in their initial inspection as detailed in the pre-appraisal questionnaire. All of the respondents identified potential motion hazards in completing the Initial Product Safety Matrix. One respondent in Group A simply identified the release trigger/switch, and another Group A respondent referred to rotation. The remaining respondents referred to the three moving elements, the winder, the release trigger and the spinner/top. Although there was a concern about the potential hazards of ejection and impact as this related to the release of the spinner, two of the respondents in Group A commented that the spinner drops rather than projects on release, and its spinning motion is easily stopped by a hand without injury. Two comments were made by Group B respondents querying the speed of the spinner at impact with the hard surface, and whether it might eject. One respondent in Group B commented on the presence of the locking mechanism to keep the spinner in place. As detailed above in relation to assembly/installation hazards, these movement hazards were noted by respondents on the Task Analysis Matrix.

Chemical Hazards

One respondent identified the potential toxicity of paint in the preliminary inspection of the toy. One respondent in Group A and one in Group B identified the potential toxicity of the paint finish on the spinner in completing the Initial Product Safety Matrix.. This was not subsequently included in the Task Analysis Matrix.

Packaging hazards

Although there were no packaging hazards identified on the preliminary inspection, one of the Group A respondents queried whether there may be any toxic materials as a result of the printing ink on the packaging, and this was mentioned by respondent B in completing the Task Analysis Matrix. In completing the Task Analysis Matrix a Group B respondent also identified a possible hazard in removing the plastic bubble wrap through use of knife or scissors.

Use / Misuse hazards

The Product Safety Matrix considered potential use or misuse in two places, as part of the consideration of cognitive factors, and in relation to the potential tasks of use and misuse as a preparation towards completion of the Task Analysis Matrix.

Two respondents in each group identified a number of foreseeable aspects of misuse, which included launching the spinner directly at a person, dropping the spinner onto a breakable surface, throwing the individual components and fighting following play.

In response to section 6 of the Initial Product Safety Matrix five respondents detailed intended tasks for the toy, as a child's plaything, as a spinning top, including in competition with other children, as an imaginary laser gun, or play gun/pistol, or thrown as separate components. All respondents listed potential tasks for reasonably foreseeable misuse, including throwing the spinner as a missile/projectile, throwing it as a weapon at other people, or into a child's face, ejecting the spinner onto a breakable surface, or at breakable items, putting the spinner into the mouth and inhaling it or choking. Five respondents included misuse hazards in the Task Analysis Matrix.

Deterioration and Maintenance and Disposal hazards

Only one respondent from Group B queried whether the locking mechanism might wear with use, or the potential access to the internal spring if the launcher split. However, this respondent also commented that the launcher was held together by crosshead screws to reduce access to its contents. No other deterioration, maintenance or disposal hazards were identified through the Initial Product Safety Matrix or Task Analysis Matrix.

Marketing

All but one respondent in Group B commented that the product's intended use was clearly conveyed on the packaging. Another Group B respondent commented that it was difficult to find the English language version of the safety information amongst the other language versions displayed on the pack. All respondents commented that the target user group was clearly conveyed as being for children, although there was a difference in the age suitability expressed. Two of the respondents in Group A commented that the target age was 4+ years as indicated on the pack, one of whom queried the inconsistency with the small parts warning for children 3 years and under on the reverse of the pack. The other respondent commented that the 4+ indication was consistent with the age of children watching the TV show. Two Group B respondents queried whether the pack labelling "4+" related to the child's age and the third indicated that the target group was children who watch the Power Ranger TV programme. Views were divided about the consistency of the age labelling given due to the presence of a small parts warning for under 36 months, and an age label of 4+.

The author considers that age labelling performs a different purpose than warnings about potential small parts hazards. The former provides information about the target user group to assist in selecting an appropriate toy, whereas the latter warns about potential hazards which may be present for other users. Only one respondent in Group B considered information in this way, indicating that a more suitable age for play was 9-10 years, and the small parts warning was appropriate for younger children who may gain access to the toy.

User

Five respondents commented that the likely sex of the child playing with the Power Ranger Turbo Launcher was male, one of these indicating that it was probably more attractive to boys. However, no respondents felt that there was likely to be a sex difference in understanding or use, there being no greater danger to either sex. There was broad agreement that the Turbo Launcher was not suitable for play by young children, i.e. under 3 years, consistent with the small parts warning. One respondent in Group A indicated the principle age of users to be 3+ years, one respondent in Group B indicated 3-10 years, two in Group A indicated 4+ years, and the final

Group B respondent indicated "say 9 years". Two respondents in each group included 3+ years in their target age range of users. Four respondents commented that the target age was 4+ years, and one suggested "children who watch Power Rangers". One respondent in each group reported that there was an age difference in understanding how to use the product, indicating that younger children would have less understanding.

In response to questions regarding skill levels required, all respondents indicated that dexterity was required, but two of Group A suggested that no skill or minimal skill was required. Two respondents from Group B and one from Group A indicated that some skill was required, one indicating fine motor skills. One respondent from each group indicated that concentration was needed, and one respondent from Group B indicated that frustration may lead to mis-use. Three respondents indicated that there were no hazards arising from human errors, but one respondent in Group B commented that incorrect insertion of the spinner into the launcher may cause unexpected release of the spinner. One respondent in Group B indicated that no measures had been taken to ensure the product was only used by appropriate persons, and another Group B respondent indicated that the age warning was the only measure taken.

Warnings and Safety Instructions

All respondents noted the use of "Warning" as a signal word. Four respondents indicated that the warning used include simple words to convey a clear concise and complete message. Only one respondent in Group A commented that the warning did not identify and describe the hazard, but all commented the warning did not explain actions which were hazardous and was not specific about the consequences of ignoring the warning.

All also commented that the warning did not describe instructions on what to do if injury occurred or how to avoid the hazard. All respondents noted that the warning was only on the packaging and not as close to the point of peril as possible, i.e. on the product itself.

Five respondents indicated that the warning could be read from normal viewing angles, one commenting that this was on the pack front, and one commenting that this was on the pack rear. However, one commented that the warning is "literally lost amongst other language versions". Four respondents commented that the packaging included an instruction "please keep for future reference", but one respondent from Group A and one from Group B commented that this referred to the distributor's address rather than the safety information. Another respondent from each of the groups commented that this information would be destroyed with the packaging.

Task Analysis Matrix

The Turbo Launcher was subject to the Nomograph method of risk assessment by authorities A, C and D and the Numerical method by authorities B, E and F. Tables 81 and 82 summarise the tasks identified, the associated hazards and injuries and risk assessment scores using the Nomograph and Numerical methods.

The tables also show that two methods demonstrated differences in the phases of use recorded and yielded slightly different outcomes, in that two respondents in the group using the Numerical method considered unwrapping the toy as a preparatory task, and there was a wider range of potential choking hazards considered. Only one respondent in the group using the Nomograph method considered loading the spinner into the launcher to be a preparatory task.

The Tables show considerable similarity in the types of injuries identified, including cuts, bruises and choking. However, two respondents in the group using the Numerical method identified potential poisoning injuries from ingesting the packaging or paint on the spinner.

Respondents using the Nomograph method identified only one hazard, considered to have a "moderate" risk of injury:-

- the risk of the spinner acting as a projectile (52).

Table 81 : Comparison of risk assessments : Turbo Launcher : Nomograph Method

Task	Hazard	Potential Injury	Maximum Injury	Probability	Likelihood of Recognition	Initial Risk Assessment	Availability	Final risk Assessment
Load spinner into launcher	Pinching (A)	Cut/ muscle strain	Minor	Remote	Highly improbable	38 Very Low	General	39 Very Low
	Not placed correctly (D) No hazard (C)	Bruise	Minor	Unlikely	Probable	5 Virtually non existent	Limited	0 Virtually non existent
Use Wind up launcher	Release early (D)	Bruise	Minor	Unlikely	Probable	5 Virtually non existent	Limited	0 Virtually non existent
Release spinner	Catch finger in trigger (D)	Bruise	Minor	Unlikely	Probable	5 Virtually non existent	Limited	0 Virtually non existent
Fire spinner onto flat surface	Use spinner as projectile (A)	Cut/ Bruising Loss of an eye	Severe	Unlikely	Possible	49 Moderate	General	52 Moderate
Misuse	Place spinner in mouth (A)	Choking /inhalation	Minor	Unlikely	Improbable	35 Very low	General	41 Low
Leave spinner & launcher on floor	Stand on/ breaks/ shatters (D)	Bruise Cuts	Minor Minor	Unlikely Unlikely	Probable Probable	5 Virtually non existent 5 Virtually non existent	Limited Limited	0 Virtually non existent 0 Virtually non existent
	Stand on (A)	Bruise to sole of foot/knee	Moderate	Probable	Probable	38 Very Low	General	41 Low

Table 82 : Comparison of risk assessments : Turbo Launcher : Numerical Method

Task	Hazard	Potential Injury	Probability of Exposure	Frequency of Exposure	No. of Persons at Risk	Maximum Probable Loss	Hazard Rating
Unwrap	Ingest toxic inks/ packaging (B)	Poisoning	Possible 2	Infrequently 0.1	1-2 persons 1	Minor temporary illness 1	0.2 acceptable
Cut plastic film with scissors	Use knife / scissors & slip (F)	Cut self	Even chance 5	Infrequently 0.1	1-2 persons 1	Laceration 0.5	0.25 acceptable
Use Engage & wind up spinner	No hazard (F, B)						
Release trigger	Possible pinching hazard (F)	Bruising/ pinching	Unlikely 1	Infrequently 0.1	1-2 persons 1	Scratch/bruise 0.1	0.1 acceptable
Release spinner onto table	Loss of control/ impact (F)	Cut / bruising	Even chance 5	Hourly 4	1-2 persons 1	Scratch/bruise 0.1	10 Low
Misuse Fire spinner as projectile	Impact with soft tissue, face, eyes (F)	Cut / bruising	Even chance 5	Hourly 4	1-2 persons 1	Laceration 0.5	10 Low
	Projectile (E)	Hit by spinner	Even chance 5	Daily 2.5	1-2 persons 1	Scratch/bruise 0.1	1.25 Very low
	Projectile (B)	Bruising	Unlikely 1	Monthly 1	1-2 persons 1	Scratch/bruise 0.1	0.1 acceptable
Put spinner in mouth	Choking (F)	Choking	Possible 2	Infrequently 0.1	1-2 persons 1	Serious temporary illness 4	0.4 acceptable
	spinfighter fits into truncated cylinder (B)	Choking	Possible 2	Weekly 1.5	1-2 persons 1	Temporary illness 1	3 Very low
	Small part (E)	Choking	Possible 2	Daily 2.5	1-2 persons 1	Serious temporary illness 4	20 Significant
	Toxic paint (E)	Poisoning	Unlikely 1	Daily 2.5	1-2 persons 1	Mild ill health effect 0.5	1.25 Very low
	Ingestion of toxic paint (B)	Poisoning	Possible 2	Weekly 1.5	1-2 persons 1	Temporary illness 1	3 Very low

The post appraisal questionnaire asked respondents what their final risk assessment was for each product. By comparison with the risk assessment scores determined via the Nomograph and Numerical method, respondent A identified the hazard of being hit by the spinner, and respondent E the possible swallowing of the spinner. Other final safety views expressed included :-

projected spinner
low risks
no real problems for age which is intended
reasonably safe if used correctly
possibly swallowing, projectile, toxic paint
low risk of laceration, even lower risk of bruising
unlikely strangulation/projectile hazards

The author's final risk assessment is consistent with the views expressed that this toy poses low risk of injury for the age intended.

Lacin' Beadin'

Initial hazards identified

In completing the pre-appraisal questionnaire, all of the Group A respondents and one respondent in Group B identified the potential choking hazard from small parts. A respondent in Group B identified the absence of instructions, the small size of the warning, and that the beads were food imitations as potential hazards at first sight. The potential hazards initially identified included:

choking hazard (3)
too small warning(1)
food imitation (1)
small parts (3)
no instructions for use (1)

When asked to indicate if any of the hazards are considered to be serious, only one respondent in Group A identified the potential choking hazard and the respondent in Group B indicated potential small parts hazards and the inadequate warning.

The author would have expected more respondents to identify through the preliminary inspection the likelihood of young children placing the fruit shapes into their mouth due to their resemblance to fruits or boiled sweets. In view of their size, and the potential to swallow/ choke or inhale these fruit shapes, this would be considered to be a serious hazard, requiring appropriate steps to be taken to prevent this foreseeable injury.

A summary of the responses recorded on the Initial Product Safety Matrix about how hazardous the product initially appeared is shown in Table 83. One respondent in each group indicated that the product initially did not appear hazardous, two respondents in each group indicated that it was hazardous due to choking or small parts hazards. The questions prompted two respondents in Group B to indicate the similarity to sweets as a hazard, and one respondent in Group A indicated a strangulation hazard due to the stretchy string. The question concerning latent or hidden hazards prompted an increase in the number of hazards identified, including strangulation, resemblance to sweets and potential toxicity of the plastic material. However, two respondents indicated there were no hidden hazards as shown in Table 83.

Table 83 : Initial Hazards & Hidden Hazards - Lacin' Beadin'

	Grp A	Grp B	
Hazardousness			
• Choking/small parts	2	2	4
• Similarity to sweets		2	2
• Strangulation	1		1
• not particularly / minimal	1		1
• not		1	1
Uncertainty - hidden hazards			
• Similarity to sweets	1		1
• Strangulation	1	1	2
• Toxicity of plastic		1	1
• No	1	1	2

Initial Product Safety Matrix : Scenario : used in bedroom by a child of 4-6 years

As with other products, the nominated scenario location was not always used as reference in completing the Initial Product Safety Matrix. All respondents commented that the Lacin' Beadin' toy could be used anywhere, although one respondent in Group A indicated that the bedroom was the most likely location. One respondent in Group B identified a potential hazard if the beads were left on the floor in areas where people might walk barefoot.

It was also apparent that respondents did not confine their comments to the target user and age as indicated at the top of Initial Product Safety Matrix and Task Analysis Matrix documents as the basis of the scenario of use being evaluated.

Product hazards

Again respondents began completion of the Initial Product Safety Matrix describing the toy rather than identifying hazards, although one respondent in Group A identified the appearance of the fruit shapes resembling unscented sweets, and one respondent in Group B identified the stretchy plastic string, querying its breaking strain as potential hazards. Two of the respondents in Group A and one in Group B made comments about the size of the beads and fruit shapes. One respondent in Group A considered that the resemblance of the fruit shapes to food would encourage children to put them into the mouth and swallow or choke on them, whereas the other commented on the small size of the pieces and the dexterity needed to play with them. The respondent in Group B commented about the small size of some of the beads causing handling difficulties, noting that some beads had sharp points, and also identified the difficulty in getting the small beads out of the container.

Portability, slipping / tripping/ falling hazards

No handling hazards had been identified on preliminary inspection and only one respondent in Group A identified a handling hazard within the Initial Product Safety Matrix. Two Group A respondents identified a tripping hazard on the Task Analysis Matrix, where beads may be spilt on the floor and trod on. One Group B respondent indicated on the Task Analysis Matrix that the container may be dropped and shatter and be trod on.

Assembly/ installation

Only one respondent in Group B indicated that assembly/installation was not required. One respondent in Group A commented that assembly was self explanatory and another Group A respondent noted that no instructions were given. Potential spillage of the beads was identified by two respondents in Group B which might enable access by younger children thinking the fruit shapes were sweets. These assembly hazards were noted by respondents completing the Numerical Task Analysis Matrix.

Materials hazards

Only one in respondent in Group B commented about the surface finish that some of the beads were irregular, badly moulded and had sharp edges or points, and one respondent in Group A queried flammability of the materials. One respondent in Group B commented that the plastic container holding the beads might shatter if dropped or stood on, which might cause sharp edges capable of causing injury, whereas a second respondent in Group B commented that non flammable materials were probably used. All respondents identified the potential of the small parts for creating a choking hazard, one from Group B commenting on the appearance of sweets which would encourage them to be swallowed. Five respondents commented about the plastic string used for threading beads onto, which might cause a strangling hazard. One respondent from each group remarked about its breaking point, commenting that it had a high breaking point, and didn't look as if it would break easily.

Motion hazards

Only one respondent in Group B identified that the two parts of the container which are screwed together present a potential motion hazard, commenting that, if overtightened, it may be necessary to force the container open and thus increase the likelihood of spilling the beads. This hazard was included on the Task Analysis Matrix.

Packaging hazards

One of the Group A respondents queried whether there may be any toxic materials as a result of the printing ink on the packaging and this hazard was listed on the Task Analysis Matrix. All of the respondents in Group B commented that the container might shatter, two commenting that this would give access to the beads, and one that this might expose sharp edges. As previously detailed, one respondent included this hazard on the Task Analysis Matrix. In contrast, one respondent in Group A commented that the plastic of the container appeared brittle but strong and that the container was too large to be swallowed. One respondent in Group B commented that the container had rough edges. Three respondents noted that the container was capable of a future use to store small items.

Use/Misuse Hazards

The Product Safety Matrix considered potential use or misuse in the consideration of cognitive factors, and in relation to the potential tasks of use and misuse as a preparation towards completion of the Task Analysis Matrix.

Five respondents detailed intended tasks for the toy, as a child's plaything, to thread beads, as a necklace and bracelet, and to play with as toy food in games such as play shops, or dolls houses. Only one respondent in Group B commented that the product's intended use was clearly conveyed on the packaging. One Group A respondent indicated that its use was self explanatory and a Group B respondent commented that its use was probably conveyed by the product name - Lacin' and Beadin'. Two Group A respondents indicated that its use was not clearly conveyed on packaging, labelling or instructions.

Two respondents in Group B and one in Group A indicated a number of foreseeable aspects of misuse, which included mistaking the fruits shapes as sweets, shooting the beads out of a pea shooter, and pushing beads/fruit shapes up the nose or putting into the mouth. Task Analysis Matrices included these misuse hazards, although the respondents completing the Nomograph method included more.

In commenting on the steps taken to prevent misuse, the Group A respondent indicated that there was a warning about choking and about age suitability on two separate labels. One of the Group B respondents noted that no other steps were taken to prevent injury other than giving a warning, another commented that steps had not been taken to avoid misuse. The third commented that the choice of fruit shapes outweighed the small parts warning. No respondents cited Home or Leisure Accident reference data as prompted within the matrix.

Deterioration and Maintenance

Only one respondent in Group B identified a potential deterioration hazard, in that the thread might break while the necklace/bracelet was in use. Only one Group B respondent noted that over tightening of the container might cause it to shatter, that beads might be spilt and lost, or that the string might break with prolonged use. No disposal hazards were identified.

Marketing

All respondents but one in Group B, commented that the target user group was clearly conveyed as being for children, although there was a difference in the age suitability expressed. Respondents indicated that the target age was for children over 3 years as indicated by the warning labels and symbols, but two of the respondents in Group B commented that the target age was 5 - 10 years, or over 5 years to enable sufficient dexterity for threading. In commenting upon the age labelling, one of the Group B respondents indicated that the age indication was very small, and one respondent in Group A commented that the age indication was given on a small label to be broken for access to the contents prior to use.

User

All respondents commented that the likely sex of the child playing with the *Lacin' and Beadin'* toy was female, two respondents in Group B qualifying this as "probably" or "maybe". However, no respondents felt that there was likely to be a sex difference in understanding or using the toy, there being no greater danger to either sex. There was broad agreement that the toy was not suitable for play by very young children, i.e. under 3 years, consistent with the small parts warning. One respondent in Group A indicated the principle age of users to be 3-6 years, one respondent in Group B indicated 5-10 years.

The potential age range was reported to be 3+ by one respondent in each group and another in Group B indicated 5+ for successful play. Four respondents indicated that there were likely to be age differences in use, commenting that small children have a tendency to put things in their mouth, younger children may have to be shown how to use the toy, and they would find the toy harder to understand. One respondent from Group A indicated that there was no reference to this in the warnings given. Views were split between one respondent in each group indicating that appropriate reference had/had not been made to age difference in the safety information supplied.

In response to questions regarding the skill levels required, only one respondent in Group A indicated that skill was required based on the age indication labelled. All of the other respondents referred to the need for physical dexterity to thread the beads. One respondent in Group A referred to the small size of the beads and one in Group B referred to fine motor skills and Left/Right handedness. However, these dexterity issues were not subsequently included on the Task Analysis Matrix. Three respondents indicated that there were no hazards arising from human errors, and particular skills and knowledge were not required. Two respondents in Group B indicated that no measures had been taken to ensure the product was only used by appropriate persons, in contrast to one respondent in Group A, who noted the measure of displaying the toy safety warning for under 36 months.

Warnings and Safety Instructions

All respondents noted the use of signal words and of the two pictorial toy safety warning symbols, and indicated that the warning identified and described the hazard. However, one Group B respondent indicated that the warning referred to small parts rather than the beads specifically. Three respondents commented that the warning did not provide instructions on what to do in the event of injury or how to avoid the hazard. All respondents noted that the warning was only on the packaging and not as close to the point of peril as possible, i.e. on the product itself.

Three respondents indicated that the warning used include simple words to convey a clear concise and complete message, and one in Group B indicated that the message was not really clear concise and complete. The remaining members of Group A gave no response. Only one respondent in Group B commented that the warning was specific regarding the consequences of ignoring it, and two respondents in Group B indicated that no instructions were given on how to avoid injury.

In considering whether the pictorial symbols used showed the hazard clearly, one respondent in Group A referred to the use of the CE mark and one in Group B indicated that symbols did not show the hazard, the consequences of ignoring the warning or how to avoid the hazard.

However, one of the respondents in Group B commented that the symbols were too small, and another commented that picture showed who should not play and did not show the hazard clearly. Four respondents (3 in Group B and 1 in Group A) commented that the warning was too small, one Group B respondent commenting that it was almost unreadable. In contrast one of the Group A respondents commented that warnings were visible and the label with the warning needed to be broken for access to the product. A respondent from each group also commented that the band around the product with the warning acted as a conspicuous seal and needed to be broken for access to the product. A Group A respondent noted that warnings were attached to packaging in two places, but a Group B respondent noted that the warning on the pack side was blurred. One respondent from Group A also commented that the warnings could be larger.

One Group A respondent commented that the warnings were fairly durable and would not come off during use, in direct contrast to a Group B respondent who queried whether the warning was attached permanently, as it could be picked off. Another respondent from Group B referred to the instructions "Keep For Future Reference".

Task Analysis Matrix

The Lacin' Beadin' was subject to the Nomograph method of risk assessment by authorities B, E and F, and the Numerical method by authorities A, C and D. Tables 84 and 85 summarise the tasks identified, the associated hazards and injuries and risk assessment scores using the Nomograph and Numerical methods. The two methods demonstrated some differences in the phases of use recorded and the injuries and outcomes, as shown in the Tables.

Respondents using the Nomograph method identified only one hazard considered to have a "significant" risk of injury :-

- the risk of the choking/ swallowing inhalation of the food imitation fruit shapes (62)

Table 84 : Comparison of risk assessments : Lacin' Beadin' : Nomograph Method

Task	Hazard	Potential Injury	Maximum Injury	Probability	Likelihood of Recognition	Initial Risk Assessment	Availability	Final risk Assessment
Break seal undo container	Ingestion of toxic inks be chewing on print (B)	Poisoning	Moderate	Possible	Possible	37 Very low	General	37 Very low
	No hazard (F)							
Use Place toy ready for use - Thread beads onto string *(Access to beads can also occur at interrupt task stage, take beads apart & store)*	Child pushes beads up nose (F)	Bruising	Minor	Possible	Improbable	38 Very low	Limited/ general	34 Very low
	Swallow small parts (B)	Choking	Death	Possible	Probable	46 Low	General	45 Low
	Small parts - food imitations (E)	Choking/ swallowing / inhalation	Death	Possible	Possible	62 Significant	General	62 Significant
	Place fruit shapes in mouth (F)	Choking	Serious	Probable	Probable	50 Moderate	Limited/ general	39 Very low
Wear item round neck	Strangulation by string (B)	Choking	Death	Possible	Probable	46 Low	General	45 Low
	Another child tugs beads strangulation (F)	Strangle / bruising	Moderate	Probable	Probable	39 Very low	Limited/ general	29 Very low

The respondents in the group using the Numerical method identified more phases of use, and identified misuse and storage hazards. This group also identified a wider range of potential injuries.

Four respondents using the Numerical method identified two hazards considered to have a "high" risk of injury:-

- the risk of swinging beads damaging the eyes of another child (100)
- the risk of a child choking on the beads (three respondents) (75);

and two hazards were identified by respondents to have a "significant" risk of injury:-

- the risk of strangling by a necklace caught in play (50)
- the risk of an adult treading on beads and injuring their feet (50).

Table 85 : Comparison of risk assessments : Lacin' Beadin' : Numerical Method

Task	Hazard	Potential Injury	Probability of Exposure	Frequency of Exposure	No. of Persons at Risk	Maximum Probable Loss	Hazard Rating
Twist top take out contents Spill beads	Step on (D) Put in mouth (D)	Bruising Choking	Possible 2 Unlikely 1	Monthly 1 Annually 0.2	1-2 persons 1 1-2 persons 1	Scratch/ bruise 0.1 Minor permanent illness 2	0.2 acceptable 0.4 acceptable
	Trip on beads (C)	Bruising	Unlikely 1	Infrequently 0.1	1-2 persons 1	Scratch/ bruise 0.1	0.01 acceptable
Drop container & shatters	Step on container pieces (D)	Cut Bruise	Possible 2 Unlikely 1	Monthly 1 Monthly 1	1-2 persons 1 1-2 persons 1	Scratch /bruise 0.1 Scratch/ bruise 0.1	0.2 acceptable 0.1 acceptable
Use Put beads ready for threading	Adult/child treads on beads (A)	Injure foot	Even Chance 5	Constantly 5	3-7 persons 2	Minor temporary illness 1	50 Significant
	Child puts beads in mouth (A)	Gagging / possibly choking	Possible 2 Unlikely 1	Constantly 5 Constantly 5	1-2 persons 1 1-2 persons 1	Minor temporary illness 1 Fatality 15	10 Low 75 High
	Child mistakes as sweets (unattended more risk) (D)	Choking	Even chance 5	Monthly 1	1-2 persons 1	Fatality 15	75 High
Put string round neck	Necklace caught during play (D)	Strangulation	Unlikely 1	Monthly 1	1-2 persons 1	Minor temporary illness 1	1 Acceptable
	Necklace caught during play (A)	Strangulation	Even chance 5	Constantly 5	3-7 persons 2	Minor temporary illness 1	50 Significant
Misuse Swing beads round	Catch other child in face, (A)	Damage to eyes	Even chance 5	Constantly 5	1-2 persons 1	Loss of eye 4	100 High
	Used as play food (A)	Gagging / possibly choking	Possible 2 Unlikely 1	Constantly 5 Constantly 5	1-2 persons 1 1-2 persons 1	Minor temporary illness 1 Fatality 15	10 Low 75 High
Store beads in toy box	Access by other children - like sweets (D)	Choking	Possible 2	Infrequently 0.1	1-2 persons 1	Fatality 15	3 Very low

Table 86 lists the hazards identified by respondents using the Numerical method considered to have a *High* or *Significant* risk of injury. It also shows the risk assessment score for each risk as identified by respondents using the Nomograph method.

Thus while both methods identified the risk of a choking injury posed by using small fruit shapes, in this evaluation, respondents using the Numerical method identified more hazards likely to cause injury. Of these, the risk of injury from the necklace being swung around, or of an adult stepping onto the spilled beads appear to be spuriously high. It is interesting that two respondents using the different methods considered the risk of strangling from the necklace during play, but that the risk assessment scores ranged from very low/low for those using the Nomograph to Acceptable/Significant for those using the Numerical method.

Table 86 : Summary of Numerical and Associated Nomograph Risks identified

The risk of :-	Numerical		Nomograph	
	High	Significant	Significant	Low/ V. Low
swinging beads round & damaging eyes	(100)			
choking on beads/fruit shapes	(75)		(62)	
strangling by necklace		(50)		(45) Low (29) V Low
tread on spilled beads and bruising feet		(50)		

The post appraisal questionnaire asked respondents what their final risk assessment was for each product. By comparison with the risk assessment scores determined via the Nomograph and Numerical method, respondent A identified an accidental strangulation hazard, and respondents D and E identified a serious swallowing hazard due to the resemblance of the beads to sweets.

The final safety views expressed included :-

accidental strangulation
low to moderate risk, imitation food depending upon age
no real problems for age which is intended
Quite unsafe - beads like sweets for age of likely use
serious swallowing hazard beads look like sweets
low risk of choking, very low strangulation

The final risk assessments identifying the risk of a swallowing and/or choking on the fruit shaped beads best match the author's expected risk assessment.

Electric Kettle

Initial hazards identified

In completing the pre-appraisal questionnaire three respondents in Group A and one in Group B identified a number of electrical safety hazards at first sight:

illegal/non BS plug (2)
wiring (1)
unsleeved pins (2)
access to live parts (1)

Two of the three respondents in Group A also identified:

contact with boiling water/steam (1)   boiling water (1)

When asked to identify any serious hazards, the respondent in Group B indicated access to live parts and one of the respondents in Group A indicated electricity and scalding. Thus, only one of the respondents noted the principal hazard for which the product was selected by the author for evaluation, i.e. the position of the steam vents, and the possibility that steam would vent onto the user's hand.

Electrical Safety legislation prohibits the sale of electrical appliances with an "old style" 3 pin plug fitted, i.e. one which did not have sleeved non earth pins. The old style plug is typical of an electrical appliance in use in the home, or as might be supplied via a "private sale" at a car boot sale. The absence of a wiring information sticker on the supply cable is also a contravention of safety legislation where electrical appliances are supplied with removable plugs. Four of the respondents commented on the initial electrical hazards evident on preliminary inspection of the kettle.

A summary of the responses recorded on the Initial Product Safety Matrix about how hazardous the kettle initially appeared is shown in Table 87. Two of the respondents indicated that the Kettle did not initially appear to be hazardous. Four respondents indicated that it initially did not appear to be particularly hazardous.

Table 87 : Initial Hazards & Hidden Hazards : Jug Kettle

	Grp A	Grp B	
Hazardousness			
• not particularly	3	1	4
• not		2	2
Uncertainty - hidden hazards			
• Immersion in water	1	2	3
• Steam vents	3	2	5
• Boil dry	1	1	2
• Plug & wiring	1		1
• Supply lead in water	1		1

When asked to indicate if there were any latent or hidden hazards, three respondents identified hidden hazards due to potential immersion in water (for which a warning was given underneath the kettle), five respondents identified the possible steam vent hazard, two respondents considered the potential to boil the kettle dry, one respondent identified the plug and wiring, and another identified the possibility of the supply lead trailing into water.

Initial Product Safety Matrix : Scenario - used in kitchen by an adult of 65-70 years

As with other products, wider scenarios of use than the nominated scenario location were used to as reference in completing the Initial Product Safety Matrix. All respondents commented that the kettle would most likely be used in the kitchen, although a Group B respondent included living room, dining room and bedroom to the list of likely locations for use. It was also apparent that respondents did not restrict their comments to the target user and age as indicated at the top of Initial Product Safety Matrix and Task Analysis Matrix documents as the basis of the scenario of use being evaluated. A number of the hazards subsequently identified were not specific to the nominated age group.

In considering unsuitable locations for use all respondents indicated that the bathroom was unsuitable, and four respondents (3 from Group A and 1 from Group B) indicated that outdoors was an unsuitable location. Respondent B indicated that use outdoors was unsuitable as the kettle might be subject to moisture ingress as it was not "IP" rated. One Group B respondent also suggested that it should not be placed on the floor in any room in case it was kicked over, and another in Group B suggested it should not be used in the bedroom.

Product

In describing the kettle components, all respondents indicated a number of potential hazards. All respondents from Group A and two of Group B commented that the kettle was quite stable. All respondents from Group A and two of Group B noted that the fill indicator and maximum/minimum capacity was marked inside the kettle and would therefore not be visible unless the lid were removed for filling, which might lead to under or over filling. Five respondents commented that its heaviness would depend on how full it was filled with liquid. One respondent from Group A queried its ease of use by the elderly or disabled when full. Another Group A respondent commented that it was "front heavy" when filled, and a respondent from Group B commented that it balanced awkwardly in the hand. In contrast, one respondent in Group A considered that it was easy to hold and comfortable.

Two of the respondents from Group B and one from Group A commented that there was a separate supply flex, described as "short" by one respondent and measured as approximately 1 metre by 2 respondents. One of the respondents in Group A noted that the plug fitted was not BS approved, and had been wired incorrectly, in that the Earth supply lead would become taut before the Neutral.

The questions within the Initial Product Safety Matrix therefore prompted recognition of a wider number of potential hazards than respondents identified on the preliminary inspection.

Portability, slipping / tripping/ falling hazards

All respondents commented that the kettle was portable, and two respondents in Group B and one in Group A indicated potential tripping/slipping instances when carrying the kettle of hot water which might give rise to injury. Five respondents also noted the potential for a child to grasp the relatively long trailing cable on a work top while the kettle was in use, potentially pulling the kettle off the work surface and spilling its contents. No tripping or falling hazards had been identified on preliminary inspection. Two respondents subsequently recorded the potential for a child to pull the kettle off the worktop on the Nomograph Task Analysis Matrix.

One respondent from each group also commented about the potential use of the supply cable still plugged into the mains but disconnected from the kettle, or as it was difficult to disconnect the kettle from its supply cable, the possibility of filling the kettle while still plugged into the mains. One respondent recorded the potential for the kettle to be used in this way as a hazard on the Numerical Task Analysis Matrix.

A number of other tripping or handling hazards were identified by respondents within the Task Analysis Matrix, in moving the kettle to its place of use.

Assembly/ installation

The kettle was provided ready for use. Two respondents from Group A and one from Group B commented that rewiring instructions should have been provided for the plug. Two respondents in Group A commented that the plug which was fitted was non approved, one respondent indicated that it was illegal. Two respondents recorded wiring hazards on the Nomograph Task Analysis Matrix.

Materials hazards

All respondents indicating that the surfaces were smooth with no sharp edges or points, and one respondent in Group A commenting that the kettle poured well. One respondent in each group queried the flammability of materials used, which were not tested, and one respondent in Group B queried toxicity. A number of views were expressed about the potential for the supply cord posing a strangulation hazard. Five respondents remarked about this potential, but this was considered unlikely, and one respondent from Group B considered it to be more likely to cause the kettle to be toppled by a child. One respondent in Group B indicated that the supply cable may be plugged into the mains at one end, and the kettle end left disconnected and trailing in water on the work surface. One respondent in Group B indicated possible pinching hazards caused by the on/off switch or in connecting the socket on the kettle. Other than the hazards regarding children pulling the kettle off the worktop by its flex, and the kettle being filled whilst still plugged into the mains, as detailed above, these hazards were not subsequently included on the Task Analysis Matrix. However, one respondent from Group B referred to immersing the kettle in liquid during cleaning as a potential hazard on the Task Analysis Matrix.

Motion hazards

Five respondents identified moving parts of the on/off switch but did not comment that this presented any hazards in using the kettle. Although three respondents commented about a potential entanglement hazard of the supply lead, this was not subsequently included on the Task Analysis Matrix. One respondent from each group commented about the automatic cut out switch when the kettle boiled as a safeguard measure, and one respondent included boiling dry as a possible hazard on the Nomograph Task Analysis Matrix.

Electrical Hazards

There was a wide range of difference in the extent of electrical examination. As the kettle was non-functioning, no respondent could "user test" its operation. However, some respondents opened the plug to examine its wiring, and some commented in detail on the rating information provided. Respondent B commented on the incorrect tension on leads within the plug which might lead to a short circuit and potential injury. None of the respondents identified metal parts which might be placed in an electrical outlet by a child, other than the plug. In commenting about measures undertaken to protect from electrical shock, one respondent from Group A commented that the lead was double insulated, one respondent from Group B commented that it was assumed that the plug was fused and earthed, and another commented that the live and earth pins were not appropriately sleeved. One respondent in Group B commented that the plug was not opened to check earthing, and another commented that the appliance was BEAB approved.

One respondent from each group indicated that interlocks were not provided to interrupt electrical power when covers/doors were opened. A respondent from Group A indicated that boil dry protection and an automatic cut out switch were provided to protect from short circuits. One respondent from each group indicated that there were no electrostatic hazards. Three respondents commented about the warning provided on the underside of the base not to immerse the kettle in liquid, a respondent in Group B remarking that the kettle had to be inverted to read it. Five electric shock hazards were subsequently identified by respondents using the Nomograph Task Analysis Matrix, and six electric shock hazards were subsequently identified by respondents using the Numerical Task Analysis Matrix.

Thermal Hazards

Only one respondent in Group B indicated that internal heating elements could be touched. The remaining five respondents indicated that elements could not be touched when the kettle was in use.

All respondents indicated the likelihood that the kettle body would get hot in use. However, respondents indicated that they considered the shape and distance of the handle from the body in assessing whether the hand was likely to touch the kettle body in use. Only one respondent in each group indicated that the hand might touch the kettle body. A respondent in Group B indicated that there was 30 mm clearance between the handle and kettle body.

All respondents indicated that they had considered the position of the steam vents at the top of the handle to determine whether they vented steam away from the user. One respondent in Group A noted that their location was not particularly obvious, another commented that it was possible to place the thumb over a steam vent when lifting the kettle, and the third indicated that the vents might contact the skin. Two of Group B respondents also noted that the steam may be directed onto the user, or may come into direct contact if held at an extreme angle. Only one Group B respondent incorrectly commented that the steam vents vented steam away from the user. Thus, the questions included within the Initial Product Safety Matrix focused the respondents on considering the steam vent hazard, such that five respondents included this hazard in the Task Analysis Matrix.

Chemical Hazards

Four respondents indicated an indirect chemical hazard associated with use of a descaler to deal with hard water and limescale build up, although the Scottish respondent indicated that limescale build up is not a problem in Scotland. One respondent in Group A identified possible skin irritation and inhalation hazards in the use of descaling products.

Although two Group A respondents identified no chemical hazards within the Initial Product Safety Matrix, it is interesting that chemical hazards associated with descaling the kettle were identified by one Group A respondent on the Numerical Task Analysis Matrix and by two Group B and one Group A respondent on the Nomograph Task Analysis Matrix.

Use/ Misuse Hazards

The Product Safety Matrix considered potential use or misuse in two places; as part of the consideration of cognitive factors, and in relation to the potential tasks of use and misuse as a preparation towards completion of the Task Analysis Matrix. Two respondents in Group B cited Home or Leisure Accident reference injury data as prompted within the matrix.

A number of foreseeable aspects of misuse were indicated, which included using the kettle in the bathroom (1 in each group), using it with an extension cable(Group B), using it outdoors (Group A), or in a situation where water might get into the socket (Group B). All respondents commented on the possibility of over filling, particularly as the fill gauge was not visible from outside. One respondent in each group identified the possibility of spillage, particularly when the kettle was taken to the place of use. In terms of measures taken to prevent potential misuse, respondents indicated that an exterior fill gauge should be fitted to prevent overfilling. Two respondents from Group A commented that the warning to avoid immersion was inappropriately placed, requiring the kettle to be inverted to read the warning. One respondent from Group B commented that the supply flex was difficult to unplug from the kettle and as a consequence, that the kettle might be filled while still plugged into the mains.

In response to section 6 of the Initial Product Safety Matrix all respondents listed boiling water as an intended task for the kettle. One respondent in each group listed other applications, including for drinks, washing up, cooking, filling baths and sinks etc. All respondents listed potential tasks for reasonably foreseeable misuse, including using with an extension lead (2), taking it to a remote location/trips (3), in a place where it might be knocked over (2), where a child might get easy access (3), by children who do not understand dangers of boiling water (1) immersed in liquid (2), in a steamy/damp location (1), over filling (1), cleaning with incorrect cleaner(1). A number of these tasks were also included within the Task Analysis Matrix.

Deterioration

One respondent in Group A identified water immersion as an element of physical deterioration which was addressed by the warning on the underside of the kettle. Another respondent in Group A also identified wear/damage to the supply flex and indicated that an instruction should have been given to replace it in case of damage. A respondent in Group B commented on potential wear of the plug, and the possibility that water might get into the kettle socket with prolonged use.

Five respondents (2 in Group A and 3 in Group B) indicated measures to be taken to deal with limescale build up during product use. Of these, two respondents in Group A and one in Group B indicated that instructions were necessary about limescale removal, and one Group A respondent indicated that some proprietary chemicals might damage a plastic kettle, thus prompting the need for suitable warnings/safety instructions. Maintenance information about the product was not provided, but most of the respondents considered this section of the matrix to be inapplicable. One respondent in each group referred to the absence of advice about descaling.

Marketing

A respondent from Group A commented that the target user group was adults and children over 8 years, and a respondent from Group B commented that there was no obvious age for use, as kettles can be used by everyone. Respondents commented that the target user group was not apparent, although commented that this might have been conveyed on packaging which would have been supplied with the kettle when new. Again, as there were no instructions for use supplied, two respondents in Group B commented that the questions about intended use were not applicable. One respondent from Group A commented that as kettles are familiar, most users would know their intended use, but criticised the location of the warning about water immersion under the base as not being a logical place, being viewable only when the kettle was upside down.

User

All respondents commented that there was no significant sex or age for users, or difference in their understanding of how to use the kettle, although one respondent in Group B commented that the kettle would be mostly used by adults or older children. One respondent in each group indicated that elderly users may have difficulty in using this design of kettle.

One respondent in each group commented that no major skills were required to use the kettle, but another respondent from each group commented on possible difficulties in use by the young or elderly. The Group B respondent suggested that jug kettles are harder to balance than traditional top held kettles, and this may create difficulties for the elderly or disabled users. One respondent from each group indicated the possibility of an overfilling hazard arising from human error, the Group B respondent also referring to trips and scalds. It would appear that the hazards identified on the completed Task Analysis Matrices causing potential burn or scald injuries are linked to these user comments.

Warnings and Safety Instructions

All respondents noted the warning on the underside of the kettle in their responses to different questions of the checklist, commenting that the warning was not as close to the point of peril as possible. As it was located on the base of the kettle, one Group B respondent indicated that it could only be viewed when the kettle was not in use, two respondents from each group commented that the warning could not be read from normal viewing angles. The Group B respondents commented that it could not easily be read, and it could only be read when there was no water in the kettle.

Only one respondent from Group B indicated that the warning identified and described the hazard, the other respondents indicated that it did not provide instructions on what to do in the event of injury or how to avoid the hazard. Three respondents commented that the warning was not specific regarding the consequences of ignoring it, and did not indicate instructions on how to avoid injury.

One respondent from each group indicated that there were no pictures or symbols, and one in Group B commented that this was not applicable. Two respondents in Group A described the labels and warnings about capacity ratings load limits etc., one of these commenting that no hertz rating was indicated as required. One respondent in Group B commented that the ratings label was well stuck to the base of the kettle. All respondents indicated that the warning was sufficiently durable to withstand the rigours of use.

Task Analysis Matrix

The Haden Jug Kettle was subject to the Nomograph method of risk assessment by authorities B, E and F, and the Numerical method by authorities A, C and D. Tables 88 and 89 summarise the tasks identified, the associated hazards and injuries and risk assessment scores using the Nomograph and Numerical methods.

As the Tables show, the Kettle evaluation by respondents elicited the greatest number of potential tasks with associated hazards and injuries on the Task Analysis matrices than any other products evaluated. In addition, although there are similarities in the overall phases of use identified, the final risk assessment outcomes using the Nomograph and Numeric methods are quite different.

The respondents using the Nomograph method identified 13 hazards which had a final risk assessment of high, significant or moderate. These hazards and risk assessments identified are summarised in Table 90, which shows the different levels of risk assessed by the respondents using the Nomograph for the same hazard. It also compares the risk assessment score where each hazard was also identified using the Numerical method.

Table 88 : Comparison of risk assessments : Jug Kettle : Nomograph Method

Task	Hazard	Potential Injury	Maximum Injury	Probability	Likelihood of Recognition	Initial Risk Assessment	Availability	Final risk Assessment
Install Plug	Unsleeved pins (B)	Electric shock	Death	Possible	Possible	57 Significant	Widespread	75 High
	Touch live parts (F)	Shock	Serious	Possible	Possible	52 Moderate	General	51 Moderate
	Plug wiring (B)	Electric Shock	Serious	Unlikely	Possible	53 Moderate	General	71 High
Fill with water	Overfill/spurt water (F)	Burn /scald	Serious	Possible	Possible	52 Moderate	General	51 Moderate
	Overfill / boil over (B)	Scald	Minor	Possible	Probable	13 Remote	Widespread	34 Very low
Use Kettle boils	Steam vents scald (B)	Scald	Minor	Possible	Possible	29 Very low	Widespread	50 Moderate
	Steam vents scald (F)	Scald	Serious	Probable	Improbable	78 Very high	General	73 High
	Scald from vents (E)	Scald	Moderate	Possible	Probable	29 Very low	General	50 Moderate
Take kettle to cup	Trip/slip /spill (F)	Burn/ scald	Serious	Possible	Probable	41 Low	Widespread	38 Very low
	Slip/trip/ scald (E)	Scald	Serious	Possible	Probable	38 Very low	Widespread	58 Significant
Pour water into cup	Spill hot liquid (F)	Burn / scald	Serious	Possible	Probable	41 Low	General	28 Very low
	Drop due to weight (B)	Scald	Serious	Possible	Probable	40 Low	Widespread	58 Significant
	Burn hand (E)	Burn	Minor	Possible	Possible	28 Very low	Widespread	51 Moderate
	Touch hot sides (B)	Burn	Minor	Unlikely	Probable	4 Remote	Widespread	34 Very low
	Burn hand on body (F)	Burn	Moderate	Possible	Possible	41 Low	General	59 Significant
Long cord/flex pulled by child	pull kettle off worktop (B)	Scald	Serious	Possible	Possible	50 Moderate	Widespread	68 Significant
	pull kettle off worktop (F)	Burn / scald	Serious	Probable	Possible	62 Significant	General	60 Significant
Refill	Overfill (D)	Scald	Minor	Possible	Probable	13 Remote	Widespread	34 V low
	Remove lid while hot (F)	Steam scald	Moderate	Possible	Possible	41 Low	General	41 Low
	Remove lid while hot (E)	Scald	Moderate	Possible	Possible	41 Low	Widespread	61 Significant
Clean	Immerse in water (B)	Electric shock	Death	Unlikely	Possible	53 Moderate	Widespread	71 High
Descale	Use wrong cleaner (B)	Poisoning	Serious	Possible	Possible	50 Moderate	Widespread	68 High
	Use descaler (F)	Inhale fumes Skin irritation	Moderate Moderate	Possible Possible	Possible Probable	41 Low 55 Moderate	General General	41 Low 53 Moderate
	Toxic Fumes (E)	Poisoning Inhalation	Moderate Moderate	Possible Possible	Possible Probable	41 Low 29 V low	General General	41 Low 43 Low
Misuse Boil Dry	Element burns out (B)	Fire	Serious	Unlikely	Possible	41 Low	Widespread	59 Significant
Use where wet /steamy	Bathroom (F)	Shock	Critical	Possible	Probable	48 Moderate	General	46 Low

Table 89 : Comparison of risk assessments : Jug Kettle : Numerical Method

Task	Hazard	Potential Injury	Probability of Exposure	Frequency of Exposure	No. at Risk	Maximum Probable Loss	Hazard Rating
Transport kettle home	Bulky/ awkward box (A)	Muscle strain/ drop on foot	Possible 2	Constantly 5	1-2 persons 1	Scratch/ bruise 0.1	1 Acceptable
Fill kettle	Still plugged into mains (D)	Electrocution	Unlikely 1	Daily 2.5	1-2 persons 1	Minor temporary illness 1	2.5 Very Low
	Overfill (A)	Burn / scald	Possible 2	Constantly 5	1-2 persons 1	Mild ill health effect 0.5	5 Very Low
	Overfill don't lift lid (D)	Boil over and scald	Possible 2	Daily 2.5	1-2 persons 1	Minor temporary illness 1	5 Very low
	Wet hands when filling (D)	Electrocution	Unlikely 1	Daily 2.5	1-2 persons 1	Minor temporary illness 1	2.5 Very low
	Unsleeved earth pins (A)	Electric shock	Possible 2	Daily 2.5	1-2 persons 1	Minor temporary illness 1	5 Very low
Use Boil kettle & pour water into receptacle	Steam from vents & spout (D)	Scald	Possible 2	Daily 2.5	1-2 persons 1	Mild ill health effect 0.5	2.5 Very Low
	Steam vent - handle (A)	Burn / Scald	Even chance 5	Constantly 5	1-2 persons 1	Minor temporary illness 1	25 Significant
	Scalded by steam (D)	Scald	Possible 2	Daily 2.5	1-2 persons 1	Mild ill health effect 0.5	2.5 Very Low
	Burn hand on kettle (A)	Burn / Scald	Even chance 5	Constantly 5	1-2 persons 1	Minor temporary illness 1	25 Significant
	Touch kettle body (C)	Burn	Unlikely 1	Daily 2.5	1-2 persons 1	Mild ill health effect 0.5	1.25 Very Low
	Drop kettle / miss cup (D)	Burn	Possible 2	Daily 2.5	1-2 persons 1	Minor temporary illness 1	5 Very Low
	Trip with kettle & spill (C)	Burn Burn	Unlikely 1 Even chance 5	Daily 2.5 Daily 2.5	1-2 persons 1 1-2 persons 1	Mild ill health effect 0.5 Mild ill health effect 0.5	1.25 Very Low 6.25 Low
Move kettle to another area	Trip/spill (D)	Scald	Unlikely 1	Annually 0.2	1-2 persons 1	Mild ill health effect 0.5	0.1 Acceptable
	Trip/spill (A)	Bruise Burn / scald	Possible 2 Even chance 5	Hourly 4 Hourly 4	1-2 persons 1 1-2 persons 1	Minor temporary illness 1 Minor temporary illness 1	8 Very Low 20 Significant
Refill	Overfill (A)	Boil over burn/ scald	Possible 2	Hourly 4	1-2 persons 1	Minor temporary illness 1	8 Very Low
	Touch kettle body (C)	Burn	Possible 2	Daily 2.5	1-2 persons 1	Mild ill health effect 0.5	2.5 Very Low
	Scalded by steam (C)	Burn	Even Chance 5	Daily 2.5	1-2 persons 1	Mild ill health effect 0.5	6.25 Very Low
	Scalded by steam (D)	Scald	Possible 2	Daily 2.5	1-2 persons 1	Mild ill health effect 0.5	2.5 Very Low
	Spill while refilling (D)	Electrocution	Unlikely 1	Daily 2.5	1-2 persons 1	Minor temporary illness 1	2.5 Very Low
Clean work area	Burn hand on kettle (C)	Burn	Possible 2	Weekly 1.5	1-2 persons 1	Mild ill health effect 0.5	2.5 Very Low
Use descaler	Fumes (C) Chemicals (C)	Poisoning /inhalation Skin irritation	Unlikely Possible 2	Annually 0.2 Annually 0.2	1-2 persons 1 1-2 persons 1	Minor temporary illness 1 Minor temporary illness 1	0.2 Acceptable 0.4 Acceptable
Use damp cloth	Contact live parts (D)	Electrocution	Unlikely 1	Monthly 1	1-2 persons 1	Minor temporary illness 1	1 Very Low
	Immerse in liquid (D)	Electrocution	Unlikely 1	Infrequently 0.1	1-2 persons 1	Minor temporary illness 1	0.1 Acceptable

For example the risk of scalding from the steam vents was assessed by respondent F as High, and by respondents B and E as Moderate. Similarly, the risk of burning the hand on the kettle body was assessed by respondent F as Significant, and by respondent E as moderate.

Although the respondents completing the Numerical Task Analysis Matrix identified broadly similar hazards as those respondents using the Nomograph Task Analysis Matrix, the majority of hazard ratings determined were determined to be Low, very low or acceptable. However, the respondents using the Numerical method identified three hazards which were considered to have a "significant" risk of injury:-

- the risk of burn/scald from steam vents (25)
- the risk of burn/scald from hand touching the kettle body (25)
- the risk of burn/scald due to trip/spill in moving kettle to another area (20)

The Nomograph and Numeric methods indicated different hazards for the Diabolo and Turbo Launcher, and showed some similarities in the risk assessment of the Lacin Beadin. Although there are some similarities in the hazards considered to pose a significant risk, there are broad differences in risk assessment between the two methods in evaluating the kettle as shown in Table 90.

Table 90 : Summary of Nomograph and Associated Numerical Risks identified

	Nomograph			Numerical		
The risk of :-	**High**	**Significant**	**Moderate**	**Significant**	**Low V. Low**	**Acceptable**
electric shock from un-sleeved pins	(75)				(5)	
scalding from steam vents	(73)		(50) (50)	(25)	(2.5) (2.5)	
electric shock from incorrectly wired plug	(71)					
electric shock from immersion of kettle in water	(71)					(0.1)
scalding if kettle pulled off worktop by flex		(68) (60)				
poisoning from use of wrong descaler/cleaner		(68)				(0.2)
scalding in removing lid of recently boiled kettle to refill		(61)			(6.25) (2.5)	
burning the hand on the kettle body		(59)	(51)	(25)	(1.25)	
fire and injury if element burns out when kettle boils dry		(59)				
scald following a slip/trip with kettle		(58) (58)		(20)		
skin irritation due to use of descaler			(53)			(0.4)
touching live parts			(51)		(1)	
scalding due to overfilling & spurting boiling water			(51)		(8)	

It is very interesting to consider why this dramatically divergent risk assessment outcome between the two methods might have occurred in appraising the kettle. The risk of injury from unsleeved pins on the plug is considered by the author to be a spuriously high assessment, given that many domestic homes include a number of electrical appliances with similar plugs fitted. With the exception of the steam vents hazard and the absence of an external fill level indicator, the other hazards would apply to any model of kettle.

The post appraisal questionnaire asked respondents what their final risk assessment was for the kettle. The final safety views expressed demonstrated the most negative final risk assessments to date, i.e. indicating potential safety problems, including :-

Spillage, steam venting in age group concerned
Some high risks - needs new plug
The most obvious hazardous product
Reasonably safe except unsleeved plug
Possible burning/scalding if misused
Highest risk from steam vent scald, significant risk of child pulling off worktop

The views expressed by the first and last respondent best match the author's expected risk assessment for the jug kettle.

Disney Ball

Initial hazards identified

In completing the pre-appraisal questionnaire, only one respondent in each group recorded potential safety hazards which were apparent on preliminary inspection:

removable plug/small parts (2)
toxicity (1)
address & warnings unsuitable (1)
choking hazard (1)
paint? (1)

When asked to indicate if any of the hazards are considered to be serious, the respondent in Group B indicated the small parts and paint.

The toy ball was selected by the author particularly because of its hazardous removable closure. The author would have expected an initial examination to identify the potential choking hazard posed by the small black closure, as a ball cut into two halves showing the closure in cross section was provided together with the complaint sample and another similar toy ball.

A summary of the responses on the Initial Product Safety Matrix about how hazardous the product initially appeared is shown in Table 91.

Table 91 : Initial Hazards & Hidden Hazards

	Grp A	Grp B	
Hazardousness			
• Closure/ choking	1		1
• not particularly / minimal	1		1
• not	2	3	5
Uncertainty - hidden hazards			
• Detached stopper/ choking	3	2	5
• Left in wrong place/ trip		1	1
• Thrown at breakable object		1	1
• Flammable/toxic materials	1		1

Five respondents indicated that the toy ball initially did not appear hazardous, and the remaining respondent indicated that it did not appear particularly hazardous. When asked to identify any hidden hazards, whereas three respondents had indicated the potential choking or small parts hazard in the pre-appraisal questionnaire, five respondents indicated a hidden choking hazard posed by the closure.

Initial Product Safety Matrix : Scenario - used in Living Room by a Toddler of 18 mths

Despite being asked to consider a scenario of use of the toy ball in the living room by a toddler, the circumstances of use and misuse considered by respondents as evidenced by their responses were much wider. All respondents commented that the ball could be used anywhere, indoors or outdoors. Two respondents in each group identified potential hazards including leaving the ball on the floor, at the top of stairs or in passages, or in the kitchen when carrying hot food which was likely to present a tripping hazard. In addition, one respondent in Group A indicated that playing with the ball near a road was potentially hazardous as children concentrated on the ball and not the road and traffic. One respondent in group B cited breakage which might occur if the ball were thrown at items indoors.

Product Hazards

In completing the Initial Product Safety Matrix the respondents largely described the toy rather than the hazards. However, one respondent in each group identified a potential hazard if the ball toppled onto the floor. In considering the size and dimensions of the ball, one respondent in Group A and two in Group B made comments about the diameter of the ball, and how easy it would be to hold. One respondent in each group commented about how the ball would be held by users, the respondent in Group A commenting that the ball fits into the palm of an adult but could not be held by a child, the respondent in Group B suggested a child would need to hold the ball in two hands.

Portability, slipping / tripping/ falling hazards

Two respondents in each group commented that there would be a tripping hazard if the ball was left in an unsuitable place and only one respondent in Group B commented that there were no slipping/tripping hazards. Tripping hazards were included in the Task Analysis Matrix by five of the respondents. One respondent from each group commented that the ball would fit into an adult hand, and a respondent from group a indicated that the ball could be used as a hand or foot toy.

Material hazards

All of the respondents commented that the ball had a smooth finish, but one respondent from each group commented about the prominence of the hard black plug, the Group A respondent querying whether this might injure if this part of the ball impacted onto another child's head. Two respondents in each group queried whether the material was flammable or toxic, another respondent in Group A querying the toxicity of paint or dyes. Two respondents in Group B indicated that the material was unbreakable/shatterproof, but one respondent in each group queried whether the ball might burst if it hit a point or sharp edge. All respondents identified the potential of the small black stopper to create a choking hazard for children under 36 months.

Only one respondent from Group B did not include the choking hazard in the Task Analysis Matrix which was posed by the black stopper.

Motion hazards

Four respondents indicated that this section of the matrix was not applicable as the toy had no moving parts. However, one respondent in Group A commented that the toy as a whole would be used in motion. One respondent in each group indicated that the ball posed potential hazards of impact, or ejection of the black stopper. Two of the respondents using the Nomograph Task Analysis Matrix included impact hazards.

Chemical and Thermal hazards

One respondent in Group A queried whether flammable materials had been used for the ball although this hazard was not subsequently included within the Task Analysis Matrix. Two respondents in Group B and one in Group A queried potential chemical hazards posed by the toxicity of paints and inks in their responses to the Initial Product Safety Matrix and also included a potential toxicity hazard from a child chewing the ball in the Task Analysis Matrix.

Packaging hazards

Although the product was supplied without packaging, one of the Group A respondents applied this section of the Initial Product Safety Matrix to the properties of the ball rather than packaging.

Use/Misuse hazards

Responses to the Initial Product Safety Matrix sought information about potential use or misuse in considering cognitive factors and subsequently at the end of the appraisal process, prior to commencing the Task Analysis Matrix. Only two respondents, one in each group indicated a number of foreseeable aspects of misuse, which included leaving the ball in an inappropriate place (e.g. the top of the stairs) and throwing it at a breakable object. One respondent from each group indicated that the ball could not be used in a dangerous activity, and three respondents indicated that it was not capable of misuse other than for the purposes intended. One respondent in Group B commented that no steps could be taken to reduce the likelihood of misuse.

In response to section 6 of the matrix, five respondents detailed intended tasks for the toy, including a child's plaything, to throw, catch, roll, squeeze, kick, use with bats, throw for a pet to return, and to collect for the cartoon design. One respondent in Group A and two in Group B listed potential tasks for reasonably foreseeable misuse, including throwing aggressively to injure, throwing at breakable objects, deliberately or accidentally bursting the ball and not storing properly so posing a tripping hazard. Four respondents subsequently included potential tripping hazards due to product misuse within the Task Analysis Matrix.

Deterioration and Maintenance hazards

Five respondents identified potential deterioration hazards. One respondent in Group B considered the ball might deflate, and another in Group B considered that the ball might split with wear and tear. The prime concern expressed by two respondents in each group was that deterioration might lead to the stopper coming out and posing a choking hazard. Although one respondent in Group A considered facilities had not been provided by the manufacturer to enable monitoring of the toy ball, one respondent in Group B indicated that visual examination should be sufficient to ensure safe use.

Four respondents made comments regarding maintenance. One respondent in Group A indicated maintenance was not required. One respondent in each group commented that deflation might result in the stopper coming out, and a Group B respondent indicated that the stopper may come out if the ball was split due to wear and tear. A Group A respondent queried whether the ball might burst with heavy use.

However, only one respondent made reference in the Task Analysis Matrix to the possible hazard caused by deflation of the ball and loss of the stopper.

Disposal

Two respondents in each group commented that there were no disposal hazards. One respondent in Group A commented that there were no particular hazards unless the ball split, and one in Group B indicated there were no obvious problems. No disposal hazards were recorded on the Task Analysis Matrix.

Marketing

All respondents in Group A and one in Group B indicated that the target user group was clearly conveyed as being for children, by the use of cartoon character decoration. One in Group A indicated that the "get up", suggested infants, and another indicated an age range of 1-5 years. One respondent in each group indicated that the use was not clearly conveyed, although one respondent in Group A commented that the intended use speaks for itself. All respondents indicated that no age labelling was given. One respondent in Group A indicated that an age label would have been expected to be present given the pictorial depictions on the ball.

User

All respondents commented that there was no significant sex for users, or sex difference in their understanding of how to play with the ball. One respondent in Group A commented that the design and different cartoon characters used might attract different sexes, and one respondent in each group commented that boys might be more likely to kick the ball in play. One respondent in Group A indicated that boys might play more aggressively with the ball. One respondent in Group B indicated that pets might play with the ball.

Although one respondent in each group felt there was no significant age for users, one respondent in Group B indicated that the principal users would be very young children, and the remaining respondents specified 5 yrs, 2-5 yrs, and 1-5 yrs. These ages were also identified as the target age. Respondents indicated however, that the users might be any age. One respondent in each group indicated that there were no age differences in understanding or using the ball, although a respondent in Group A indicated that more boisterous play was likely at upper age ranges.

In response to questions regarding the skill levels required to play with the toy, two respondents in Group B indicated that no skill was required, and one respondent in Group A indicated only a low skill level was necessary to play with the toy. Three respondents commented that dexterity was necessary to grip/catch and throw the toy, one respondent in Group A indicating that a child under 2 years would not have the dexterity to play with the toy. No respondents indicated any hazards arising from human error.

Warnings and Safety Instructions

There were no warnings or symbols displayed in the ball as noted by all respondents. One respondent in each group noted the presence of the CE mark. None of the respondents considered personal protective equipment to be required. One of the respondents in Group B cited Home and Leisure Accident reference data as prompted within the matrix.

Task Analysis Matrix

The Disney ball was subject to the Nomograph method of risk assessment by authorities A, C and D, and the Numerical method by authorities B, E and F. Tables 92 and 93 summarise the tasks identified, the associated hazards and injuries and risk assessment scores using the Nomograph and Numerical methods. The two methods identified broadly similar hazards, although respondents completing the Nomograph Task Analysis Matrix identified a wider range of hazards for risk assessment, also including injuries from impact, i.e. impact with the ball, and by the ball breaking objects and causing secondary injuries. The Tables also show similarities in the types of injuries identified through both methods, i.e. cuts, bruises, choking and poisoning, but also demonstrate contrasting views on the final risk assessment.

One respondent using each Task Analysis method identified that the choking hazard might cause death. However, the Nomograph method as shown in Table 92 yielded a *High* final risk assessment for this injury, whereas the Numerical method as shown in Table 93 yielded a *Low* final hazard rating.

Respondents using the Nomograph method indicated four "High" risk assessment scores, three "Significant" risk assessment scores, and three "Moderate" risk assessment scores.

Three hazards were scored to have a "high" risk of injury:-

- the risk of a child placing the closure in the mouth and choking (75), (73)

- the risk of bruising/cuts from slipping/tripping over the ball left on the floor (75), also considered to be "Significant" by two respondents (62) (57), and "Moderate" by another (55);
- the risk of poisoning due to toxic surface materials (70).

Table 92 : Comparison of risk assessments : Disney Toy Ball : Nomograph Method

Task	Hazard	Potential Injury	Maximum Injury	Probability	Likelihood of Recognition	Initial Risk Assessment	Availability	Final risk Assessment
Bring to place of use	Possible tripping hazard (C)	Bruising	Minor	Probable	Improbable	59 Significant	General	53 Moderate
	Place on floor slip/trip (A)	Bruising cut	Severe	Probable	Probable	60 Significant	Widespread	75 High
	Trip over ball (D)	Bruising	Minor	Probable	Probable	25 Very low	Widespread	55 Moderate
Use Play	Access to black closure - place in mouth (A)	Choking	Death	Unlikely	Possible	62 Significant	Widespread	73 High
	If fails bite test - stopper (D)	Choking	Serious	Unlikely	Improbable	55 Moderate	Widespread	75 High
Chew ball	Toxic surface (A)	Poisoning if toxic	Severe	Possible	Possible	64 Significant	Widespread	70 High
Ball hits child	Impact (C)	Bruising	Minor	Probable	Improbable	59 Significant	General	57 Significant
Ball hits another child	Impact (D)	Bruise	Minor	Probable	Probable	25 Very low	Widespread	55 Moderate
Ball hits fragile object	Breakage sharp pieces on floor (D)	Bruise/ cut	Moderate	Unlikely	Almost inevitable	6 Remote	Widespread	32 Very low
Ball left around	Tripping (C)	Bruising	Minor	Probable	Improbable	59 Significant	General	57 Significant
	Trip / stood on (D)	Bruise	Minor	Possible	Probable	37 Low	Widespread	62 Significant

A further potential impact hazard was identified which might injure a child and was considered to have a "significant" or "moderate" risk of injury.

As shown in Table 93, respondents completing the Numerical method only identified one hazard which presented a "Significant" risk of injury:-

- the risk of a child placing the closure in the mouth and choking (12.5).

Table 93 : Comparison of risk assessments : Disney Toy Ball : Numerical Method

Task	Hazard	Potential Injury	Probability of Exposure	Frequency of Exposure	No. of Persons at Risk	Maximum Probable Loss	Hazard Rating
Give to child who leaves on floor	Trip/slip (F)	Bruise	Even chance 5	Daily 2.5	1-2 persons 1	Mild ill health effect 0.5	6.25 Low
Use Play	Plastic closure can be removed (B)	Choking	Possible 2	Weekly 1.5	1-2 persons 1	Minor temporary illness 1	3 Low
	Ball deflates & stopper comes out (F)	Gets into child's mouth & chokes	Possible 2	Infrequently 0.1	1-2 persons 1	Fatality 15	3 Low
	Stopper may come out (E)	Choking	Even chance 5	Daily 2.5	1-2 persons 1	Minor temporary illness 1	12.5 Significant
Chew ball	Ingestion of toxic paint (B)	Poisoning	Possible 2	Weekly 1.5	1-2 persons 1	Minor temporary illness 1	3 Low
	Ingestion of toxic paint (E)	Toxic hazard	Unlikely 1	Daily 2.5	1-2 persons 1	Minor temporary illness 1	2.5 Low

Table 94 shows the risk assessment score for each hazard identified by respondents using the Nomograph method and the equivalent risk assessment score where the hazard was also identified by respondents using the Numerical method.

Table 94 : Summary of Nomograph and Associated Numerical Risks identified

	Nomograph			Numerical	
The risk of :-	**High**	**Significant**	**Moderate**	**Significant**	**Low**
bruising/cuts from slipping/tripping	(75)	(62) (57)	(53)		(6.25)
placing the closure in the mouth and choking	(75) (73)			(12.5)	(3) (3)
poisoning due to toxic surface materials	(70)				(3) (2.5)
impact of child and ball		(57)	(55)		

Whilst a final score of 70 would be considered to be *High* risk for either method, a score of 10 represents a *Significant* risk within the Numerical method, and a *Remote* risk within the Nomograph method. The Nomograph method, thus, differentiates between a wider number of different categories of risk of injury over a narrower range of scores. However, as previously commented, the value of either method in evaluating the safety of consumer products depends not so much on identifying a greater number of potentially high or low risk hazards, as in reliably identifying the *critical* safety hazards, and in reliably predicting the likelihood of these hazards causing injury. The author has plotted the risk assessment score for a safety critical hazard for each product on these graphs, to compare with the risk assessment scores determined by respondents using the two methods.

It is interesting that this product also elicited divergent risk assessment outcomes between the two methods, as was noted in the previous section regarding the jug kettle. Again respondents using the Nomograph method identified more hazards giving rise to risks of injury. However, for identifying the hazards and risks associated with the jug kettle the Nomograph method was used by respondents A, C, and D, and for identifying the hazards and risks associated with the toy ball the Nomograph method was used by B, E and F.

The post appraisal questionnaire asked respondents what their final risk assessment was for each product. The range of comments included :-

> "Child toxicity/ loose plug"
> "Low risk"
> "Tripping adult/child may not be aware"
> "Quite safe as long as it passes the bite test"
> "Possible choking hazard paint"
> "Low risk tripping/ very low choking on stopper"

Three of the respondents considered that the ball was relatively low risk, although two of these respondents also referred to the potential choking hazard. None of the respondents identified the actual risk presented by the ease of removal of the loose plug by toddlers, which was the reason for the selection of this product by the author.

7.6 Comparison of Usability of the Safety Appraisal Methods

In the post appraisal questionnaire, respondents were asked a number of questions regarding the two stage safety evaluation, i.e. the completion of the Initial Product Safety Matrix and the Task Analysis Matrix. Respondents were also asked about possible future applications for the two matrices in evaluating consumer complaints, and whether to investigate, in safety sampling and in identifying products to be subject to external testing , and whether they would use these matrices in the future.

The respondents were evenly divided in their comments on the ease of use of the Initial Product Safety Matrix, two of the respondents from Group A and one from Group B reported that they found it easy to use, and one of the respondents from Group A and two from Group B reported that they did not find it easy to use. One of the respondent who had indicated that the matrix was easy to use commented that:

> " It was time consuming and long winded but did cover all safety issues and could evaluate the effectiveness of warnings"

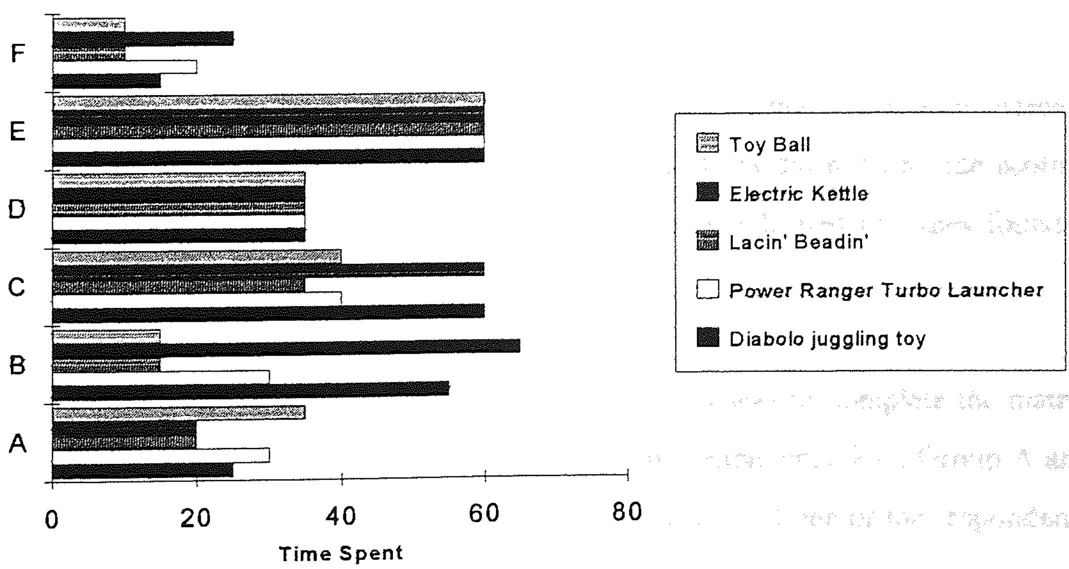
Another respondent who had indicated that the matrix was not easy to use commented that the matrix was:

> "Work commitments meant I had to stop initial appraisal after 35 mins "

Respondents were asked to indicate the time spent to complete all of the questions in the Initial Product Safety Matrix for each product, which ranged from 10 minutes to 65 minutes. Their completion times are illustrated in Graphs 3 and 4.

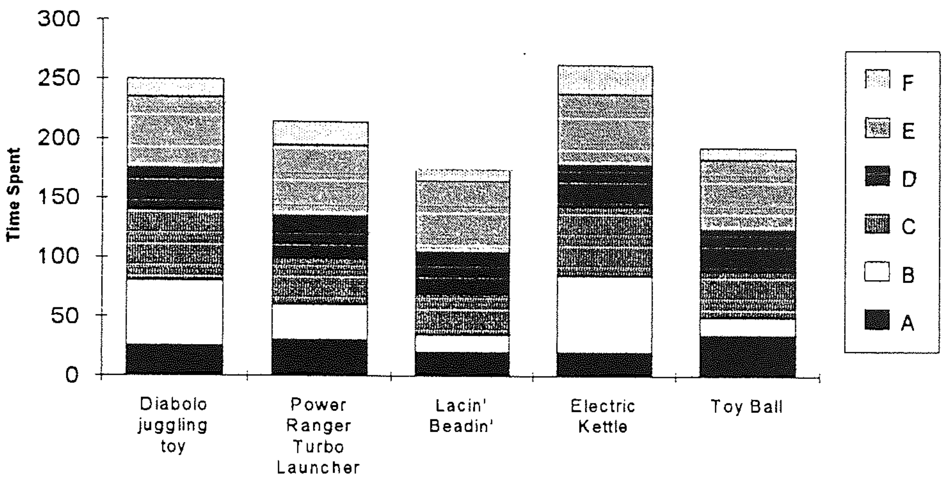
Graph 3 shows that at 60 minutes per product appraisal, respondent E generally took longer for all products, although respondent C typically took longer than the other respondents for all products. Respondent F spent less time than any of the respondents for appraising each product.

Graph 3 : Product Completion Time by Respondent : Initial Product Safety Matrix



Graph 4 shows the total time spent appraising each product, to determine whether there were any patterns shown in any product taking longer to appraise than another. The Electric Kettle took the longest to appraise, followed by the Diabolo juggling toy, the Power Ranger toy, the toy ball, and then the Lacin' Beadin' toy.

Graph 4 : Completion Time by Product : Initial Product Safety Matrix



The respondents were asked a number of questions about the ease of use of the Task Analysis Matrix. Only one respondent from Group A indicated that the sub headings were easy to use, and therefore most of the respondents did not find the headings easy to use. However, only one respondent from Group B commented that it was not easy to associate hazards with tasks, and all respondents indicated that it was easy to associate injuries with the hazards identified.

Four respondents, two from each of the groups, indicated that the risk assessment scoring system was easy to use, therefore two respondents did not find the scoring systems easy to use. All but one respondent in Group A indicated that they found it easy to determine a final risk assessment.

The responses were evenly divided regarding how easy it was to complete the matrix for each possible user and location of use, two of the respondents from Group A and one from Group B reported that they found it easy to use, and one of the respondents from Group A and two from Group B reported that they did not find it easy to use. Two respondents also commented that:

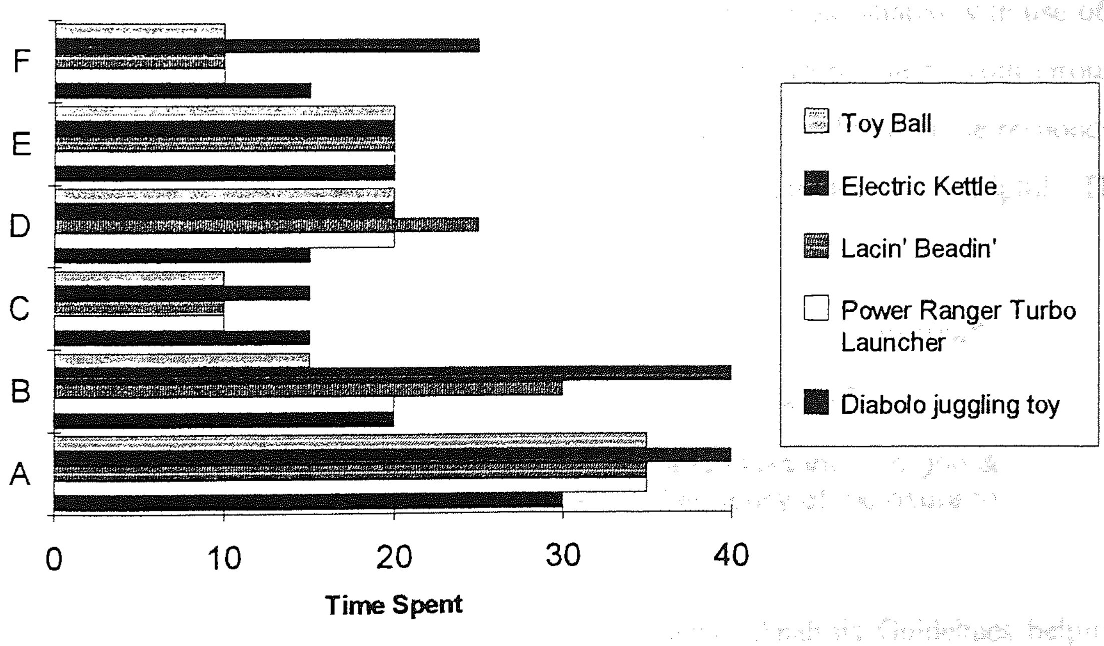
> " This was quicker than the initial assessment & results I felt were good but did not allow you to analyse the warnings in detail"

> "Difficult to get relative scores between the two methods"

Respondents were also asked to indicate the time spent to complete the risk assessment process for the hazards they identified on the Task Analysis Matrix for each product, which ranged from 10 minutes to 40 minutes. Their completion times are illustrated in Graphs 5 and 6.

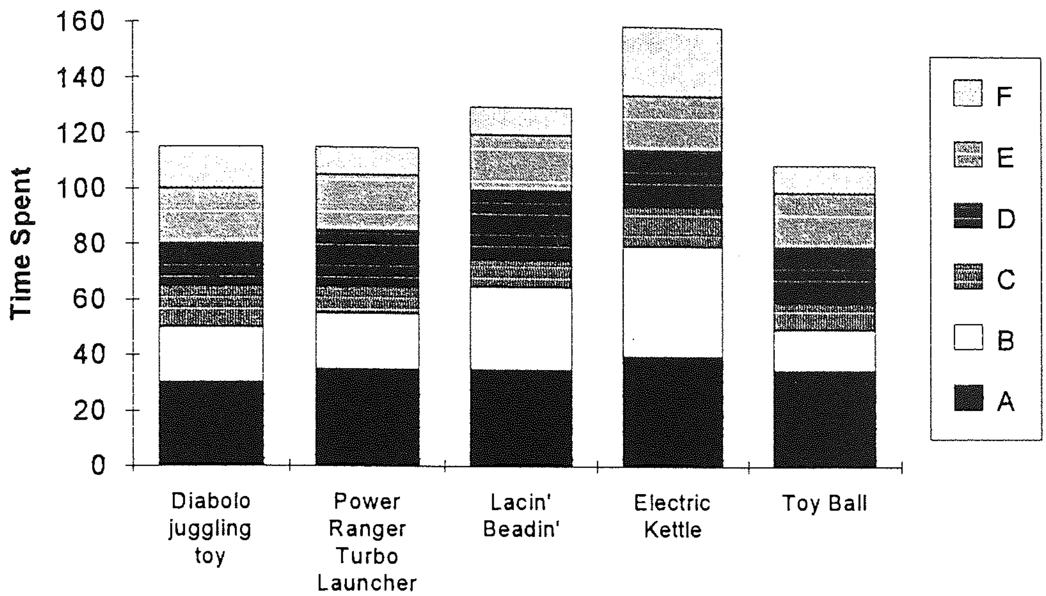
Graph 5 shows that respondent A generally took longer and respondents C and F generally took less time to complete the Task Analysis Matrix for all products than the other respondents

Graph 5 : Product Completion Time by Respondent : Task Analysis Matrix



Graph 6 shows the total time spent appraising each product, and illustrates a similar pattern to that for completion of the Initial Product Safety Matrix.

Graph 6 : Completion Time by Product : Task Analysis Matrix



Again the Electric Kettle took the longest time for completion of the matrix. However, in completing the Task Analysis Matrix the Lacin' Beadin' took the next longest, followed by the Diabolo juggling toy, Power Ranger toy and the toy ball.

Respondents were also asked whether the systematic approach was helpful in identifying all potential stages of use, activities and injuries associated with use of the product, and their views were split evenly. One of the respondents from Group A and two from Group B reported that they found it helpful, and two of the respondents from Group A and one from Group B reported that they did not find it helpful. Three respondents commented that :

> "Couldn't relate to manufacture/distribute display in particular"
>
> "Found a problem in grasping phase of use column"
>
> "It was hard to fit all possible misuse and tasks into the grid & found number of persons at risk and frequency of exposure to hazard to general for use"

All respondents indicated that they found the Hazard Analysis Guidelines helpful in identifying all potential injuries associated with the hazard categories, although only two respondents from Group A subsequently indicated that they would use these guidelines in the future.

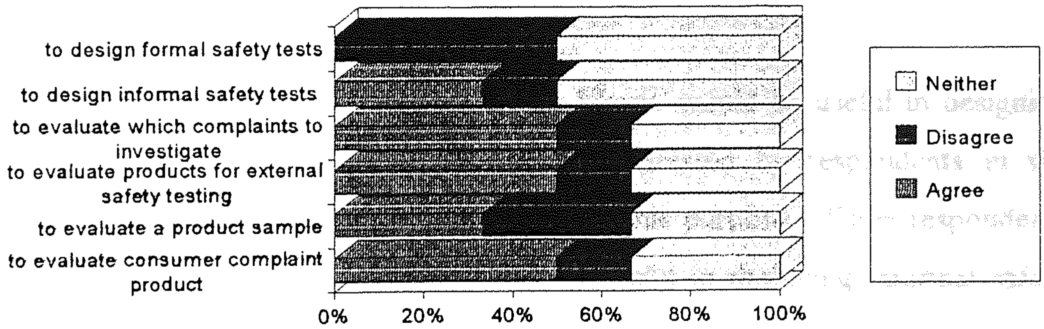
The respondents were asked to comment on potential future applications for the Initial Product Safety Matrix, and the Task Analysis Matrix, and then indicate whether they would use either of the Matrices in the future.

Their responses regarding whether the questions within the Initial Product Safety Matrix were useful in:

- evaluating products which were the subject of consumer complaint,
- identifying product samples being considered for safety testing,
- selecting products to be submitted for external testing, and
- determining whether to investigate consumer safety complaints.

are shown in Graph 7.

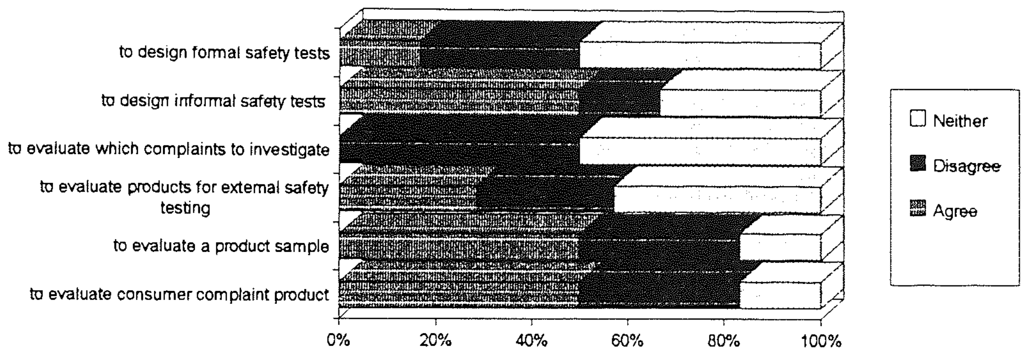
Graph 7 : Future Applications of Initial Product Safety Matrix



Respondents were split evenly regarding disagreeing about the use of the Initial Product Safety Matrix for designing formal safety tests, or neither agreeing or disagreeing. I.e. no respondents agreed this would be a useful application. There was broadly the same level of agreement about the usefulness of the Initial Product Safety Matrix to evaluate which complaints to investigate, which products to submit for external testing, and in evaluating the safety of product subject to consumer complaint. On balance, however, the number of respondents disagreeing or who were undecided outweighed those indicating their agreement of the future applications of the Initial Product Safety Matrix.

Respondents were also asked whether the process of carrying out a task analysis to identify hazards and potential injuries associated would be useful in evaluating products which were the subject of consumer complaint, product samples being considered for safety testing, selection of products to be submitted for external testing, and whether to investigate consumer safety complaints. Their responses are shown in Graph 8.

Graph 8 : Future Applications of Task Analysis Matrix

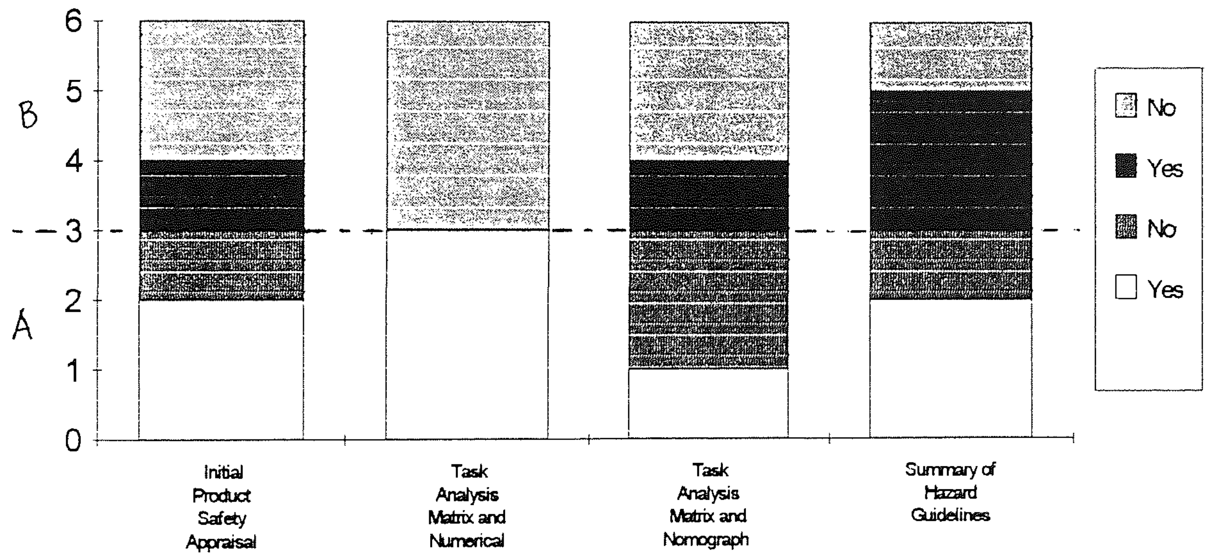


One respondent agreed that the Task Analysis Matrix would be useful in designing formal safety tests, despite the disagreement expressed by respondents in the usefulness of the Initial Product Safety Matrix for this purpose. Three respondents agreed that the Task Analysis Matrix would be useful in designing informal safety tests.

Two respondents agreed that the Task Analysis Matrix would be useful for evaluating products to submit for external safety testing, and three respondents agreed that the Matrix would be useful for evaluating products which were the subject of consumer complaint and product samples being considered for safety testing. Three respondents disagreed that the Task Analysis Matrix would be useful in evaluating which complaints to investigate and the other respondents were undecided.

The acid test for the usefulness of the product safety evaluation method is whether respondents would use it, or elements of it in the future. When asked which elements of the safety evaluation method respondents would use in the future, three respondents indicated that they would use the Initial Product Safety Matrix, three respondents indicated that they would use the Task Analysis Matrix and Numerical scoring method, two respondents indicated that they would use the Task Analysis Matrix and Nomograph scoring method and four respondents indicated that they would use the Summary of Hazard Guidelines in the future. Graph 9 indicates these responses when analysed by Group A/B.

Graph 9 : Responses By Group A and B Indicating If They Would Use Elements of the Safety Evaluation Method in the Future



More of the respondents from local authorities in Group A, i.e. those authorities selected as having more experience in objective techniques, indicated a willingness to use these objective measures in the future. Relatively fewer of the respondents from Group B authorities, i.e. selected as having less experience in using objective techniques, indicated a willingness to use these objective measures in the future.

7.7 Influence of Cognitive Factors on Risk Assessment Outcome

The pre-appraisal questionnaire included a number of questions to identify how product familiarity and initial safety impressions might affect their final risk assessment score. Respondents were asked to select from a range of choices to determine their

The pre-appraisal questionnaire asked respondents about its familiarity and whether the respondent had seen it before.

In their responses to the pre-appraisal questionnaire, two respondents in each group indicated that were familiar with the kettle and toy ball and one respondent in each group indicated that they were familiar with the Lacin' Beadin' and Diabolo juggling toy. However, all respondents indicated that they were not familiar with the Power Ranger Turbo Launcher. All respondents indicated that they had seen the toy ball and jug kettle before and all but one of the Group B respondents had seen the Diabolo toy and Lacin' Beadin' before. Again, one respondent in Group A and two respondents in Group B indicated that they had not seen a Turbo Launcher before.

By comparison with their pre-appraisal questionnaire responses, all of the respondents indicated in their responses to the Initial Product Safety Matrix that they were very familiar with the jug kettle and toy ball - thus indicating an increase in familiarity. Their responses to the Initial Product Safety Matrix seemed to indicate an increase the reported familiarity of the Diabolo juggling toy in Group B, but decrease the reported familiarity in Group A, by comparison with their pre-appraisal questionnaire responses. The level of expressed familiarity noted on the Product Safety Matrix for the Turbo Launcher indicated an increase for Group A, but not for Group B by comparison with their pre-appraisal questionnaire responses, and indicated an increase for both groups in relation to the Lacin' Beadin' by comparison with their pre-appraisal questionnaire responses.

In their responses to the post appraisal questionnaire, respondents were asked to select from a number of choices, whether their familiarity with the product made them assess the product as less safe / more safe, or indicate that it made no difference. Graph 10 illustrates the choices selected by the respondents, where the responses for respondents in each Group are plotted as separate columns.

All of the Group B respondents and two of the Group A respondents indicated that level of familiarity with the Power Ranger toy made no difference to the final risk assessment.

Familiarity

Table 95 summarises for each product the responses given regarding product familiarity given by respondents in relation to the pre-appraisal questionnaire and to the Initial Product Safety Matrix.

Table 95 : Comparison of Pre-Appraisal Questionnaire (PQ) and Initial Product Safety Matrix (IPSM) - Familiarity

	Group A		Group B	
	PQ	IPSM	PQ	IPSM
Pro Diabolo				
I am familiar with the product	1		1	
I am not familiar with the product	2		2	
Have seen this type before	3		2	
Have not seen this type before			1	
Familiarity				
• Fairly				1
• Seen but not used				2
• Not very		2		
• Not at all		1		
Turbo Launcher				
I am familiar with the product				
I am not familiar with the product	3		3	
Have seen this type before	2		1	
Have not seen this type before	1		2	
Familiarity				
• Very		1		
• Fairly		2		
• Not very				1
• Not				2
Lacin' Beadin'				
I am familiar with the product	1		1	
I am not familiar with the product	2		2	
Have seen this type before	3		2	
Have not seen this type before			1	
Familiarity				
• Very		1		1
• Fairly		2		2
• Not				
Haden Jug Kettle				
I am familiar with the product	2		2	
I am not familiar with the product	1		1	
Have seen this type before	3		3	
Have not seen this type before				
Familiarity				
• Very		3		3
• Not				
Disney Toy Ball				
I am familiar with the product	2		2	
I am not familiar with the product	1		1	
Have seen this type before	3		3	
Have not seen this type before				
Familiarity				
• Very		3		3
• Not				

familiarity with the product, whether they had seen it before, whether they had used it before and whether they felt able to use it safely without reading safety instructions or information. Respondents were also asked if there were any obvious hazards in using the product.

In completing the Initial Product Safety Matrix respondents were asked to make comment regarding:

- ◊ **Familiarity** - How familiar is the product?
- ◊ **Obviousness** - Is the intended use immediately apparent?
- ◊ **Hazardousness** - How hazardous does the product initially appear?
- ◊ **Uncertainty** - Are there any hidden/latent hazards?

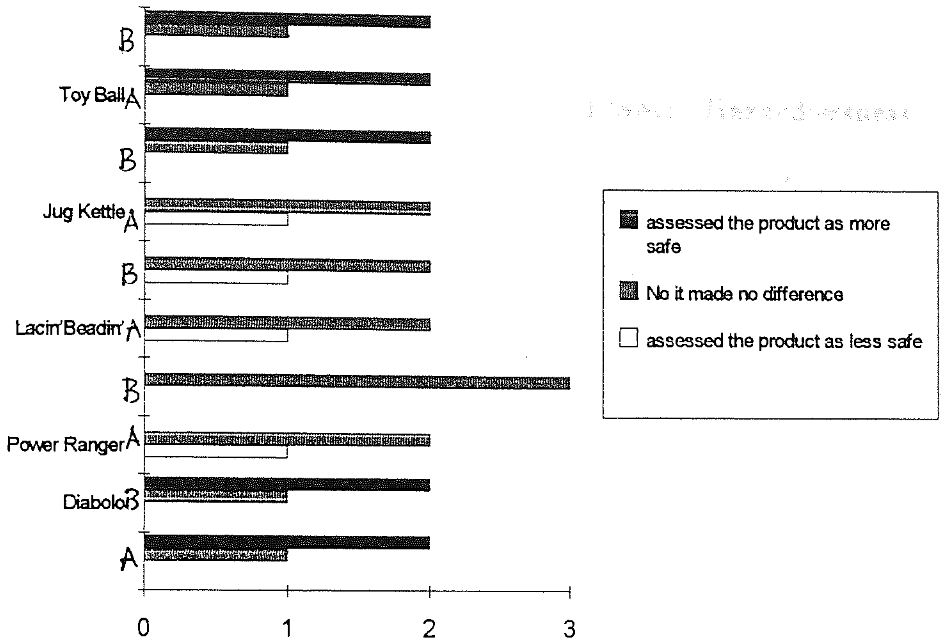
In the post-appraisal questionnaire, respondents were asked to select from a number of choices to indicate whether their final assessment of safety was affected by their :

- ◊ familiarity with the test object
- ◊ seriousness of consequences of hazards
- ◊ obviousness of safety hazards
- ◊ uncertainty about safety hazards

in assessing the product as more or less safe, or made no difference to their final safety assessment. Respondents were also asked about their familiarity with the brands of the products assessed, and asked about any associations between product brand and implied safety hazards in use in assessing the product as more or less safe, and were also invited to indicate any other factors which affected their safety assessment if the products.

The influence of these cognitive factors at each of these stages of the research is discussed for the different products and respondents, taken each cognitive factor in turn.

Graph 10 : Post Appraisal Responses : Familiarity with the Test Product



The results for the other products are rather less clear cut, although two respondents in each group indicated that this made no difference for the Lacin' Beadin' , and two respondents in Group B indicated that this made no difference for the jug kettle.

Hazardousness & Seriousness Of Consequences

Table 96 summarises for each product the responses given regarding the hazardousness of the products given by respondents in Groups A and B via the Initial Product Safety Matrix.

The checklist questions within the Initial Product Safety Matrix sought to identify how hazardous the product initially appeared. It has been possible to compare the actual hazards initially identified by respondents in their responses to the pre-appraisal questionnaire and post-appraisal questionnaire, and the hazards identified and risk assessment scores within the Task Analysis Matrix.

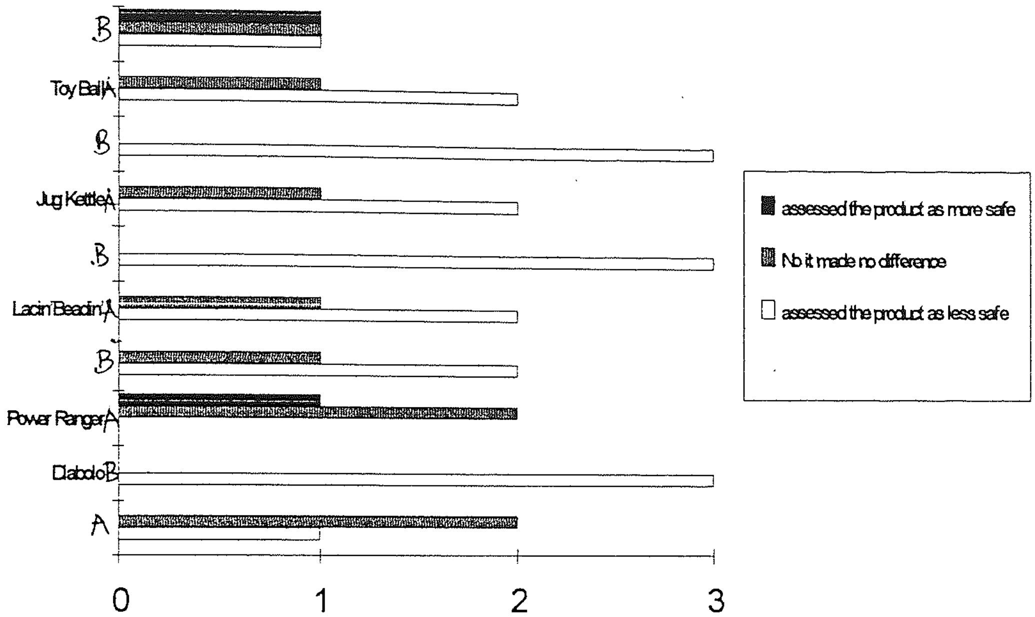
In their responses to the post appraisal questionnaire, respondents were asked to select from a number of choices, whether the seriousness of the consequences associated with hazards identified them assess the product as less safe / more safe, or indicate that it made no difference.

Table 96 : Initial Product Safety Matrix (IPSM) - Hazardousness

Pro Diabolo	Group A	Group B
Hazardousness		
• Quite	1	
• Depends on how used		1
• Seems less than it probably is		1
• not particularly / minimal	1	
• not	1	1
Turbo launcher		
Hazardousness		
• Speed of release		2
• not particularly / minimal	2	
• not	1	1
Lacin Beadin		
Hazardousness		
• Choking/small parts	2	2
• Similarity to sweets		2
• Strangulation	1	
• not particularly / minimal	1	
• not		1
Jug kettle		
Hazardousness		
• not particularly	3	1
• not		2
Toy Ball		
Hazardousness		
• Closure/ choking	1	
• not particularly / minimal	1	
• not	2	3

Graph 11 illustrates the choices selected by the respondents, where the responses for respondents in each Group are plotted as separate columns. In relation to the Diabolo, there was a range of responses about how hazardous the product initially appeared, from quite hazardous to not hazardous where Groups A and B were relatively evenly divided. In their post appraisal responses all of Group B respondents and one Group A respondent indicated that the seriousness of the consequences made the respondents assess the Diabolo as less safe, and two respondents in Group A indicated it made no difference.

Graph 11 : Post Appraisal Responses : Seriousness of Consequences



Group A respondents reported less concerns regarding the hazardousness of the Turbo Launcher than Group B, but the level of uncertainty regarding latent hazards was broadly similar in both groups. Two Group B respondents referred to the potential speed of release of the spinner. In their responses to the post appraisal questionnaire, more of the respondents indicated that the seriousness of consequences influenced them in assessing the product as less safe than indicated that it made no difference. Only one respondent in Group A indicated that this made them consider the Power Ranger was more safe, and one respondent in Group B indicated that it made them consider the toy ball as more safe.

In relation to the initial hazardousness of the Lacin' Beadin' Group B respondents identified initial hazards associated with the small parts and potential for choking or swallowing, particularly because of the resemblance of the fruit shapes to sweets or gums, and increased likelihood of being put into the mouth. By contrast, one Group A respondent commented that the toy initially appeared not to be very hazardous another commented that the hazard was only to children under 36 months, and the third identified initial hazards from choking on the small parts and strangulation by the string. All of the Group B respondents and two Group A respondents indicated in their post appraisal questionnaire responses that seriousness of consequences of injury for the Lacin' Beadin' made them assess the product as less safe and one respondent in Group A indicated it made no difference.

A number of comments were expressed by both groups regarding the initial hazardousness of the jug kettle. One Group A respondent identified an initial hazard associated with the non BS approved plug, and another commented on the hazard of immersion of the kettle in water, or the supply lead getting into water. However, generally, the views indicated that the kettle did not appear initially very hazardous. In their responses to the post appraisal questionnaire all of the Group B respondents and two Group A respondents indicated that seriousness of consequences of injury for the jug kettle made them assess the product as less safe and one respondent in Group A indicated that it made no difference.

In terms of the initial hazardousness of the toy ball one respondent in Group A referred to the stopper/closure, but respondents indicated the ball initially appeared not to be hazardous. Two of the Group A respondents and one Group B respondent indicated that seriousness of consequences of injury for the toy ball made them assess it as less safe, one respondent in each group indicated that it made no difference, and one respondent in Group B indicated it made them assess the ball as more safe.

Obviousness

Table 97 summarises for each product the responses given regarding product familiarity given by respondents in relation to the pre-appraisal questionnaire and to the Initial Product Safety Matrix.

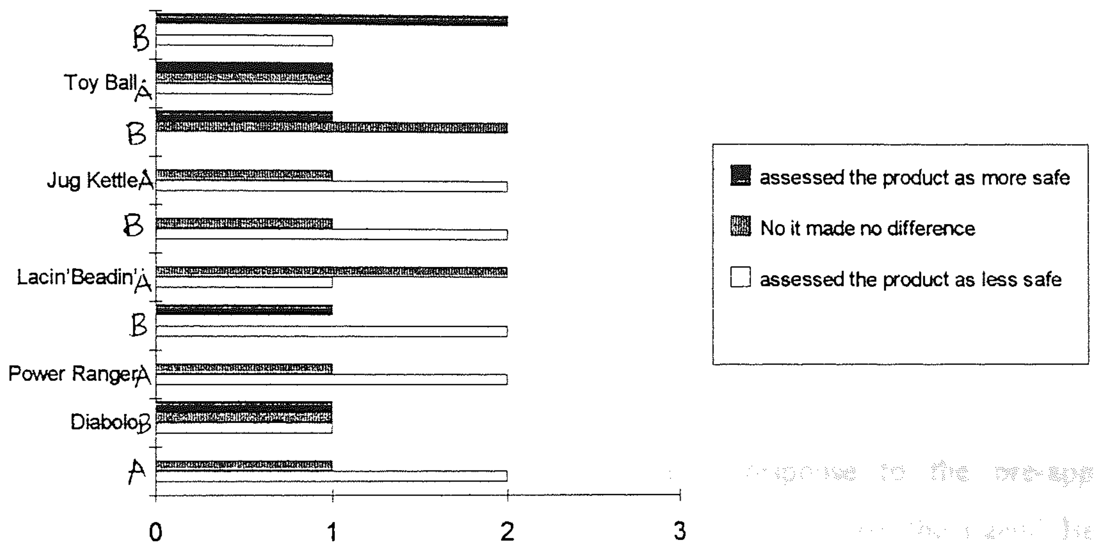
The pre-appraisal questionnaire asked respondents whether they could tell how to use the product safely without reading any instructions or safety information, and whether they had used the product before. The questions in the Initial Product Safety Matrix also asked about the obviousness of use.

Table 97 : Comparison of Pre-Appraisal Questionnaire (PQ) and Initial Product Safety Matrix (IPSM) - Obviousness

	Group A		Group B	
	PQ	IPSM	PQ	IPSM
Pro Diabolo				
I can tell how to use it safely without reading any instructions or safety information	1		2	
I can't tell how to use it safely without reading any instructions or safety information	2		1	
I have used this type of product	1		1	
I have not used this type of product	2		2	
Obviousness -				
• the use is apparent		1		2
• the use is reasonably apparent		1		1
• may need to read the instructions		1		
Turbo launcher				
I can tell how to use it safely without reading any instructions or safety information	2		1	
I can't tell how to use it safely without reading any instructions or safety information	1		2	
I have used this type of product	2		1	
I have not used this type of product	1		2	
Obviousness -				
• the use is apparent		1		1
• the use is reasonably apparent		1		1
• may need to read the instructions		1		
• the use is not apparent				1
Lacin Beadin				
I can tell how to use it safely without reading any instructions or safety information	3		2	
I can't tell how to use it safely without reading any instructions or safety information			1	
I have used this type of product	2		1	
I have not used this type of product	1		2	
Obviousness -				
• the use is apparent		3		3
• the use is reasonably apparent				
• may need to read the instructions				
• the use is not apparent				
Jug kettle				
I can tell how to use it safely without reading any instructions or safety information	3		2	
I can't tell how to use it safely without reading any instructions or safety information			1	
I have used this type of product	2		1	
I have not used this type of product	1		2	
Obviousness -				
• the use is immediately apparent		3		3
• the use is not apparent				
Toy ball				
I can tell how to use it safely without reading any instructions or safety information	3		3	
I can't tell how to use it safely without reading any instructions or safety information				
I have used this type of product	3		3	
I have not used this type of product				
Obviousness -				
• the use is very obvious		1		1
• the use is apparent		2		2
• may need to read the instructions				
• the use is not apparent				

In their responses to the post appraisal questionnaire, respondents were asked to select from a number of choices, whether the obviousness of use made them assess the product as less safe / more safe, or indicate that it made no difference. Graph 12 illustrates the choices selected by the respondents, where the responses for respondents in each Group are plotted as separate columns.

Graph 12 : Post Appraisal Responses : Obviousness of safety hazards



In their responses to the pre-appraisal questionnaire, two respondents in Group B indicated that they could tell how to use the Diabolo without instructions, but two respondents in Group A could not. Two respondents in each group had not used this type of product before. In their responses to the Initial Product Safety Matrix, however, there was an increase in obviousness of use indicated in responses by both Group A and B, only one respondent indicated they may need to read the instructions in order to use the Diabolo safely. In the post appraisal questionnaire in response to the question about whether their final assessment of safety was affected by how obvious the safety hazards were, two Group A respondents and one Group B respondent indicated they assessed the product as less safe. One respondent from each group indicated that it made no difference, and one respondent in Group B indicated that it made them assess the product as safer.

Although all respondents had previously indicated that they were not familiar with the Power Ranger Turbo Launcher, their responses to the pre-appraisal questionnaire were evenly split about whether its use was obvious without reading instructions. Two respondents from Group A respondents indicated that they could tell how to use the Turbo Launcher without instructions, but two respondents in Group B could not, and two respondents from each group indicated that they had not used this type of product before. In their responses to the Initial Product Safety Matrix, however, there was an increase in obviousness indicated in responses by both Group A and B, two respondents in each group indicating that its use was apparent or reasonably apparent. One respondent in Group A indicated they may need to read instructions and one respondent in Group B indicated the use was not apparent. In their post appraisal questionnaire responses two respondents from each group indicated they assessed the product as less safe, one respondent from Group A indicated that it made no difference and one from respondent from Group B indicated they assessed it as more safe.

Only one respondent in Group B indicated in response to the pre-appraisal questionnaire that they would need to read instructions to use the Lacin' Beadin' safely. One respondent from Group A and two respondents from Group B had not used this type of product. However, all respondents indicated that its use was apparent in their responses to the Initial Product Safety Matrix. The responses to the post appraisal questionnaire were split, two respondents from Group B and one from Group A indicated that the obviousness of hazards made their final assessment less safe, and two respondents from Group A and one from Group B indicated that it made no difference.

Only one Group B respondent indicated the need to read instructions to use the jug kettle safely, and one respondent in Group A and two in Group B indicated that they had not used this type of kettle before. In their responses to the Initial Product Safety Matrix all respondents indicated that the use was immediately apparent. The responses to the post appraisal questionnaire about the jug kettle were also split, one respondent from Group A and two from Group A indicated that the obviousness of hazards made no difference to their final assessment. Two respondents from Group A indicated it made their final risk assessment less safe and one respondent from Group B indicated that it made their final risk assessment more safe.

All respondents indicated that they could tell how to use the toy ball safely without instructions and had used this type of product. In their responses to the Initial Product Safety Matrix one respondent from each group indicated that the use was very obvious, and the remaining respondents indicated that the use was apparent. In their post appraisal questionnaire responses Group A respondents indicated each of the options, i.e. more safe, less safe and no difference. Two Group B respondents indicated their final assessment was more safe and one indicated that it was less safe.

Uncertainty

The pre-appraisal questionnaire asked respondents to consider whether they felt any uncertainty in how the products should be used, if they were uncertain about any safety hazards associated with each product, and to select from the Yes/No options for each product. None of the respondents took the opportunity to make any additional comments following their responses. Table 98 illustrates the Yes and No responses by both Groups to questions 10 and 11.

Table 98 : Pre-Appraisal Questionnaire : Uncertainty about product use and associated safety hazards

	Yes		No	
Uncertainty about product use	Group A	Group B	Group A	Group B
Diabolo Juggling Toy	2	2	1	1
Power Ranger	3	3		
Lacin' Beadin'			3	3
Electric kettle			3	3
Disney Ball			3	3
Uncertainty about safety hazards	Group A	Group B	Group A	Group B
Diabolo Juggling Toy	2	3	1	
Power Ranger	2	3	1	
Lacin' Beadin'	1	1	2	2
Electric kettle	2	1	1	2
Disney Ball	2	1	1	2

It is clear from these responses that both Groups responded similarly in their uncertainty about how to use the Diabolo and Power Ranger toys. All of the respondents were uncertain about use of the Power Ranger, and two respondents from each group were uncertain about use of the Diabolo. No respondents were uncertain about how to use the Lacin' Beadin', Electric kettle or Disney Ball. As previously shown in Graphs 14 - 18 , these three products were subsequently given higher risk assessment scores by respondents.

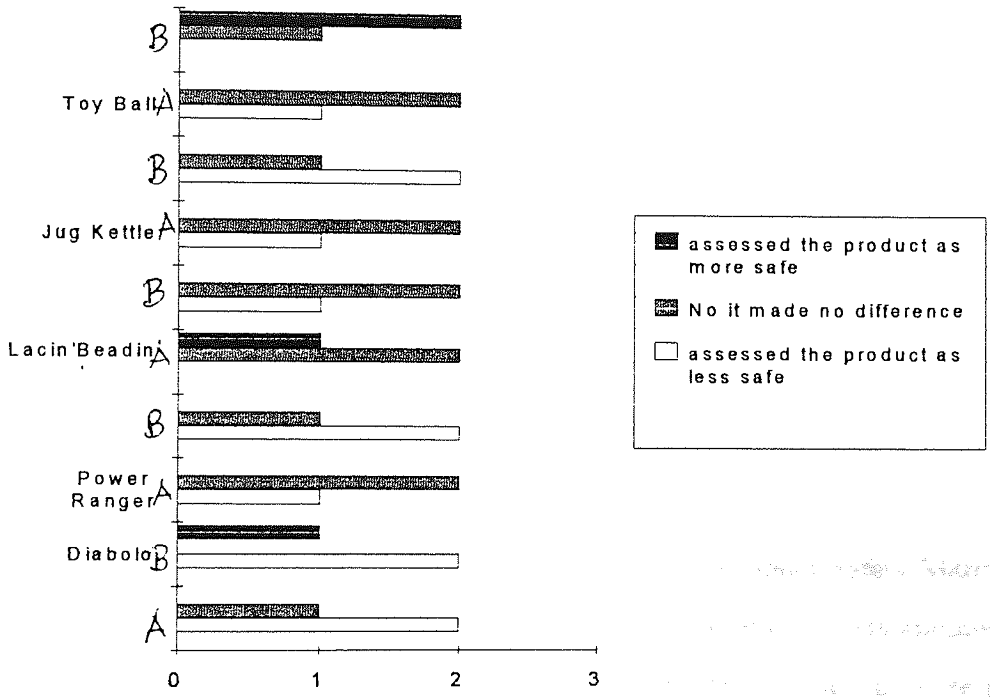
The pattern of responses about uncertainty of associated safety hazards is less clear. Fewer respondents in Group A than Group B were uncertain about safety hazards associated with the Diabolo and Power Ranger. However, this pattern was reversed for the Electric kettle and toy ball, where fewer respondents in Group B than Group A were uncertain about associated safety hazards. In the case of the Lacin' Beadin' toy only one respondent in each group was uncertain about associated safety hazards.

Table 99 : Initial Product Safety Matrix (IPSM) - Uncertainty/Hidden Hazards

Pro Diabolo	Group A	Group B
• only if expose small parts		1
• supervision needed (spinning etc.)		1
• No	3	1
Turbo Launcher		
• toxicity	1	
• flight		1
• No	2	2
Lacin Beadin		
• Similarity to sweets	1	
• Strangulation	1	1
• Toxicity of plastic		1
• No	1	1
Jug kettle		
• Immersion in water	1	2
• Steam vents	3	2
• Boil dry	1	1
• Plug & wiring	1	
• Supply lead in water	1	
Toy ball		
• Detached stopper/ choking	3	2
• Left in wrong place/ trip		1
• Thrown at breakable object		1
• Flammable/toxic materials	1	

Table 99 summarises for each product the responses given regarding the hazardousness of the products indicated by respondents in Groups A and B via the Initial Product Safety Matrix. Graph 13 illustrates the choices selected by the respondents to the post appraisal questionnaire, in relation to whether how uncertain they were about the safety hazards of the test object influenced their final assessment as less safe / more safe, or made no difference.

Graph 13 : Post Appraisal Responses : Uncertainty of safety hazards



In terms of the uncertainty about hidden hazards in relation to the Diabolo all of Group A and one of Group B commented that there were no latent hazards. Two respondent from each group indicated that uncertainty about safety hazards made their final assessment of the Diabolo less safe. One respondent in Group A indicated that it made no difference to their final safety assessment, and one respondent from Group B indicated it made them assess the product as more safe.

Three respondents (2 in Group A and 1 in Group B) commented via the Initial Product Safety Matrix on the level of uncertainty regarding latent hazards for the Lacin' Beadin'. One of the Group A respondents referred to the attractiveness of the fruit shapes and likelihood of them being placed in the mouth, indicating a tentative view that this would fail the General Safety Requirement. The other commented that the string was long enough for the beads to be made into a necklace, and because it was strong, there was a potential strangulation hazard. In their post appraisal responses two respondents from each group indicated that the uncertainty made no difference to their final assessment. The remaining respondents commented the uncertainty made the final assessment more safe (Group A) and less safe (Group B).

There was a much wider range of latent hazards identified by respondents for the jug kettle via the Initial Product Safety Matrix. These included the hazard of water immersion indicated by a respondent in Group A and two in Group B, the potential of boiling dry indicated by a respondent in each group, and the likelihood of steam venting onto the user's hand identified by three respondents in Group A and one in Group B. One Group A respondent also identified the unsleeved pins on the plug, and the incorrect wiring tension on the earth terminal. The respondents in each group were split about the influence of this uncertainty on their final safety assessment, one respondent in Group A and two respondents in Group B indicating that it made them assess the kettle as less safe, and two respondents in Group A and one respondent in Group B indicating it made no difference.

In relation to the latent hazards identified via the Initial Product Safety Matrix for the toy ball, most respondents (3 in group A and 2 in Group B) commented on the choking hazard posed by a detached stopper. One of the Group A respondents referred to the possibility that materials may cause a flammability or toxic hazard, and a Group B respondent queried whether the ball might be left in the wrong place, creating a tripping hazard, or be thrown at a breakable object. Only one respondent in Group A, however, indicated that this uncertainty led to making a less safe final assessment. Two respondents in Group A and one respondent in Group B considered this uncertainty made no difference to their final safety assessment, and one respondent in Group B indicated that it made them assess the product as less safe.

Brand Familiarity

None of the respondents were familiar with the brand of the Diabolo toy, and three respondents, one from Group A and two from Group B indicated that there was no association made between the brand of the Diabolo toy and safety. All but one Group B respondent were unfamiliar with the brand of the Lacin' Beadin' toy and one respondent from each group indicated that they made no association between the brand name and safety.

In contrast, all of the respondents were familiar with the brand of the jug kettle. One respondent from Group B indicated that the brand may have influenced the final assessment as less safe, one respondent from Group A indicated that the brand may have influenced the final assessment as more safe and the remaining three respondents indicated that they made no association between the brand name and safety.

Two from each group indicated that they were familiar with the brand of the Power Ranger toy and the toy ball. One respondent from Group B indicated that the brand of the Power Ranger may have influenced the final assessment as more safe, and the remaining respondents, two from each group indicated that they made no association between the brand name and safety. Three respondents (1 from Group A and 2 from Group B) indicated that the brand of the toy ball may have influenced the final assessment as more safe, one respondent indicated that they made no association between the brand name and safety.

Only two respondents indicated that they were aware of any other factors which might have affected the way they assessed the safety hazards of the product, respondents A and B indicating:-

> "my own experience, knowledge of products, interests and previous accidents"
> "other known products"

7.8 Concluding Remarks

The analysis in this section indicates a number of rather unexpected findings. The range of hazards identified, and the variation in risk assessment scores determined by the respondents for the products proved to be unexpected. As is discussed in Chapter

8, this may be due to the apparent distortions in scoring introduced by individual interpretation of risk assessment categories, rather than differences in risk assessment.

As was previously indicated by Schoone-Harmsen (1990) in relation to the Product Safety Method, familiarity with the method is essential for it to be applied successfully to complete the analytical stage, to identify critical product features, actions of users and critical environmental conditions, and to synthesise these elements. Benedyk and Minster (1998) in describing the application of the BeSafe technique for product safety evaluation, also highlight potential limitations due to the wide ranging consumer product environment scenarios, where many factors are too diffuse or impractical to measure.

The research also highlights the difficulties enforcement staff experienced in applying objective measures for identifying product safety hazards and applying risk assessment techniques. Despite this, however, participants in the research indicated that they were willing to use some of the product safety appraisal techniques in the future.

The differing risk assessment outcomes achieved by respondents using a systematic approach for the products selected, however, does provide an indication of why different Member States may have experienced differing levels of RAPEX notification for products marketed throughout Europe, where safety is assessed without any objective framework. Therefore further work is necessary, in developing clearer instructions in applying the risk assessment scoring methods consistently and/or provision of training in their use to improve the reliability and consistency of risk assessment outcomes.

There was considerable discussion in Chapter 4 about subjective factors and their influence on risk perception and risk assessment. Hale (1987) indicated nine dimensions of risk, which included uncertainty versus obviousness of the hazards, and the consequences/ severity of outcome. Also as indicated by Wogalter, Desaulniers and Brelsford (1987) perceptions of hazardousness were influential in encouraging precautionary behaviour.

For these reasons, questions were included at the different stages of research to establish the influence of the subjective factors of :

- ◊ product familiarity,
- ◊ obviousness of use,
- ◊ hazardousness / seriousness of the consequences of the hazard; and
- ◊ uncertainty about hazards

to establish any potential influence of these cognitive factors towards their safety risk assessment using the two stage safety evaluation process. Despite the discussion about the results of responses made by the respondents to the pre-appraisal questionnaire, Initial Product Safety Matrix, and post-appraisal questionnaire, the results are not clear cut. It has not been possible to establish a clear pattern in the declared or actual influence of these cognitive factors in the final assessment of the products as more or less safe.

The clearest indication and influence on the final risk assessment reported by respondents was the seriousness of consequences factor. As shown in Graph 13, all Group B respondents indicated that this made them assess the Diabolo, Lacin' Beadin' and kettle as less safe, and two of Group A respondents also indicated that this made them indicate the Lacin' Beadin', kettle and ball as less safe.

As shown in Graph 12, unfamiliarity with a product was not reported to lead to a final risk assessment as less safe. Also, familiarity with the product brand did not influence the final safety assessment.

The obviousness of use of a product and the obviousness of any safety hazards appeared to give mixed results. Reported uncertainty about product use was greater for the Diabolo and Power Ranger toys. However, higher final risk assessment scores were given for the Lacin' Beadin', Jug kettle and Disney Ball although respondents were not uncertain about their use.

Chapter 8 : Comparison of Nomograph and Numerical Risk Assessment Scoring Methods

8.1 Introduction

As discussed in Chapters 6 a study was carried out considered the initial survey of responses from 63 local authority Trading Standards Departments and a number of related issues addressed in the responses of the representatives of the six participating authorities to the Pre-Appraisal questionnaire. Chapter 7 described the Product Safety Appraisal study evaluating what hazards were identified by the different respondents, what subjective influences may have led to the risk assessment score determined and issues of usability and consistency of outcome. The final study described in this chapter considers the different scoring systems utilised by the participants and compares the risk assessment outcomes using the Nomograph and Numerical scoring systems, addressing the practical requirements raised by the PROSAFE enforcement practitioners. It also considers how might the safety appraisal method be developed to improve consistency in outcomes of risk assessment and its usability.

8.2 Comparison of Risk Assessment Outcomes

In Chapter 7 the final risk assessments achieved using the Nomograph and Numerical risk assessment methods were discussed in some detail. A comparison was also made for each individual product of the different high, significant, moderate and low risks identified by each method, and for three products as shown in Tables 86, 90, 94 the range of responses for commonly identified hazards was also compared.

Table 100 shows the number of hazards where considered to be *Moderate* to *High* risk and Table 101 shows the number of hazards where considered to be *Low* or lower high risk, identified by either method for all of the different products evaluated. The values in the table which are shaded relate to the risk assessment scores of respondents A, C and D.

Table 100 : Comparison of Risk Assessment Outcomes - Moderate to High

	Nomograph				Numerical		
	High	Significant	Moderate	Sum	High	Significant	Sum
Diabolo		3		3		3	3
Power Ranger			1	1		1	1
Lacin'Beadin'		1		1	4	2	6
Kettle	5	7	6	18		3	3
Toy Ball	4	3	3	10	1		1
Total	9	14	10	33	5	8	14

Table 101 : Comparison of Risk Assessment Outcomes - Low

	Nomograph			Numerical		
	Low	Non-existent	Sum	Low	Acceptable	Sum
Diabolo	6	4	10	6	9	15
Power Ranger	6	4	10	6	5	11
Lacin'Beadin'	6		6	3	6	9
Kettle	10		10	20	5	25
Toy Ball	1		1	5		5
Total	29	8	37	40	25	65

On this basis, it would appear that respondents using the Nomograph method identified more moderate to high risk hazards than those using the Numerical method for each product, except the Lacin' Beadin'. Conversely, the respondents using the Numerical method identified more low risk hazards than those using the Nomograph method for all products, and particularly for the jug kettle. In this instance, respondents using the Numerical method identified more than double the number of low risk hazards.

Table 102 : Patterns of Response for Nomograph and Numerical Methods

	Nomograph			Numerical		
	Mod to High	Low	Total	Mod to High	Low	
A, C, D	14	21	35	9	34	45
B, E, F	19	16	35	5	31	33
Total	33	37	70	14	65	78

As shown in Table 102, when these results are summarised for all products, it is clear that there were more than double the total number of these higher risk hazards identified by the respondents using the Nomograph than Numerical method. Conversely, there were also more than double the total number of the lower risk hazards identified by the respondents using the Numerical than Nomograph method.

The risk assessments by either method for each of the five products have been plotted graphically in Graphs 14-18 for the purpose of comparison. The graphs illustrate the risks identified by the respondents, and seek to identify any patterns in responses by the individual respondents A - F, and any similarities in the scoring outcome within and between each method. The New Zealand Ministry of Consumer Affairs would investigate any product where the risk assessment score determined through the application of the Nomograph method exceeds 60, placing higher priority on products as the score increased above 60. By comparison, the action timetable developed by Steel (1992) in relation to work related safety risks, requires action to be taken within one month for products with a HRN score of 10-50, and within one week for a score between 50-100.

Respondents A and B identified the most *High* risk hazards by either method. The respondents identified the most moderate to high risk hazards for the jug kettle (18) followed by the Toy Ball (10), and Diabolo (3). Only respondent A identified a moderate risk hazard for the Power Ranger, and only respondent E identified a moderate risk hazard for the Lacin' Beadin'. Respondent C identified the fewest moderate to high risk hazards using either method. Respondents C and D determined mainly *Low* risk assessment scores using either method, except D's final risk assessment scores of the Lacin' Beadin' using the Numerical method, and the toy ball using the Nomograph method, and C's final risk assessment scores of the Diabolo using the Nomograph method.

In order to make comparisons between the risk assessment outcomes, the scoring protocol used by the Nomograph and Numerical risk assessment methods, as summarised in Table 103, must also be considered. It is important to note the difference in the actual scores and their relative risk assessment outcome be the two methods, and that direct comparisons of the final risk assessment numerical scores are not applicable. To ensure that these scoring systems are understood when interpreting the graphical data for each method, the graphs are labelled with the appropriate Moderate, Significant and High risk datum lines.

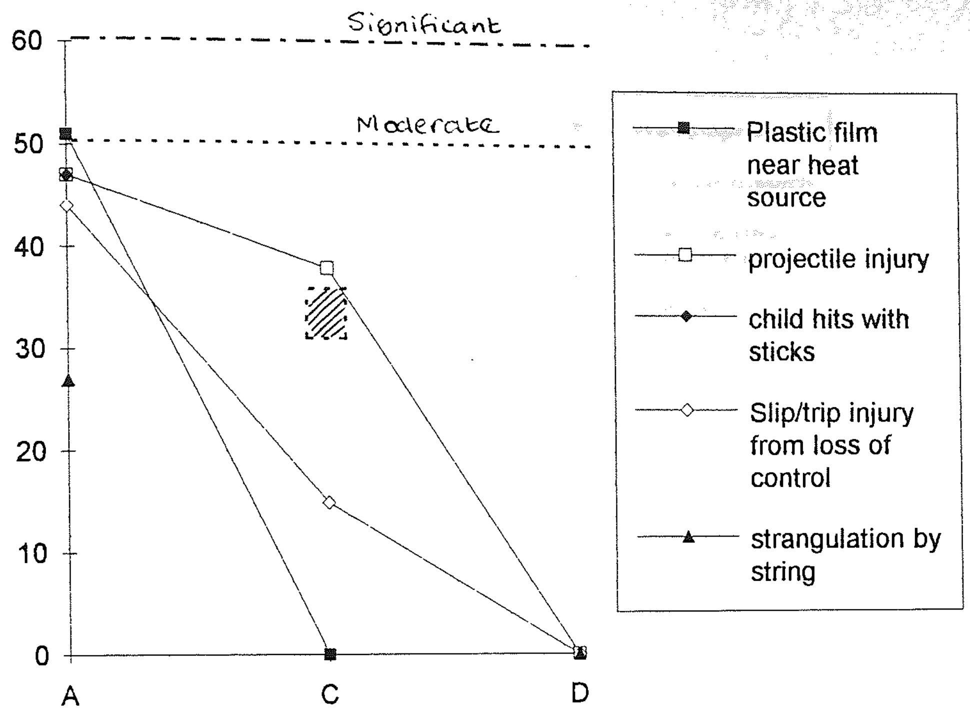
Table 103 : Scoring Protocol For Nomograph & Numerical Risk Assessment Methods

Nomograph Risk Scores		Numerical Risk Scores	
Virtually non -existent	0-10		
Remote	10-20		
Extremely low	20-30	Acceptable	0-1
Very low	30-40	Very Low	1-5
Low	40-50	Low	5-10
Moderate	50-60		
Significant	60-70	Significant	10-50
High	70-80	High	50-100
Very high	80-90	Very High	100-500
Extremely high	>90	Extreme	500-1000
		Unacceptable	>1000

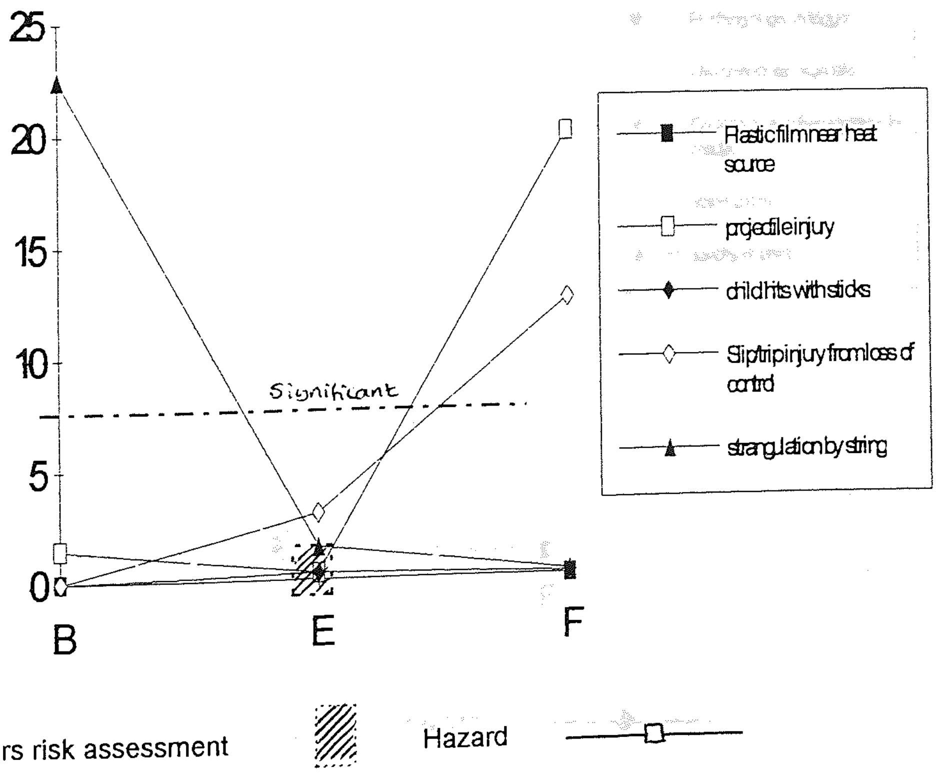
In terms of correlation with the author's risk assessment of safety critical hazards, respondents using both methods identified the potential projectile injury associated with the Diabolo, the potential choking hazard posed by the spinfighter for the Power Ranger Turbo Launcher, the potential choking hazard posed by the fruit shapes for the Lacin' Beadin', the potential scalding hazard from the steam vents for the jug kettle, and the potential choking hazard posed by the black stopper plug on the toy ball.

However, respondent F using the Numerical method for the Diabolo attributed a higher risk score to the potential impact hazard than considered by the author, and respondent A using the Numerical method included a spuriously high score for potential flammability of the plastic film. Respondent E using the Numerical method for the Power Ranger attributed a higher risk score to the potential choking hazard than considered by the author and respondent B using the Numerical method identified a higher risk score for the potential pinching hazard posed by the trigger.

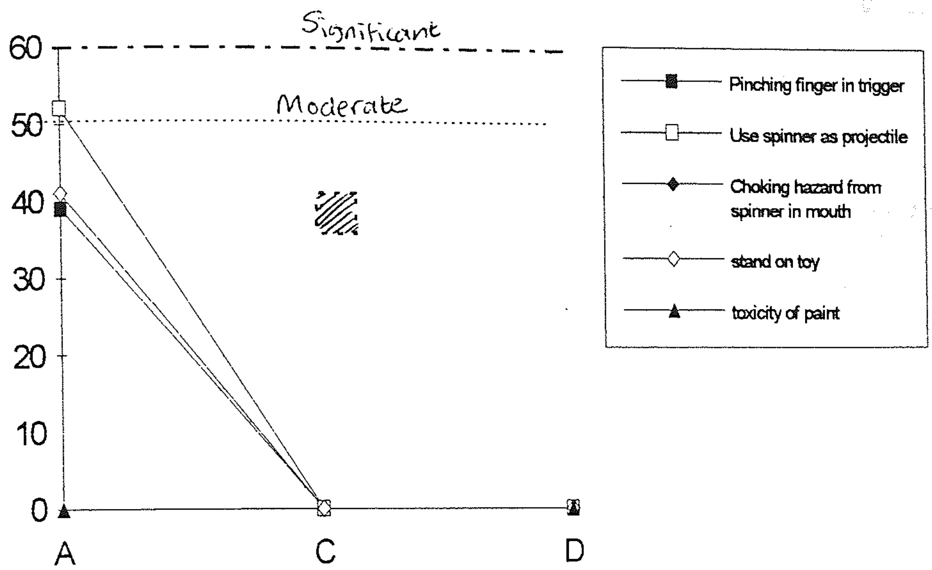
Graph 14A : Summary of Risk Assessments Diabolo : Nomograph



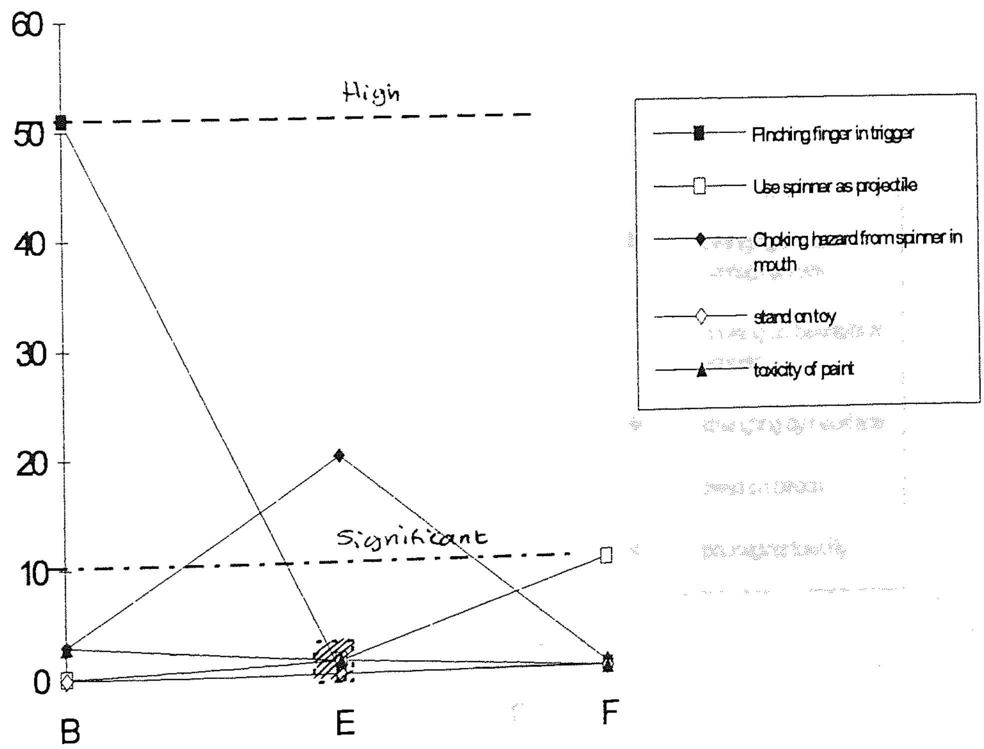
Graph 14B : Summary of Risk Assessments Diabolo : Numerical



Graph 15A : Summary of Risk Assessments Power Ranger : Nomograph

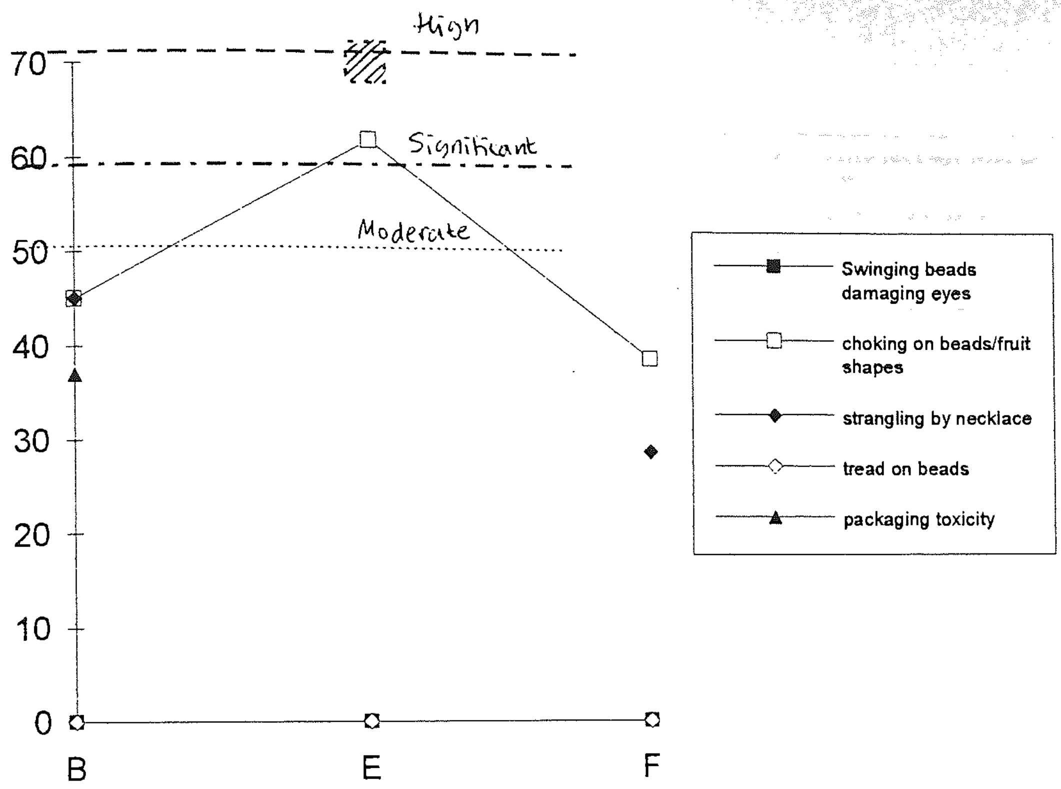


Graph 15B : Summary of Risk Assessments Power Ranger : Numerical

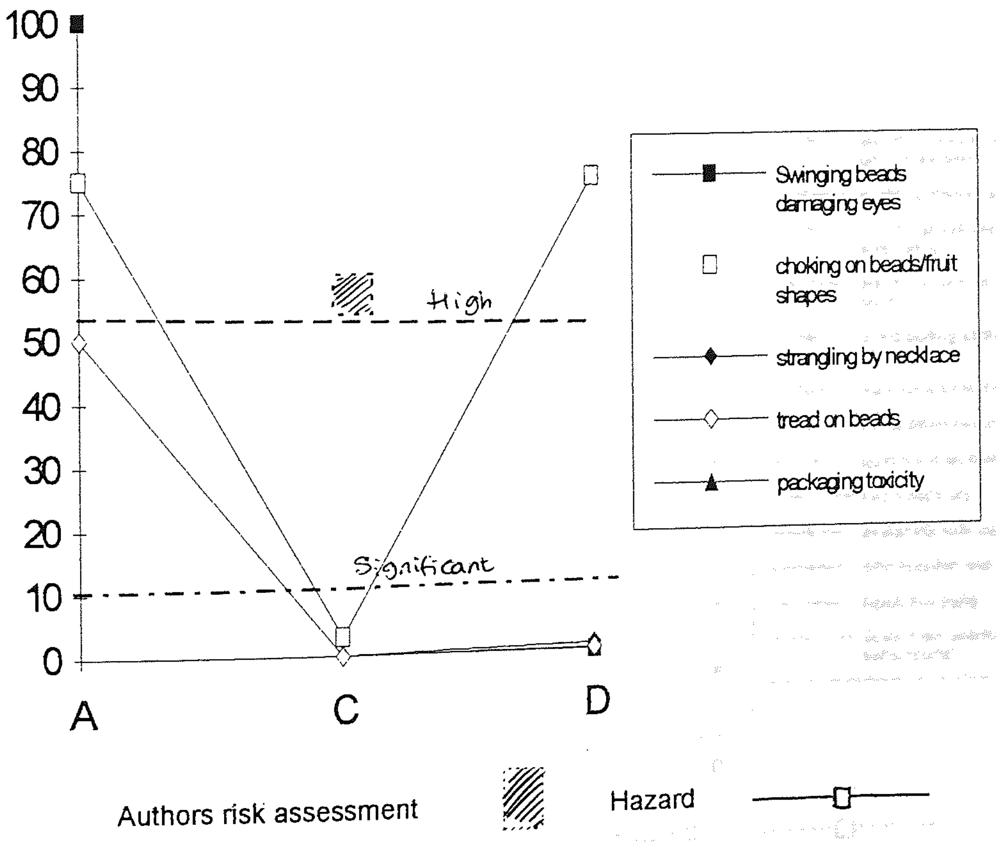


Authors risk assessment Hazard

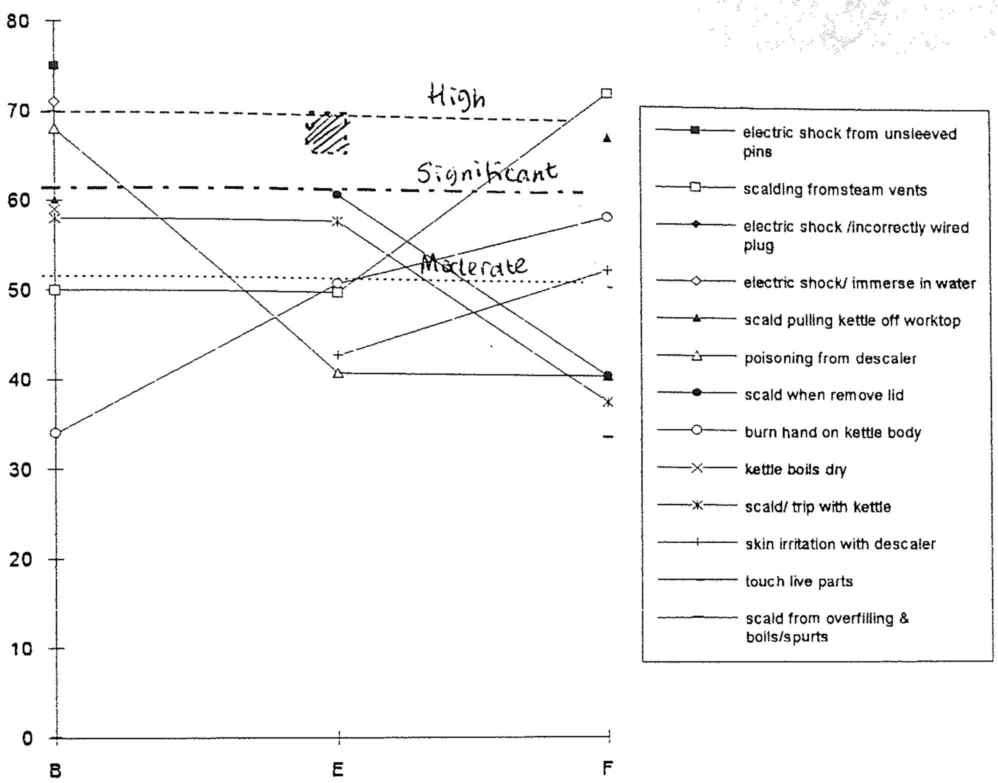
Graph 16A : Summary of Risk Assessments Lacin' Beadin' : Nomograph



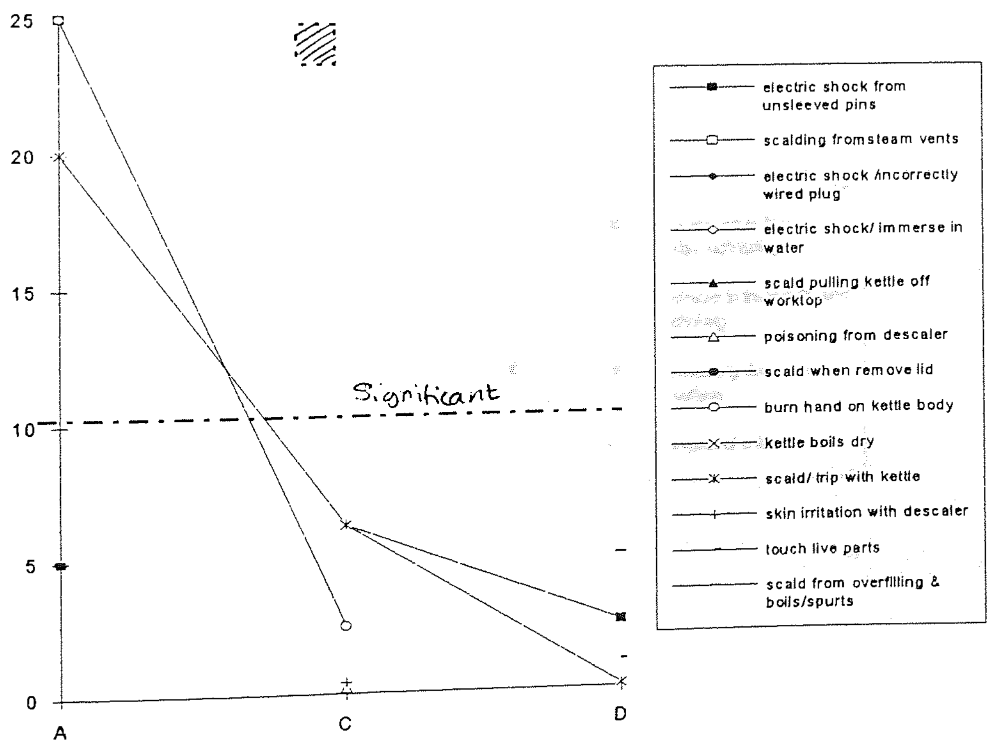
Graph 16B : Summary of Risk Assessments Lacin' Beadin' : Numerical



Graph 17A : Summary of Risk Assessments Jug Kettle : Nomograph

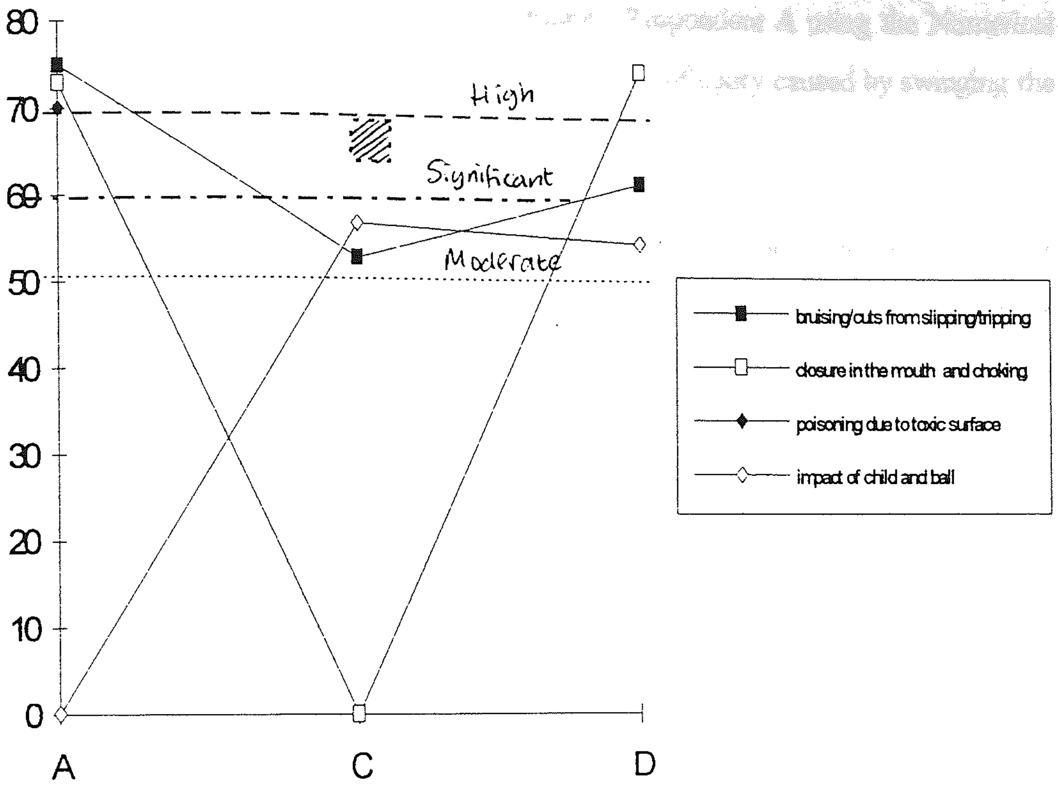


Graph 17B : Summary of Risk Assessments Jug Kettle : Numerical

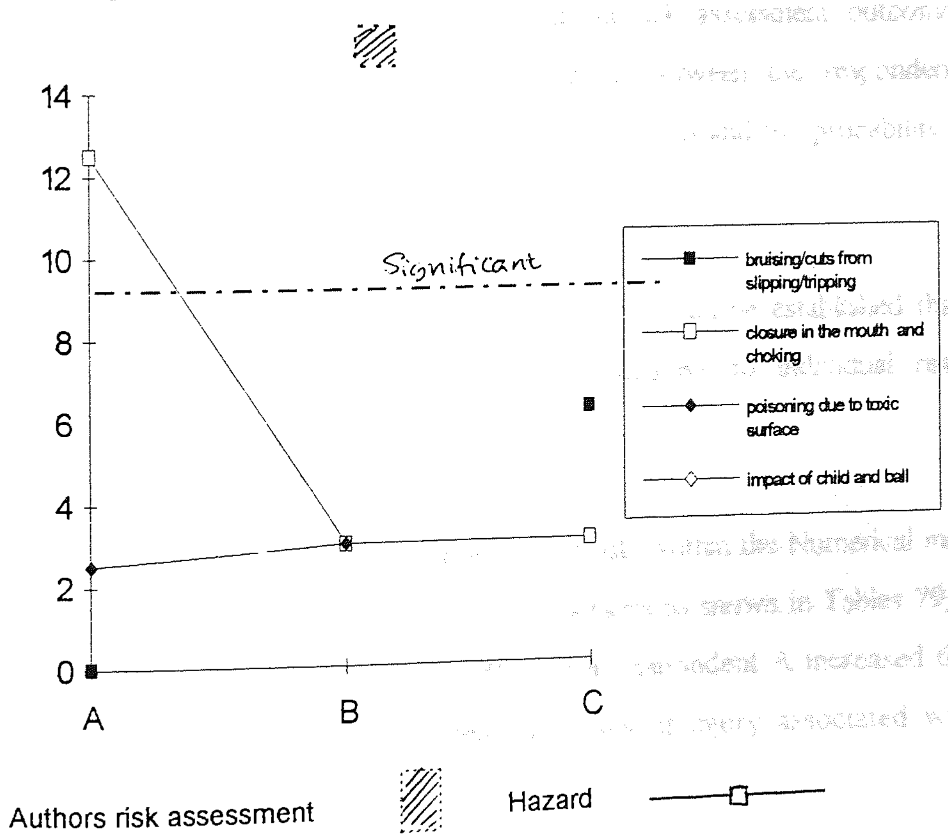


Authors risk assessment ▨ Hazard —□—

Graph 18A : Summary of Risk Assessments Toy Ball : Nomograph



Graph 18B : Summary of Risk Assessments Toy Ball : Numerical



Only respondent E using the Nomograph method for the Lacin' Beadin' attributed a risk score of the same order as the author, and respondents A and D using the Numerical method attributed higher risk scores than the author. Respondent A using the Numerical method included a spuriously high score for potential risk of injury caused by swinging the necklace round and injuring a child in the eye.

Two respondents using the Nomograph method attributed risk scores one category below the author (B and E) and only respondent F attributed a risk score of the severity as the author in relation to the risk of scalding posed by the steam vents in the jug kettle. However, only respondent A attributed a risk score of the same order as the author using the Numerical method. Two respondents using the Nomograph method attributed risk scores similar to the author in relation to the potential choking hazard posed by the black stopper plug (A and D). Only one respondent using the Numerical method attributed a risk score to this potential hazard in the general order of that identified by the author (respondent A), which was below the risk score identified by the author.

The pattern of results of risk assessment using either method and correlation with the author's risk assessment is therefore not entirely clear. It is apparent from this summary that similar hazards identified resulted in different risk assessment outcomes by the different respondents. There were also variations between the respondents in the maximum severity of injury associated with similar hazards and the probability of similar injuries.

By comparing the completed Task Analysis Matrices it can be established that the risk assessment score derived via either method is sensitive to individual respondent's assessment of the categories within the Matrix.

For example, the category "Number of persons at risk" within the Numerical method was invariably completed by all respondents as 1-2 persons as shown in Tables 79, 82, 89, and 93. However, as shown in Table 85, when respondent A increased this to 3-7 persons in scoring the risks associated with risks of injury associated with Lacin'

Beadin' to the foot from spilt beads, and from strangulation by the necklace being caught in play, this effectively doubled the final score for each hazard.

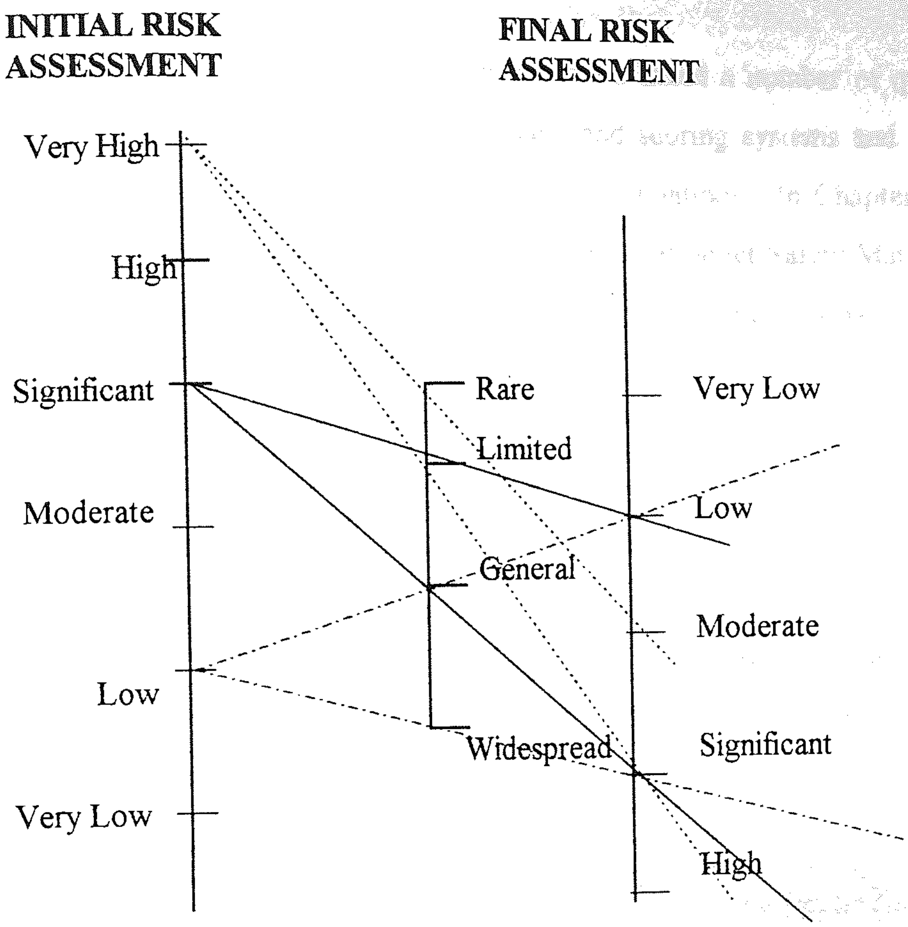
Also in relation to the Numerical method, variations in respondent's choice of category for "Frequency of Exposure" to the hazard identified was also capable of distorting the final score. Only respondents A and F used a higher frequency than daily for the Power Ranger, Lacin' Beadin' and Jug kettle. However, this increased the multiplier effect of this category from "Daily" @ 2.5 multiplier, to an "Hourly" @ 4 multiplier and a "Constantly" @ 5 multiplier.

A similar comparison can be carried out for respondents using the Nomograph method, and their selection of the "Availability" category. For example, respondents evaluating the availability of the Diabolo elected either "Limited" or "Rare". In completing the Task Analysis matrix for the Power Ranger and Lacin' Beadin' respondents also selected two availability categories, "General" or "Limited" and when completing the Task Analysis Matrix for the jug kettle and toy ball respondents elected to choose either "General" or "Widespread" availability categories.

The impact of this difference in the category of availability chosen on the Final Risk Assessment for the product is illustrated in Figure 35. This difference between these two categories chosen by respondents for the Diabolo was capable of converting a *Very High* Initial Risk Assessment with Rare availability to a *Moderate* rather than *Significant* Final Risk Assessment with Limited availability.

Also, the difference between General rather than Limited availability for the Power Ranger and Lacin' Beadin' could change a *Significant* Initial Risk assessment from a *Low* to a *Significant* Final risk assessment. An Initial Risk Assessment score of Low for the jug kettle and toy ball could change from a *Low* Final Risk Assessment if the availability is considered to be General to a *Significant* Final Risk Assessment if the availability is considered to be Widespread.

Figure 35 : Impact of Availability Categories Selected on Final Risk Assessment



Having identified the potential bias in these categories demonstrated by respondents using either method, it is important that future work provides greater clarification to assist respondents in using the method, to increase their consistency in selecting these categories within the scoring system, and reduce any potential distortion.

The range in the choice of categories regarding the availability or frequency of exposure of the products selected by respondents was unexpected, as both the availability of the *particular* consumer product in the market, and the likely frequency of exposure to the identified hazard for that *particular* product in the scenario depicted were considered to be capable of objective assessment.

8.3 Usability of the Scoring Methods

In the post appraisal questionnaire, respondents were asked a number of questions regarding the two stage safety evaluation process and scoring systems and possible future applications for the two matrices in safety investigations. In Chapter 7, we saw that respondents had some difficulty using the Initial Product Safety Matrix, and the checklist technique was time consuming. Although there were individual differences in the time taken and time limitations for participation.

Equally, the respondents also experienced some difficulties in using the Task Analysis Matrix. However, four respondents, two from each of the groups, indicated that the risk assessment scoring system was easy to use and all but one respondent in Group A indicated that they found it easy to determine a final risk assessment. Comments were expressed that either scoring method provided a quicker safety assessment. However, it is considered that requiring that respondents try both the Nomograph and Numerical methods but on different products created some uncertainty in the relative scores using either method.

To determine whether either the Nomograph or Numerical scoring methods took longer to complete, Table 104 identifies the time spent completing the Task Analysis Matrix per product, the shaded areas of the table relating to time taken by respondents to complete the Numerical method. There is no clear pattern in either method taking more or less time

Table 104 : Task Analysis Completion Time - by respondent

	A	B	C	D	E	F
Diabolo juggling toy	25	55	60	35	60	15
Power Ranger Turbo Launcher	30	30	40	35	60	20
Lacin' Beadin'	20	15	35	35	60	10
Electric Kettle	20	65	60	35	60	25
Toy Ball	35	15	40	35	60	10

Respondents were also asked to indicate which risk assessment system they found easier to use. Two respondents from Group A and one respondent from Group B indicated that they found the Numerical method easier to use. The remaining respondents indicated that the methods were both about the same. Thus, none of the respondents indicated that the Nomograph method was easier to use.

As discussed in Chapter 7, the acid test for the usefulness of the product safety evaluation method and the risk assessment scoring systems is whether respondents would use it, or elements of it in the future. When asked which elements of the safety evaluation method respondents would use in the future, three respondents indicated that they would use the Initial Product Safety Matrix, three respondents indicated that they would use the Task Analysis Matrix and Numerical scoring method, two respondents indicated that they would use the Task Analysis Matrix and Nomograph scoring method

More of the respondents from local authorities in Group A, i.e. those authorities selected as having more experience in objective techniques, indicated a willingness to use these objective measures in the future. Relatively fewer of the respondents from Group B authorities, i.e. selected as having less experience in using objective techniques, indicated a willingness to use these objective measures in the future.

In particular, these results show that the Numerical scoring method was more popular. All of the Group A respondents indicated that they would use it again, whereas only one respondent in each group indicated they would use the Nomograph scoring method again.

8.4 Concluding Remarks

The range of hazards identified, and the variation in risk assessment scores determined by the respondents for the products proved to be unexpected, which may reflect apparent distortions in scoring introduced by individual interpretation of risk assessment categories.

These findings emphasise the need for providing better instructions and guidance in applying the risk assessment scoring methods to improve the consistency of the outcome and is an area where further work is needed. Clearly, the "self-help" guidance provided as part of the safety appraisal documentation did not provide sufficient clarification for the respondents for consistency. There was insufficent familiarity with the method for it to be applied successfully in completing the analytical stage, in consistently identifying critical product features and to synthesise these elements.

Further work using the same product samples with a wider group of participants, repeating both scoring methods for each product would improve the relative usability of the scoring systems in assessing the risks associated with the critical product safety hazards identified.

The research also highlights the time constraints imposed on operational enforcement staff in applying objective measures for identifying product safety hazards and determining risk assessment techniques, and gaining the level of experience and expertise in these techniques to improve familiarity and consistency. Despite this, the participants in the research indicated that they were willing to use some of the product safety appraisal techniques in the future. Further work is necessary, in developing clearer instructions in applying the risk assessment scoring methods consistently and/or provision of training in their use to improve the reliability and consistency of risk assessment outcomes.

Chapter 9: Conclusions & Recommendations for Future Research

9.1 Introduction

We have seen that the increasing complexity in the range and nature of consumer products marketed appears not to have been matched by concomitant increases in the level of understanding of the associated hazards by their users. Although the numbers of home accident fatalities have continued to show a gradual annual decline, the epidemiological data examined demonstrate that injuries in the home and workplace requiring medical treatment have not significantly declined in the last decade. There has been a slight recent upturn in the numbers of workplace injuries, yet the number of home accidents requiring medical treatment continues to exceed these workplace accidents. In both of the fields of consumer product safety and health and safety in the workplace it would appear that the accidental incidents are relatively resistant to legislative intervention.

The human factors which contribute towards safe behaviours, or even unsafe behaviours have been considered in some detail in a number of chapters. A number of models were considered to provide a framework for addressing the relevant interacting components which influence safety behaviours to be included within the proposed model for product safety appraisal.

The focus of research has been to draw upon the various disciplines and perspectives presented in the literature survey in order to develop a system of hazard analysis applicable for a wide range of consumer products. From this literature review, a series of systematic checklists and structures for hazard analysis and risk assessment has been established to develop a product safety evaluation method to be used for evaluating a broad range of consumer products. As the basis of the empirical stages of research, this method has been applied to a small number of portable consumer products selected on the basis of the range of hazards identified by the author. Although the model has been designed for use in its pilot form by selected "volunteer" Trading Standards Departments, it might equally be applicable to be developed for use by product designers and manufacturers and for a broader product range.

A number of criticisms have been made about concentrating a human factors product safety evaluation too late in the marketing process on near finished, or finished products. This type of reactive testing might limit corrective action to post hoc changes to the documentation accompanying the product, rather than addressing the product safety deficiencies identified, or might prompt minor changes only, effectively delaying product development where major changes are required. Despite the benefits discussed of conducting safety appraisal early in the design process, in practice this type of finished product testing does provide a marketing aid in checking whether the product fulfils the identified needs of potential users. It is also a major component of the distributor's statutory defence to show that all **reasonable steps** have been taken, and **all due diligence** has been exercised to avoid the commission of a safety offence.

A number of subjective factors on risk perception and risk assessment have been identified within the literature survey, including:

- ◊ uncertainty versus obviousness of the hazards;
- ◊ the consequences or severity of potential injury;
- ◊ the influence of perceptions of hazardousness in encouraging precautionary behaviour, and how this might influence perceptions of warnings associated with the product.

The review of civil case law highlighted the importance of safety instructions and warnings as a legal component in a product liability defence. However, in forewarning the user about certain hazards through use of warnings and safety instructions, their existence does not make an inherently unsafe product "safe".

The Risk theories discussed in some detail suggest a number of explanations for risk-taking behaviours, including Risk Homeostasis, the interaction between attitudes, beliefs, behaviours and behavioural intention, and communication versus decision making approaches to safety instructions and warning compliance. Whether these messages influence safety behaviour critically depends upon the attention users pay to such warnings and instructions, and what methods are employed by users to assess risk.

The general inferential rules employed by laypeople to evaluate risk or judgmental rules or heuristics employed to reduce the difficulty of this task were also discussed, and that they may themselves lead to misperception of risk or distort risk judgements. In order to manage product safety hazards legislative intervention increasingly requires that users are informed about the risks they face, as indicated in Figure 36.

Therefore, the safety appraisal method was designed to incorporate checklist questions assessing the need for safety information and warnings for the different products to be evaluated, and where utilised, to seek respondent views concerning whether this information addressed the hazards identified.

The influence of the subjective factors of :

- ◊ product familiarity,
- ◊ obviousness of use,
- ◊ hazardousness / seriousness of the consequences of the hazard; and
- ◊ uncertainty about hazards

for each respondent in applying the two stage safety evaluation process was also determined by seeking their views via the pre and post safety appraisal questionnaires.

We have also seen the European interest in implementing a protocol for risk assessment procedures for use by Member States to increase uniformity in safety enforcement. Funded by DGXV division of the European Commission the Product Safety Enforcement Forum of Europe (PROSAFE) provides a European forum for experts in consumer product safety and aims to achieve effective, efficient and fair enforcement of consumer product safety legislation. PROSAFE has expressed a wish to counter any cultural differences in safety expectations which might differentiate the process of making and enforcing safety standards and result in differences in the level of reporting of safety issues by Member States, for example via the RAPEX system.

The possibility of different levels of safety enforcement throughout Europe due potentially to cultural differences in consumer complaining and/or the hazard analysis trigger for enforcement action is clearly inconsistent with freedom of movement of consumer products within a single market.

A systematic approach to hazard analysis, drawing more formally upon ergonomics disciplines of hazard analysis and task analysis provides the basis for a more comprehensive and objective product safety appraisal process. The two stage hazard analysis and risk assessment protocol developed by the author has been presented to the PROSAFE group at their meeting in September 1997 and was warmly welcomed by EC Member State representatives. The outcome of the empirical work as considered in Chapters 6-8 has also been presented for further consideration by PROSAFE at their meeting in November 1998, together with indications for future work.

9.2 Overview of Findings

Chapter 6 considered a number of broad questions posed to evaluate the final outcome of the empirical work and to give potential indications of future work, which considered:-

◊ the level of understanding and application of objective risk assessment techniques within local authorities;

◊ the personnel who were involved in evaluating the sample products, and the safety appraisal method;

◊ the product safety factors identified by the personnel, before, during and after applying the safety appraisal method;

◊ the usability and reliability of the two different risk assessment scoring methods in identifying the "key" hazards identified by the author, and assessing safety risks;

◊ the subjective influences which might have affected the risk assessment outcome;

◊ how the safety appraisal method might be developed to improve consistency in outcomes of risk assessment and its usability.

Although the majority of the 63 Trading Standards authorities who responded to the initial questionnaire indicated that they were generally interested in using objective systems for risk assessment and for determining which safety complaints to investigate, it was also clear that the level of experience in applying these objective systems for risk assessment, for safety testing and to prioritise safety complaints for investigation was more limited. Local authorities also expressed some concerns about the constraints introduced by objective systems, and how to incorporate into any objective protocols the elements of subjective judgement and experience to enable flexibility in relation to local enforcement pressures.

However, there was significant interest in being more systematic about safety investigations and in using systematic methods if published and LACOTS was chosen by most respondents as the source for guidance on protocols for hazard analysis and risk assessment. Their responses regarding approaches to investigations into safety complaints identified a number of issues worthy of further research, in particular the different circumstances and extent of Home Authority involvement in safety investigations would merit further investigation.

Generally, responding authorities reported limited experience of referring safety products by the RAPEX system, and there were indications that authorities were more concerned with notifying UK colleagues rather than their European counterparts about product safety issues.

Taken with the individual comments expressed regarding their utilisation of the support of their Home Authority colleagues, this demonstrates a ***singular*** approach towards safety enforcement which might contribute to local inconsistencies within the UK, and also in the wider European context. It also questions whether enforcement practitioners have the ability to apply objective methodologies for product safety appraisal, particularly in considering their comments expressed about the limitations of objective techniques to respond to local priorities.

Taken together with the variation demonstrated in the risk assessment outcomes determined by the respondents for the sample products it is apparent that more work is necessary to identify the factors which contribute to this variability, and to consider how to control them.

These observations indicate a counter trend in practice in approaches toward risk assessment by comparison with the expressed wish for greater objectivity, uniformity and consistency within Europe as expressed by safety enforcement practitioners represented on PROSAFE.

About the respondents

Of the six local authorities whose staff participated in applying and evaluating the product safety appraisal method, both genders were represented in the staff who applied the safety appraisal method. Their ages ranged from within the age band of 22-30 yrs to over 50 years, and they indicated a range of experience within Trading Standards spanning from 7 to 23 years.

The respondents were divided into the A and B groups to reflect expressed experience of objective techniques as indicated in the initial questionnaire to assist in comparisons of their comments regarding the usability of the safety method. It was expected that staff more used to objective approaches to safety appraisal and risk assessment would find the proposed approach easier to use. I.e. respondents A, B and C in Group A were expected to have greater experience of objective techniques, and respondents D, E and F were expected to have lesser experience of objective techniques. However, the subsequent comparison of group responses did not prove to be particularly meaningful or helpful in the analysis of results described in Chapters 6-8 in drawing preliminary conclusions.

Although Group A was intended to reflect greater experience in objective techniques, in practice, Group A included both a Trading Standards Officer B who appeared to provide the most extensive enforcement experience and the most extensive knowledge and experience in safety matters, and also included Enforcement Officer C with the least enforcement experience, who was involved in safety for less than half of the time, describing herself as having a good background in safety matters.

By comparison, Group B included Enforcement Officer E, the oldest participant, who indicated a wide range of involvement in safety issues, and although being involved in safety for less than half of the time, who indicated that he was considered to be the department's expert on safety. Group B also included Trading Standards Officer D who appeared to have the least involvement in safety enforcement and described herself as having never specialised in safety legislation with only a basic knowledge of safety standards.

None of the respondents perceived themselves to be expert in safety legislation or standards or had previous experience of formal safety testing, i.e., where the results of their tests would be capable of being used as evidence in a prosecution. However, more respondents in Group A had been involved in any product safety referrals to the Consumer Safety Unit (CSU) for a RAPEX notification. Respondent E, who was the only Group B respondent who had experience of a RAPEX product safety referral, was also the respondent who had provided the most information regarding obvious hazards at first sight for each product and in identifying serious hazards.

Influence of Cognitive Factors on respondents

The analysis of safety factors identified by the personnel, before, during and after applying the safety appraisal method also indicated a number interesting findings. The range of hazards identified, and the variation in risk assessment scores determined by the respondents for the products proved to be unexpected. There was some discussion in Chapter 8 concerning whether this variation might be due to the apparent distortions in the method of scoring introduced by individual interpretation of risk assessment categories. It was suggested that better instructions and guidance in applying the risk assessment scoring methods might improve the consistency of the outcome.

The results achieved through the application of the Nomograph and Numerical methods of risk assessment are not clear cut and it has not been possible to establish a clear pattern in the declared or actual influence on the respondents of the cognitive factors identified for consideration in the final assessment of the products as more or less safe.

The clearest indication of influence of one of these human factors on the final risk assessment reported by respondents was the seriousness of consequences factor. All Group B respondents indicated that the seriousness of consequences of the hazards identified made them assess the Diabolo, Lacin' Beadin' and kettle as less safe, and two of Group A respondents also indicated that this made them indicate the Lacin' Beadin', kettle and ball as less safe. The obviousness of use of a product and the obviousness of any safety hazards appeared to give mixed results. Although the reported uncertainty about product use was greater for the Diabolo and Power Ranger toys, respondents reported that they were not uncertain about the use of for the Lacin' Beadin', the Jug kettle and Disney Ball, and these products achieved higher final risk assessment scores than the other products.

In retrospect, the acid test would have been to have concluded the appraisal by asking respondents whether they would have undertaken a product safety investigation on the basis of their appraisal using the two stage method, of any of the products, and whether they would have had the strength of conviction to seize or suspend the item in question. Although this question was not posed it is considered that this would be an essential conclusion to application of the method in future work.

About the different methods

The intention of enabling respondents to apply the product safety appraisal method, and to try both the Numerical and Nomograph risk scoring systems was to enable a comparison of the final risk assessment scores using both methods, and to seek respondent views regarding the relative usability of either risk assessment scoring system. However, the limited number of respondents applying the safety appraisal process and the limited number of times each scoring system was used must be considered before drawing definitive conclusions based on their comments.

The differing risk assessment outcomes achieved by respondents, even though using a systematic approach for the products selected, may indicate why different Member States have experienced differing levels of RAPEX notification for products marketed throughout Europe where safety is assessed without any objective framework.

This may not be wholly attributable to individual differences in the risk assessment strategies adopted by respondents. It may be partially attributable to the usability of the safety evaluation process developed by the author, and areas of ambiguity in particular in the respondent's interpretation of the categories for scoring utilised in the Numerical and Nomograph Task Analysis matrices.

Respondents using the Nomograph method identified more moderate to high risk hazards than those using the Numerical method for each product, except the Lacin' Beadin'. Conversely, respondents using the Numerical method identified more low risk hazards than those using the Nomograph method for all products, and particularly for the jug kettle. In this instance, respondents using the Numerical method identified more than double the number of low risk hazards.

The respondents identified the most moderate to high risk hazards for the jug kettle (18) followed by the Toy Ball (10), and Diabolo (3). There was a pattern in the number of high risk assessment scores by individual respondents. Respondents A and B identified the most High risk hazards by either method. Respondent C identified the fewest moderate to high risk hazards using either method. Respondents C and D determined mainly Low risk assessment scores using either method.

In terms of correlation with the author's risk assessment of safety critical hazards, respondents using both methods identified the potential projectile injury associated with the Diabolo, the potential choking hazard posed by the spinfighter for the Power Ranger Turbo Launcher, the potential choking hazard posed by the fruit shapes for the Lacin' Beadin', the potential scalding hazard from the steam vents for the jug kettle, and the potential choking hazard posed by the black stopper plug on the toy ball. It is also apparent that similar hazards identified resulted in different risk assessment outcomes by the different respondents. There were also variations between the respondents in the maximum severity of injury associated with similar hazards and the probability of similar injuries.

The New Zealand Ministry of Consumer Affairs indicated that would investigate any product where the risk assessment score determined through the application of the Nomograph method exceeds 60, placing higher priority on products as the score increased above 60.

Three hazards were considered by the author to be sufficiently significant to undertake a safety investigation, i.e. the risk of choking on the fruit shapes within the Lacin' Beadin', the risk of scald by steam from the vents on the jug kettle, and the risk of choking from the detachable black plug within the toy ball.

When the Nomograph risk assessment scores determine by the respondents for each of the products are compared with this "trigger value" only three products elicited Nomograph scores for hazards exceeding 60. This included the small parts choking hazard posed by the fruit shapes in the Lacin' Beadin' identified by Respondent E. For the jug kettle it included the unsleeved pins and also plug wiring identified by respondent B, the potential scald via the steam vents identified by respondent F, the potential to pull the kettle off worktop identified by Respondents B and F, and use of the wrong cleaner identified by Respondent B. For the toy ball it included the small parts choking hazard posed by the black closure identified by Respondents A and D, potential tripping hazard identified by Respondent D, and potential poisoning if the surface was toxic identified by Respondent A.

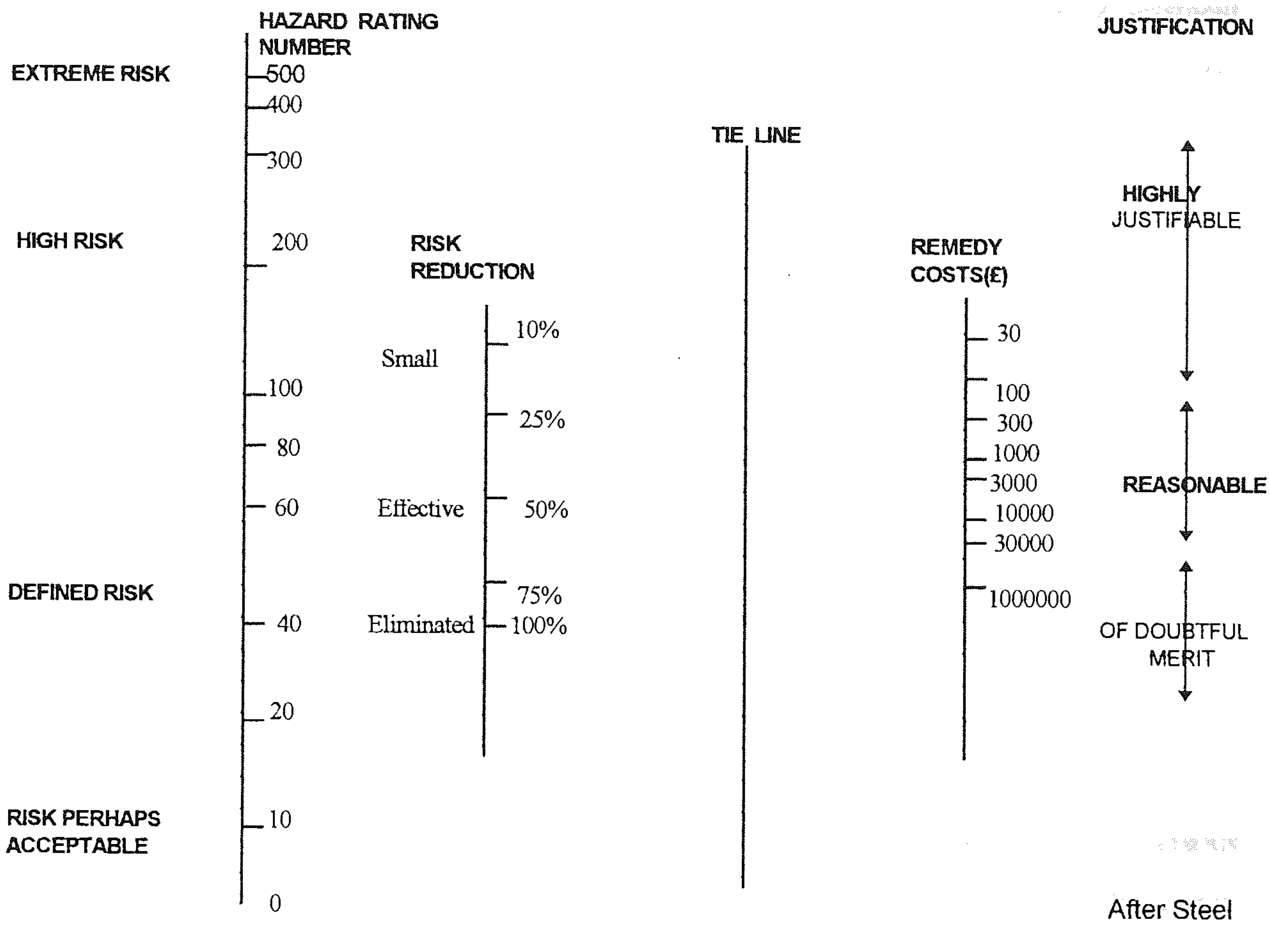
Two respondents using the Nomograph method attributed risk scores one category below the author (B and E) and only respondent F attributed a risk score of the severity as the author in relation to the risk of scalding posed by the steam vents in the jug kettle. Two respondents using the Nomograph method attributed risk scores similar to the author in relation to the potential choking hazard posed by the black stopper plug (A and D). Only one respondent using the Numerical method attributed a risk score to this potential hazard in the general order of risk identified by the author although a lower score than the author.

By comparison, the action timetable developed by Steel (1992) in relation to intervention strategies for work related safety risks, requires action to be taken within one month for products with a HRN score of 10-50, and within one week for a score between 50-100. These intervention timescales are more applicable to the work environment where safety actions can be introduced through improved working techniques or guards than for the home environment.

It is interesting that Steel proposes a method of evaluating the remedy which combines a knowledge of the remedy cost and the effects its application will have upon the risk for which it has been selected to provide consistent justification for the HRN values generated.

As shown in Figure 37, plotting the justification for strategies using his graphical model bears a close resemblance to the graphical model used within the Nomograph method.

Figure 37: Justification for Intervention



Spuriously high risk scores by comparison with the author's risk assessment were elicited by the Numerical method by Respondent A for the potential risk of injury caused by swinging the necklace round and injuring a child in the eye for the Lacin' Beadin' and for the Diabolo for potential flammability of the plastic film of its packaging, and by respondent F for the potential impact hazard for the Diabolo. In addition, higher risk assessment scores using the Numerical method than determined by the author were attributed by Respondent E in assessing the potential choking hazard posed by the Power Ranger and by Respondent B in assessing the potential pinching hazard posed by the trigger of the Power Ranger.

Respondents using the Numerical risk scoring system were not given the opportunity to test justifications for any safety intervention strategies to address the hazards for risk scores identified, and this would be another area for future work.

A number of difficulties were also expressed by enforcement staff in applying the method for identifying product safety hazards and applying risk assessment techniques. Three respondents indicated that the Numerical method was easier to use than the Nomograph method and three respondents found both risk scoring methods to be the same. No respondents reported that the Nomograph was easier to use than the Numerical method. There was no clear pattern, however, in the time taken to complete the Task Analysis matrices using either method. Despite these expressed difficulties, however, it is encouraging that the participants indicated that they were willing to use some of the proposed product safety appraisal techniques in the future.

It also apparent by comparing the completed Task Analysis Matrices that the risk assessment score derived via either method is sensitive to individual respondent's assessment of the categories within the Matrix.

Within the Numerical method variations in respondent's choice of category for "Frequency of Exposure" to the hazard identified and the category "Number of persons at risk" were capable of distorting the final score. A similar comparison can be carried out for respondents using the Nomograph method, and the influence of their selection of the "Availability" category on the final risk assessment score.

The range in the choice of categories regarding the availability or frequency of exposure of the products selected by respondents was unexpected, as both the availability of the particular consumer product in the market, and the likely frequency of exposure to the identified hazard for that particular product in the scenario depicted were considered by the author to be capable of objective assessment. However, clearer definition of the terminology and its application within the scoring system for future work would enable control of this variation in interpretation.

Having identified the potential bias in these categories demonstrated by respondents using either method, it is important that future work provides greater clarification to assist respondents in using the method, to increase the consistency of selection of these categories within the scoring system, and reduce any potential distortion.

The pattern of results of risk assessment scores using either method and correlation with the author's risk assessment is therefore not entirely clear. However, the Nomograph method appeared to elicit risk assessment scores more closely associated with those attributed by the author. It is rather ironic, therefore, when asked in the post appraisal questionnaire whether they might use either method again, that of the two methods five respondents indicated that they would use the Numerical method again, whereas only two respondents indicated that they would use the Nomograph method again.

Therefore further work is necessary, not only to encourage the take-up by enforcement officials across Europe of the utilisation of objective methods for safety appraisal and risk assessment, but also in providing training and developing clearer instructions in applying the safety appraisal and risk assessment scoring methods to improve the reliability and consistency of risk assessment outcomes.

9.2 Indications for Future Research

At best, the empirical work provides a pilot study for future work to develop and potentially simplify the two stage appraisal method. However, respondents were critical of the time taken in completing the Initial Product Safety Matrix, commenting that the re-iteration of aspects was unduly repetitive and time consuming, and the structure and content of the checklist appraisal would benefit from review. Before undertaking further research it would be beneficial to take the opportunity to improve the presentation of this element of the method.

At the outset, the author's intention was to develop an appraisal process which might be applicable to a broad range of consumer products, which has been reflected in the diversity of questions included within the Initial Product Safety Matrix. With hindsight this may have been over optimistic, and it may be possible to segment the range of consumer products into sub-categories to provide a dedicated matrix for each type of consumer product, and thus simplify the content of each matrix and the time taken in its completion.

The first stage therefore of future work would be to identify appropriate categories of consumer products and develop a number of simpler Initial Product Safety Matrices. However, caution is necessary to ensure that over-simplication does not reduce the applicability of the Matrices to products which potentially possess a number of novel features, or to address future novel products.

Also, it would be beneficial to undertake follow up research as part of training for safety enforcement practitioners in objective methods, potentially as part of a workshop following a formal session setting out how to apply the two stage method. This would provide an opportunity to reduce potential for ambiguity and inconsistency, and enable clarification of areas of misunderstanding or lack of knowledge or experience.

Improving the Definition of Risk Assessment Categories to Reduce Distortion

In order to reduce the potential for distortion in final risk assessment scores determined by respondents using the Task Analysis Matrix, it is proposed that elements of the Task Analysis Matrix would benefit from review. By defining each category within the Task Analysis Matrix more explicitly, this would increase the consistency of interpretation by product safety evaluators. In this respect it would be helpful to incorporate practical guidance from personnel currently using either risk scoring method.

As evidence of the current level of interest in application of objective techniques, a Trading Standards colleague has requested a secondment by the Institute of Trading Standards Administration (ITSA) College of fellows to visit New Zealand to work alongside consumer safety practitioners who developed the Nomograph method, as part of a study scholarship. The opportunity to combine the current research with the outcome of these practical experiences would enable the proposed product safety evaluation method to be developed and to reduce ambiguity and inconsistency, particularly to reduce the potential distortion of final risk assessment scores by different interpretations of "Availability". It also provides an ideal opportunity for future collaboration by colleagues within the UK and in the Pan European safety enforcement.

As there was a preference shown in the pilot study for a Numerical scoring method, future work would assist in improving its applicability to consumer product safety scenarios. For example providing actual examples of categories for "Frequency of Exposure" to the hazard identified and the category "Number of persons at risk" would assist the consistency and reliability of the final risk assessment scores determined when using the Task Analysis Matrix. Future work might also develop Steel's graphical method justifying intervention as described earlier in this chapter.

With the increasing number of Unitary local authorities and therefore joint Environmental Health and Trading Standards enforcement Departments this provides a further opportunity for joint working. Trading Standards and Environmental Health colleagues might work together both locally and regionally in discussing and developing scoring protocols derived from the Health and Safety at Work environment to apply to consumer product safety scenarios.

Simplifying the Task

Having refined the product safety evaluation method as discussed, in relation to the specificity of the Initial Product Safety Matrix, and definition of Risk Assessment Categories within the Task Analysis Matrix, it would be beneficial to carry out a further trial of the two stage method by a number of safety enforcement practitioners. To reduce the time spent in participating in research, the appraisal could be confined to the three products which potentially included significant safety hazards, i.e. the Lacin' Beadin', Haden Jug kettle and toy ball.

Also, to enable more meaningful comparisons of the usability and reliability of both scoring methods each participant would be asked to complete a Task Analysis Matrix to score **each** product using **each** method. A weakness of the current approach is that each participant scored two products using one method and three using the other. As a result it was difficult to determine whether variability on final risk assessment scores was due to individual differences in identification and analysis of hazards based on their previous knowledge and experience, or due to variability in interpretation and application of the risk scoring methods themselves.

The European Dimension

PROSAFE has not yet provided feedback regarding the suitability of application of the author's safety appraisal model by enforcement representatives from each Member State following further consideration of the empirical work. However, it would be interesting to test the applicability of the model for use in different countries. Ideally, for optimum comparison, the method would be repeated in relation to the same selection of consumer products by enforcement practitioners from each State to detect any national or cultural differences in their responses, strategies for completing the matrices and risk assessment outcomes.

Effectively, this European phase would follow the second experimental phase to carry out a safety appraisal of the three products which potentially included significant safety hazards, i.e. the Lacin' Beadin', Haden Jug kettle and toy ball. Again, to enable more meaningful comparisons of the usability and reliability of both scoring methods each participant would be asked to complete a Task Analysis Matrix to score **each** product using **each** method. This would also enable a comparison of the risk assessment outcomes of the further UK work with those determined by European safety enforcement colleagues. This would potentially enable exploration of whether variability on final risk assessment scores was due to cultural differences in identification and analysis of hazards based on their previous knowledge and experience, or due to variability in interpretation and application of the risk scoring methods.

9.3 Conclusions

The purpose of this research was to draw together various different disciplines to attempt to solve a practical problem for safety enforcement practitioners, and for those who market, design or manufacture consumer products, that is to develop and apply a robust model for appraising the safety of consumer products. By reviewing the ergonomics contribution to accident research, current approaches towards safety testing and the concepts of risk assessment and hazard analysis an insight has been provided into the interface between people and products, to enable the human factors contribution of risk assessment, hazard perception, and information processing to be considered. The focus of the research has been to develop a system of hazard analysis which can be applied to a wide range of consumer products, by drawing upon the various disciplines and perspectives presented in the literature survey.

As discussed within this and the foregoing chapter, the research has produced a number of unexpected findings, and also a number of interesting areas for further work. Rather than providing definitive answers, the research has posed a number of new questions and has identified a way forward, suggesting a number of areas for further work.

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