

SAFETY PSYCHOLOGY AND THE ERGONOMICS OF COMMERCIAL
KITCHENS

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ABSTRACT

The purpose of this study is to address the problem of safety in commercial kitchens and to isolate the causes of accidents. The term "accident" is defined in such a way so as to allow for purposeful investigation. Ergonomic principles are considered when looking at all the interacting elements of the system. An accident report form was designed for use in commercial kitchens. One hundred and thirty five accident report forms from fourteen restaurants in the East Rand and Johannesburg areas were collected over a period of eleven months. As this is an exploratory study, the statistical technique of correlation was employed in order to infer associations among variables. From the analyses of the results, three major accidents were isolated. These are slips, trips and falls; burns; and cuts. It is concluded that through the incorporation of design improvements the occurrence of accidents in restaurant kitchens would be greatly reduced. Hence, recommendations for the appropriate design and redesign of safe equipment to reduce the risk of injuries have been made.

DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Arts in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Talia Amiel

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9 day of 12, 1988.

In Memory of a Dear Friend

Charles Cohen

1962-1988

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CHAPTER 1

INTRODUCTION

A problem common to all societies is that of workers suffering injury, sometimes fatal, as a result of occupational diseases and accidents. The present research is thus concerned with isolating the causes of such accidents and thereby preventing their occurrence.

A major shortcoming of past safety research is the absence of a theoretical framework necessary for both predicting accidents before they happen and for acting as a cohesive force for drawing together the vast amount of information available. Perhaps the major drawback has been the omission of any attempts to analyse a whole sequence of events that lead up to the occurrence of an accident.

In order for any research into accidents to be meaningful, the definition of the term has to be decided upon in such a way that will allow for purposeful investigation. This is of great importance because of the emphasis which is placed on the consequence and cost of accidents. Thus, it will be established what constitutes deliberate, calculated and avoidable events in an attempt to overcome the central problems associated with the definition of "accident" such as an accident only being labelled an accident after the event.

In industrial practice attention tends to be focused primarily on accidents that cause injury. However, because injury prevention should be accident prevention as well, the task of incorporating safety and health considerations at the design stage of new equipment and technology depends

on the engineer's, designers', and technicians' knowledge of ergonomics and occupational safety and health.

The majority of injuries, including occupational injuries, are due to mechanical objects which cause injury through moving parts of machinery or falling objects. Thus, the appropriate design of safe equipment in order to prevent injuries is perhaps the most important prevention strategy possible.

When determining which events truly constitute an "accident" and which do not, will be shown to be a complex attribution process which will vary according to the decision makers involvement in the event. For the purpose of this research a suitable definition of "accident" will be presented as it is essential to broaden the definition of "accident" to include contributing factors such as health and safety and to demonstrate how they interact with other factors.

With the evolution of technology it is becoming more and more difficult to isolate and identify hazards. Thus, a more sophisticated approach to maintaining safety, other than mere intuitive intervention is therefore required. Initially this will involve the careful design of interacting elements by considering ergonomic principles.

In order to find the optimal structures to meet the criteria in the definition of ergonomics, it is necessary to look at the dynamic relationship between interacting components of the human-machine system (human, machine, workspace, environment, task structure and procedures). This will therefore be dealt with in detail with ergonomic principles being outlined. It will then be seen that accidents are symptomatic of a

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failure in the system and therefore they provide clues about the location of the source of failure, indicating where the mismatches occur and what kind of action is likely to be effective in reducing these mismatches. Thus, it is necessary to investigate all incidents which may offer symptomatic evidence of malfunction and not merely those incidents identified as "accidents" through consequences such as damage or injury.

Thus, the appropriate design of safe equipment to prevent injuries is perhaps the most important prevention strategy available. This study will attempt to isolate the causes of accidents in restaurant kitchens, which are suspected to be caused mainly through bad design of equipment.

The food service industry in South Africa is expanding rapidly. It can therefore be assumed that the number of accidents in this industry will increase. As such there is a definite need to explore the present situation and to assess what recommendations can be made in order to prevent, as far as possible, accidents from occurring.

Accidents in kitchens may result from cuts, burns, scalds, lifting injuries causing strains, falling objects, electrical shocks, trips, slips and falls.

It is suspected that results in the present study will yield information regarding the importance of a safe kitchen design. The present research will involve the combination of safety and ergonomic data. From this an appropriate conceptual framework in which to analyse activity in kitchen safety in commercial kitchens will be developed. Within this framework mismatches in interface design will be identified via a questionnaire which has been formulated based on the questionnaire administered by

Adams, Barlow and Hiddlestone (1981). All incidents which may offer symptomatic evidence of malfunction will be determined.

It is strongly suspected that from analysing the data, poorly designed equipment, poor procedures and poorly prepared individuals will be identified.

The research can be seen as comprising two distinct sections. The first, consisting of chapters two three and four, involves a theoretical analysis of accidents. The elements of an accident will be defined and this definition will be situated within the concepts which surround the field of ergonomics. Once this has been outlined, the issue of safety in the catering industry in South Africa will be expanded upon, including issues such as legislation and compensation.

The second section, consisting of chapter five through seven, contains the practical research. The rationale and procedure of the study are set out, the results are presented and then discussed in detail. The research concludes with suggestions for the improvement of safety in the catering industry as a whole.

CHAPTER 2

ACCIDENT DEFINITION

Many attempts have been made to define what is meant by the term "accident" in the context of industrial activity and exposure to hazard. Arbus and Kerrick (1951) define an accident as being the occurrence of an unplanned event, which being the result of some non-adjustive act on the part of the individual (variously caused) may or may not result in injury, in a chain of events, each of which is planned or controlled (Arbus and Kerrick, 1951).

From this definition a number of aspects concerning an accident may be observed. Firstly, it is the occurrence of the unplanned or unpredicted event that results in the accident. Secondly, this unplanned event is due to some non-adjustive act on the part of the individual concerned. Thirdly, the resulting injury is a consequence of this unplanned event, and the injury itself does not constitute the accident - it follows afterwards.

Probably the most theoretically important and comprehensive analysis comes from Suchman (1961) and takes the form of a set of seven related probability dimensions upon which the event is judged:

The degree of unexpectedness. The lower the probability of anticipation the more likely the event is to be labelled an accident.

The degree of avoidability. The lower the probability of avoidance the more likely it is that the event will be labelled an accident.

The degree of intention. The lower the probability of deliberate intent the more likely it is that the event will be labelled an accident.

The degree of warning. The smaller the extent of warning the greater the likelihood of the event being labelled an accident.

The duration of the occurrence. The quicker the event the greater the likelihood of it being labelled an accident.

The degree of negligence. The greater the recklessness or carelessness surrounding the event the less likelihood of it being labelled an accident.

The degree of misjudgment. The more mistakes in judgement surrounding an event the less likelihood of it being labelled an accident.

An "accident" will most likely contain some of the qualities of each of these probability dimensions. However, depending on the situation, the proportion of each dimension will vary. However, a number of problems are encountered when one puts these ideas into practice.

A central problem is that an accident is only labelled an accident after the event (Suchman, 1981). In addition there is a high reliance on the recall and interpretation of people who were involved in the accident in some way. Emphasis is placed on the outcome of the accident as opposed to the cause of the accident (Russel-Davis, 1966). A further problem is that the issue of negligence is hard to interpret (Fisher, 1986). Negligence can be interpreted in many ways and the characteristics of "recklessness" and "carelessness" are so varied that it becomes difficult to ascertain what negligence is or what forms negligence can take. This presents problems as to how much could have been known about the consequences of an accident or the potential for an accidental event. In addition, questions can be raised as to how much should have been known, and what level of awareness is acceptable under the particular circumstances surrounding the event. This in turn raises questions which are

related to wider issues of general awareness of technical factors which may at the time of the event be remote from the factors influencing the direct involvement in the activity leading to the event.

Thus, although the probability dimensions offered by Suchman (1961) present a clear statement of the major qualities of accidents, when determining which events truly constitute an "accident" and which do not, still remains open to complex attribution processes which will vary according to the decision makers involvement in the event (Kelly, 1979). The problem of cause, responsibility and blame, thus still remains unresolved. However, it is indicated that the resolution will normally depend on agreement between the differing estimates of these probability dimensions as may arise from various interested and involved parties.

Dunn (1971) advocates that in terms of human science research an accident should be defined as "an unexpected, unintended but not necessarily damaging or injurious event that disrupts the completion of (a planned) event" (Dunn, 1971; p7). In broadening the definition of accident it becomes important to broaden the idea of contributing factors, not simply looking for personal or environmental factors but also their interaction and their relationship with other factors which do not necessarily fall into either category, e.g; time of day and the effects of adjustment in circadian rhythm (twenty four hour "body functioning" cycle) upon performance, health and safety. This is important where the working of shifts is concerned.

Accidents present a major problem to all communities throughout the world. Advances in technology, communications and increased industrialisation bring with them economic and social changes with many consequences both

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Accidents present a major problem to all communities throughout the world. Advances in technology, communications and increased industrialisation bring with them economic and social changes with many consequences both

positive and negative. Accidents are a prominent feature in respect of the negative factors (Cliff, 1974). Many workers die or suffer injury on account of occupational diseases and accidents every year all over the world (Malentacchi, 1982). The most recent estimated number of deaths in the world shows that nearly three million people die annually because of an injury - producing accident (Romer, 1987). Figures indicate that while Britain suffered an average of 2.2 work related deaths for every 10 000 workers each year, and the United States suffered 12.8, South Africa suffered 22.8 (Sunday Star, 17 May 1987). In addition injury statistics may underestimate the severity of the problem as there are allegations that there is a large amount of "fiddling" by safety officers of injury statistics (Sunday Star, 3 May, 1987). No matter what the type of work in which the population in general is involved, there is always the potential risk of worker exposure to safety and health hazards (Nogueira, 1982).

Accidents in industry and agriculture cause heavy losses in terms of disability and mortality every year in the industrialised countries and are now increasing in the developing world. Although the World Health Organisation (WHO) has drawn up a medium term programme on the study and control of occupational and work - created diseases, it has so far given little attention to injuries due to occupational accidents. Very little has been done on the epidemiology of occupational accidents especially in developing countries and there is a need to establish national and international monitoring programmes in this field with adequate analysis of causes of accidents and means of control (Romer, 1987).

Occupational safety and health is a multidisciplinary and highly dynamic area of practical and scientific activity. The need to constantly improve

physicians', engineers', technologists', and workers' knowledge regarding accidents and safety derives from modern production developments such as the industrial and agricultural use of the latest scientific and technical innovations and the introduction of new processes, machines, equipment and rationalised procedures. These developments are often accompanied by chemical, physical, and biological risks to the workers' health and safety. Previously, occupational health was oriented to occupational disease and accident prevention. It is now involved in establishing optimal working conditions to prevent fatigue. Prevention of late effects of occupational exposure to mutagenic, teratogenic, embryotoxic, and carcinogenic factors are increasingly important. The pathologic action of certain agents are possible even at the low exposure levels; their effects may be long in manifesting themselves and may also appear in subsequent generations (Kundiev, 1982).

Thus, industrial activity exposes humans to a wide range of health hazards (Fisher, 1986). Hazards may be physical (exposure to physical agents such as radiation, heat, noise and vibration), such as in the catering industry, chemical (encountered principally through inhalation of workplace air but they may also be absorbed through the skin or ingested in the form of dusts, poisonous fumes or gases), and biological (including exposures to viruses, bacteria fungi and their products which may be released accidentally to the work environment). A fourth health hazard may be due to psychological factors and bad design of equipment (Beach, 1980). The effect of a hazard may manifest itself on a large scale such as the Kinross mine disaster of 1986 where a unique combination of events lead to dramatic and tragic consequences.

Although industrial activity exposes humans to a wide range of health hazards, this does not mean that exposure to hazards automatically leads to ill effect. The link between hazard and health is less direct. Moreover, the processes by which hazard is converted into ill health are often hidden. In many cases the hazard itself is not perceptible to the victim's sensory registers; for example exposure to ultraviolet light cannot be smelt, tasted, touched or heard; and many of the biological and chemical hazards to which we are exposed are evident in such small quantities that they escape detection. At other times the threat inherent in a particular hazard may be hidden by complex temporal events or by spatial proximity masking it, as is most common in impact events. Under such circumstances the most forceful indicator of exposure to hazard comes after a unique combination of events which declare the hazard in terms which may be both dramatic and tragic, as in for example, the Bhopal Gas Disaster of 1984, or, as earlier mentioned, the Kinross Mine Disaster of 1986. Typically when such events occur on less dramatic or smaller scales the term "accident" is used as opposed to terms such as "disaster", "catastrophe" or "tragedy" (Fisher, 1986).

Early studies in the field of accident research and safety utilised large quantities of data drawn from accident and other records, and attempted to categorise events and search for common factors by using standardised statistical techniques (Dunn, 1971).

The first major systematic investigation into accident causation comes from the statisticians Greenwood and Woods (1919) and Greenwood and Yule (1920) who published an account of accidents sustained by workers in munitions factories during World War I. Their findings suggested that the majority of accidents happened to a small number of workers. These

suggestions were largely supported by other industrial data collected by Newbold (1926). However, in each case the authors stressed that statistical research could only show what had happened, and not why or how it had happened. However, these findings were responsible for shaping volumes of research, mainly by psychologists, directed at discovering these missing determinants.

Throughout the 1930's and 1940's research findings from statistical, experimental and clinical investigations extended the list of potential "personal" factors which were thought in some way to underlie accident proneness (Surry, 1971 and Dunn, 1971). Examples of potential "personal" factors are: Vision: acuity, peripheral vision, colour vision, etc.

Psychomotor performance: motor control, speed of movement, accuracy of movement, applied force capabilities, etc.

Central nervous system attributes: arousal, vigilance, attention, simple reaction time, etc.

Sex differences

Intelligence and learning

Personality

Age differences

Differences in experience and training exposure

Risk acceptance differences

General health factors: temporary and long term illness- both organic and psychiatric, effects of artificial substances such as alcohol or common medication and drugs, etc.

Fatigue

Individual motivation

This same type of extensive research began to identify a wide range of influential "environmental" characteristics, in addition to those personal factors. For example:

Social factors: including economic, social and social psychological influences such as work group pressures, rate of output required, shared motivation, etc.

Thermal environment: factors such as temperature, humidity, etc and their effects upon human performance variables

Mechanical environment: noise, vibration, acceleration

Bio-chemical environment

Visual environment: factors such as field of view, glare, flicker, colour use, colour rendering, etc.

However, when looking at these factors it must be realised that an accident can be caused by any one of these factors or a combination of them. None of these factors alone can adequately explain accidents in all situations. To believe that a single characteristic such as sex differences or fatigue will determine an individual's involvement in all types of accidents goes against the notion of common sense and cannot be substantiated (Fisher, 1986). There is no easy combination of a few factors which can enable one to make a prediction as to the occurrence of an accidental event across a broad spectrum of circumstances (Surry, 1971; Shaw and Sichel, 1971).

A large amount of early research focused on the notion of "accident proneness" and attempts were made to isolate factors which characterised accident prone individuals in order to determine if there was a certain group which was more likely to have accidents.

The concept of "accident proneness" is based upon the idea that a person with certain personality characteristics was very likely to have accidents. When a person was said to be accident prone it was generally meant that he/she had some psychological characteristics which predisposed him/her toward having accidents (Ramdial, 1981).

However, when reviewing the early research on "accident proneness", it can be seen that the term "accident proneness" is often loosely and incorrectly applied to anyone who has more accidents than others who do the same type of job (Ramdial, 1981). These early studies ignore the fact that factors such as individual background and emotional disposition, alone cannot provide an adequate explanation of all accidents in every situation.

furthermore, no matter what combination of constitutional factors may be involved in their make up, the suggestion that a fixed group of people are responsible for majority of accidents, or are more prone to all types of accidents (Kerr 1950; Newbold, 1926; Farmer and Chambers, 1926), has no unequivocal experimental support (Arbus and Kerrick, 1951; Froggat and Swiley, 1964; Hadon, Suchman and Klein, 1964; Shaw and Sichel, 1971). Many of the factors singled out for research simply do not reflect the essential criteria for accident proneness (Surry, 1971). For example, the inclusion of "age" as a potential factor in determining an accident prone individual ignores the allegation that "proneness" is a relatively enduring personal idiosyncrasy. Membership of a particular age band is not an enduring personal characteristic, but rather a transient phase, so that if age is a contributing factor to unequal liability it is making its contribution in some way other than through "proneness".

Kirchner (1961) suggests that the concept of accident-proneness has received far more attention than it deserves. The term *accident-proneness* is often loosely applied to anyone who has more accidents, or *appears* clumsier than others who do the same type of work. However, this could be due to factors which are not the individual's fault such as a lack of training or no training at all, or because the area in which the person is working is cramped thus restricting his/her movement. Poor supervision or unfavorable attitudes towards accident prevention could also lead to accidents as well as a tolerance of poor work and safety conditions. A language barrier between the worker and his/her immediate superior could also be a contributing factor (National Safety Council, 1974).

Schulzinger (1956) suggests that true accident-proneness is a very rare and extremely ill defined phenomenon. During any one time period, it is virtually impossible to pick out certain people who tend to have more than their share of accidents. He argues that when the study is extended to a longer period, it will be found that the composition of the group changes, with new people coming in and old ones dropping out. Therefore, the majority of accidents over a lengthy time period cannot be attributed to a constant group of employees (Kirchner, 1961). This therefore discounts the theory that individual traits can be isolated in order to determine and identify accident prone individuals.

Kirchner (1961) makes the following observations:

1. By chance alone, some people are bound to have more accidents than others. (However, how is this determined?). This does not necessarily mean that these people are accident-prone; this may be illustrating nothing more than the law of probability or a propensity

to report "unusual events". In the same way, anyone can have a succession of accidents through chance alone.

2. This small group of people which is incorrectly labelled "accident-prone", is essentially dynamic in its membership. It is constantly gaining new members and losing old members.
3. Most accidents are the single experiences of many people. A few people will have many accidents, but most people will have none or very few. However, from the definition presented by Arbus and Kerrick (1951) it is unrealistic to assume that an individual will never have an accident as an accident does not necessarily have to result in an injury in order for it to be labelled an accident. From this it thus becomes questionable as to how Kirchner (1961) defines an accident.
4. There probably is a phenomenon that can be labelled "temporary-accident-proneness", temporary being the operative word. As people become more adjusted to the stresses and strains of living, and build psychological defences, they tend to avoid having accidents. From this observation it is necessary to question once again the notion of "accident-proneness" as "temporary-accident-proneness" in no way concords with the concept and definition of "accident-proneness".
In addition there is little convincing experimental evidence to support the suggestion of "temporary-accident-proneness".

Thus, without carefully investigating the circumstances surrounding an accident which a person has, it would be unwise to label a person accident-prone, as what at first may appear to be accident-proneness, could upon closer examination reveal other factors or conditions which are causes of accidents. A worker could be a victim through no fault of

his/her own. He/she may be working in poor environmental conditions such as having to use faulty machinery, or in a poorly lit and ventilated area, or under stress conditions, or the individual could have had little or no adequate training (Ramdial, 1981).

Thus, although the theory of accident-proneness seemed for many years to be a promising solution to the problem of work injuries, in actuality, when put in proper perspective, it contributed little to the overall problem (Beach, 1980).

It can therefore be seen that there is an absence of stable evidence to support the theory of "accident proneness". This notion has been viewed as too simple a concept (Reason, 1979). One cannot explain accidents by looking for personal or other factors as these factors do not recognise the complexity of the behavioural environment.

Dunn (1971) has presented a summary of the shortcomings of this early research. Because early research utilised records such as medical files or lost work time records in order to analyse existing accidents, a number of problems for data collection and analysis were created.

1. As has been discussed at the beginning of this chapter an accident is difficult to define. Definitions will depend upon whether one is concentrating on the causal factors or on the consequences of an accident. As a result differences are likely to occur as to the exact nature of the event recorded between records from one organisation or industry to another.
2. Events which are recorded in one industry or organisation may not be recorded in another. Thus, there is a differential recording of events. Because accident report records are based upon reported

accidental events, inconsistent reporting practices distort the analysis. As a result, such distorted records will normally hide large quantities of relevant information. More importantly, however, underreporting will lead to serious underestimates of the size of hidden consequential costs which are attached to accidental events.

3. Terms used to describe accidents may vary amongst sets of records. Description of elements such as jobs, workstations and procedures often hide similarities or create false ones. As a result there is difficulty in forming analytical dimensions for research purposes because of a lack of or non-standardised classification of data.

4. When the records being analysed are constructed to obtain "lost-time" information, it becomes difficult to separate lost time which is as a result of illness as opposed to lost time which is due to accidental events. Thus, there may be the compounding of accident and illness.

5. Severity estimates of damage and/or injury vary between organisations and with time. Interpretation depends upon the experience and qualifications of the individual making the estimate.

Commonality of accident and consequent injury will reduce the severity level reported. Conversely, Senneck (1975) has suggested that over a period of time, (years), views will change "about what types of injury a person should suffer and still be expected to continue working" (Senneck, 1975; p149). Such changes will distort the analysis of records if adequate correction is not made. Both the estimate of severity and the duration of recovery time are mediated by economic and social values as well as by certificating practices on the part of Medical Officers. Certification of a 3 or 7 or 14 day absence from work for recovery purposes need not necessarily reflect injury severity but may rather reflect the accepted norms for convenient certification.

The analysis of this accumulated data is influenced by a further five points of difficulty (after Dunn, 1971).

1. Conceptual and theoretical limitations. Limitations in determining what constitutes an accident present fundamental problems in terms of both definition and conceptual relationships. These limitations in turn lead to greater problems when isolating and investigating the phenomenon of accident causation.
2. Number of events. The number of "accidents" is comparatively small when comparing these events against the number of non-accidental events. These small number of events, upon which theories and investigation are based often do not lend themselves to isolating complex interactions.
3. Oversimplification of accident causes. Many researchers and theorists have attempted to identify and isolate single factors as causal determinants. Whilst such simplicity cannot be entirely ignored it is, however, more appropriate to examine multiple interactive components within any situation as true causes may be multiple and interactive.
4. Differential job requirements. Risks, skill requirements, social and economic pressures etc. It is extremely difficult to generalise from one situation to another as there are differences in factors such as risks, skill requirements, social and economic pressures.
5. The "missing behavioural link". Most of the early research into accident causation involved the analysis of data using standardised statistical techniques to reveal common factors. A major criticism here is that the records available for such analysis typically contain only minimal facts about each incident. Many critical factors within the behaviour preceding the event may thus be ignored. This may result in ad hoc assumptions about similarity

between events which in actual fact are not behaviourally related other than by the same consequences and outcomes attached to them.

Dunn (1971) made the suggestion that for the preceding fifty years safety research had lacked the theoretical framework necessary for both predicting accidents before they happen and for acting as a cohesive force for drawing together the vast amount of information available. Perhaps the major drawback to early work has been the omission of any attempt to analyse a whole sequence of events that lead up to the occurrence of an accident. The foundations for such an approach to accident investigation were laid in the mid 1960's. Russel-Davis (1966) investigated a group of thirty four railway engine drivers who had all passed signals at danger. Investigating each incident separately he found a variety of causes ranging from poor sight, to false expectation, to relaxation after stress (Russel-Davis, 1966).

In order for any research into accidents to be meaningful, the definition of the term has to be decided upon in such a way that will allow for purposeful investigation. This is extremely important because of the emphasis which is placed on the consequence and cost of accidents. It is inevitable that the cost arising from accidents, especially involving industrial accidents, should be clearly established, that liability for these costs should be identified, and ultimately, blame should be assigned, where relevant. Thus, it becomes necessary to legally and practically establish what constitutes deliberate, calculated and avoidable events.

With regard to accidents, management is faced with a serious and twofold problem. Firstly, there is direct financial loss, caused by accidents,

to the organisation, not only as a result of the actual loss in production of the workers who have the accidents, but also the holding up of work in other sections. Secondly, accidents give rise to a general state of disorganisation, such as crowding round the victim, and unnecessary movement which may have a demoralising effect on others (Roodhal, 1981).

For many years employers have had two reasons for making active efforts to reduce work injuries and advance the health of their employees. One is the humanitarian concern for the well-being of their employees and the other is cost. It is more economical to maintain an accident-free plant and have full attendance on the job than it is to have extensive lost time due to job-connected injuries and illness and to non-occupational sickness.

The cost of work injuries and illness includes the costs of lost wages, medical expenses, insurance claims, production delays, lost time, and equipment damage (Ashford, 1976). It thus becomes apparent that these costs reflect a serious problem in terms of human anguish, loss of income to affected workers, and cost to employers (Beach, 1980).

In industrial practice attention tends to be focused primarily upon accidents that cause injuries. But injury prevention should be accident prevention as well. In addition to the anguish and suffering experienced by injured employees, accidents are very expensive to the employer. In many cases the indirect costs of an accidental injury are considerably greater than the direct costs. Accident costs are classified into two categories. First are the insured cost which includes money paid for doctor and hospital bills, for weekly benefits while the injured employees are absent from work, and for any scheduled payments due to death, acci-

dental dismemberment, or permanent disability. This cost is readily apparent and is met by the insurance premium. The second category of costs due to accidents is called the uninsured costs or the indirect costs of accidents. These costs include lost time of injured worker, lost time of fellow employees who render aid to the injured worker, time spent by supervisory personnel to assist the injured man and to investigate the cause of the accident, lost production, possible damaged material or equipment, and administrative expenses to process paper work connected with the accident (Beach, 1980). Other costs include costs of replacing the injured employee and miscellaneous costs including any overtime caused by the accident, loss of income due to missed delivery dates, and the costs of maintaining a first-aid dispensary for accidents that do not technically result in lost work time (Flippo, 1984).

The ratio of the uninsured to the insured costs varies widely from factory to factory according to the particular situation. However, investigators have found that these uninsured costs tend to average about four times those of the insured costs. Thus, the insured or direct costs represent only about 20% of the total costs on the average (Beach, 1980). For some companies in high-risk industries the premium for workers' compensation insurance may run as high as 15% to 20% of payroll. If one estimates that the total cost for accidents in any one year is five times this figure, it can be readily seen that the accident rate can determine the difference between profit and loss for a company (Beach, 1980).

Positive action by management to maintain not only "good" working conditions but in addition "good" employee health (physical and mental) is bound to reduce the accident rate and lower charges for workmen's compensation. The initial cost of establishing a good work environment and

an occupational health programme often discourages management from making investment, however, the long-term prospect of reduction in the cost of accidents may provide the impetus to adopt such a comprehensive programme (Beach, 1980).

The task of building in safety and health at the design stage of new equipment and technology depends on the engineers', designers', and technicians' knowledge of ergonomics and occupational safety and health. Existing education and training systems in this field should be improved and training programmes on ergonomics, safety engineering and occupational health should be developed (Kundiev, 1982).

Common to most ergonomic changes is that they interfere with the production process. New equipment often interrupts the production process and the workers require additional training. Often some aspect of the production process itself needs to be altered, requiring the assistance of production engineers. The financial implications of such changes are sufficiently important to be considered in detail by company management. Management and production engineers usually have no training in ergonomics and may therefore be reluctant to accept that certain tasks can have serious consequences to the workers' health. This reluctance and the financial consequences often turn what is a positive attitude in principle into a negative one, and it is found that much-needed changes in the work environment are blocked or delayed for a number of formal reasons which could have been avoided (Westgard and Aaras, 1982).

In addition to the financial burden imposed by accidents upon a company, those workmen who are injured also bear a substantial cost. Most workers have to wait before they receive compensation. Compensation is often

not sufficient, and for permanent partial dismembersments the scheduled benefits are rarely adequate to compensate a worker for his future loss of earning power (Beach, 1980).

In conclusion, at all stages of accident research it is important to bear in mind the problems involved such as the central problem of an accident only being labelled an accident after the event (Suchman, 1961). When determining which events truly constitute an "accident" and which do not, still remains open to complex attribution processes which will vary according to the decision makers involvement in the event (Kelly, 1979).

When looking at early research into accident research it can be seen that there is a difficulty in drawing together the vast amount of available information because there has been a lack of a theoretical framework necessary for predicting accidents before they happen. Perhaps the major drawback to early work has been the omission of any attempt to analyse a whole sequence of events that lead up to the occurrence of an accident (Dunn, 1971).

In order for any research into an accidents to be meaningful, the definition of the term has to be decided upon in such a way that will allow for the operationalisation of purposeful investigation. Thus, for the purposes of the present research, an accident will be defined as "an unexpected, unintended but not necessarily damaging or injurious event that disrupts the completion of (a planned) event" (Dunn, 1971; p7). It is essential to broaden the definition of "accident" to include contributing factors such as health and safety and to demonstrate how they interact with personal or environmental factors as it is not sufficient to consider only personal or environmental factors.

In modern industry, when looking at work, it can be seen to involve more than simply human-work interaction. As technology has evolved humans have been progressively separated from primary work transformations through the introduction of equipment, machinery and procedures. This more complex situation makes it less easy to isolate and identify hazards. Thus, it is becoming increasingly difficult to maintain safety by relying solely on intuitive intervention. A more sophisticated approach is therefore required. Initially this would involve the careful design of interacting elements by carefully considering ergonomic principles. However, it must be emphasised that the consideration of ergonomic principles in system design is only a first and starting point as it is unrealistic to expect that there will be a perfect matching of elements and if such a perfect match is found that it will endure as work practices evolve and task demand characteristics change. Work design must be constantly monitored for systems malfunction and any malfunction which is detected must be constantly redesigned (Fisher, 1986).

The present research will involve the amalgamation of safety and ergonomic data in order to develop an appropriate and rigorous conceptual framework to analyse activity and kitchen safety in industrial kitchens. Within this framework mismatches in interface design will be identified via a questionnaire, which will be formulated in a manner similar to that administered by Adams, Barlow and Hiddlestone (1981). The use of this questionnaire will yield information that is already categorised in terms of injury agent, activity surrounding the incident, immediate cause of injury and interface matching. The major advantage to using this questionnaire is that the accumulated data, which can be easily analysed and interpreted will reveal redesign needs. By recognising the importance of focusing on mismatches between components of the system it becomes

imperative that all incidents which may offer symptomatic evidence of malfunction be determined.

The problem of accidents and safety in the catering industry and commercial kitchens has been brought to the attention of the present researcher by the industry who wish to investigate the causes. However, the incidents of accidents in the catering industry, specifically in commercial kitchens, are difficult to define. From the nature of the industry accidents are likely to be small scale and as a result won't necessarily require reporting. Thus, there is severe underreporting and the full extent of accidents is therefore not known despite the fact that the problem is a continuous one. Due to the small scale nature of accidents, there is very little available data from which to work.

It is strongly suspected that from analysing the data, poorly designed equipment, poor procedures, and poorly prepared individuals will be identified. From this generated data further recommendations will be made regarding alternative designs.

It now becomes pertinent to review the ergonomics approach to accidents in more detail. This will be discussed in Chapter 3.

CHAPTER 3

ERGONOMIC PRINCIPLES

Ergonomics is the analysis and design of work supporting "human-machine" systems" based upon the joint criteria of systems efficiency and the preservation and promotion of human well being. Its main concern is the adaptation of work, mainly in the field of physical and perceptual demands, and some of the psychological demands presented by experimental psychologists to what people can and ought to do.

Thus, it is necessary to take an in depth look at all the interactive elements of the system. However, before this can be done, it is necessary to define what ergonomics is.

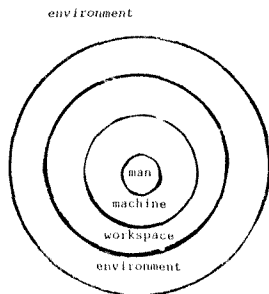
Ergonomics is defined as the study of the relation between man and his occupation, equipment and environment, and particularly the application of anatomical, physiological and psychological knowledge to the problems arising from them (Shackel, 1966). Machine designers are mostly concerned with the improvement of the mechanical, electrical and other performance aspects of their machines. However, the machine is a part of the total system and must not be viewed in isolation. Often the machine is one element in the man-machine system, and what is important is how well the machine works in conjunction with the operator who has to use it day after day in his routine work (Shackel, 1966).

Thus, finding the optimal structures to meet the criteria encompassed in the definition of ergonomics, necessitates recognising the dynamic relationship between interacting components of any human-machine system

which are the human, machine, workspace, environment, task structure and procedures.

The interaction between man and his equipment must be optimised. With man at the centre of the system, it is possible to work outwards from him/her, (considering factors such as sex, age, and motivation), firstly looking at his/her interaction with the machine or task (which involves looking at the man in terms of information transfer, actions and layout panels and equipment e.g., display control compatibility). Secondly, one looks at man's interaction with the workspace around him/her (reach, chairs, machine size, desks, etc.), and finally one looks at the general environment e.g., the influence upon behaviour and performance of physical, chemical, biological and physical aspects such as light, smell, ventilation, workteam, shift conditions, discomfort or risk (Singleton, 1966). This is illustrated in Figure 1.

Figure 1. Man's interaction with machine, workspace, and



From W.T Singleton.

Current trends towards systems design. (1966)

An understanding of the ergonomics approach to the analysis and design of work is particularly dependent upon a correct grasp of the complexities of the human at work. A general statement of the ergonomics perspective would be to consider the whole of the human in the whole of the work situation. Thus, it is necessary to expand on what is meant by "the whole of the human", and "the whole of the work situation".

A useful way to conceptualise "the human" is to consider the individual's capacities to work, and the constraints which limit his performance. The term "work" is not used in this context to denote gainful, paid employment, but rather it represents something more fundamental such as the expenditure of energy, or the application of effort or exertion to a purpose. In more specific terms, "work" is any activity which requires more than the minimal energy exchange necessary to support life (the basal metabolic rate). Once this minimal level has been surpassed it becomes possible to identify 3 major work-supporting dimensions inherent in the human organism.

The first dimension is one of anatomical, structural reality. Its determinants will be anthropometric characteristics and musculoskeletal organisation. The variation in human anthropometric characteristics is not confined to the obvious factors such as height, but extends to each body component identifiable as a metric difference between skeletal or muscular "landmarks". A further set of dimensions emerges when the body is engaged in such physical activities as stretching or reaching. These are referred to as functional or dynamic anthropometric measurements. Anthropometric variation is further complicated by factors such as age, gender, race, nutrition, time of day (which leads to postural and skeletal adaptive changes). Thus, it is necessary to note that people exist in a

remarkable range of shapes and sizes and that this in itself creates design problems.

The second major work-supporting dimension is the individual's ability to engage in physical work which is dependent upon the dynamic functioning of anatomical structures. The efficiency of converting stored energy into musculoskeletal activity, the limitations of joint movements and the general functional construction of the musculoskeletal system, together dictate the range, speed, strength or force, endurance and accuracy characteristics of our bio-mechanical functioning (Grieve and Pheasant, 1982; Tichauer, 1978). Once again these characteristics present a wide range of individual differences which become important when an attempt is made to prescribe physical work for people to undertake.

The third major work supporting dimension is a necessary factor in the regulation and control of the overt application of our physical capabilities. The human capability to process information from a changing environment is at the heart of our physiological, psychological and social reality (Lindsay and Norman, 1977). Effective use of our musculoskeletal system is dependent upon the complex functioning of the central nervous system. Its ability to convert environmental changes into mental representations, to process these representations, and the manifestation of this processing in terms of our interaction with the physical and social environment, is the key to our continuing existence (Anderson, 1980; Kantowitz and Sorkin, 1983).

The human capacity to process information, our internal mental capabilities, includes many subtle cognito-perceptual characteristics. On an intra-individual basis our human information processing strategies are

highly flexible. On an inter-individual basis the range can be staggering (Anderson, 1981; Eysenck, 1984).

Any attempt to consider the "whole of the human" must thus recognise that the human capacity for work covers a range from purely physical to purely cognitive (internalised) mental workloads and that any notion of a common obvious capacity to perform any particular aspect of the work is compounded by the high inter-individual variability apparent in each of the three principal work-supporting dimensions.

Having thus created a complex and highly variable image of "the whole of the human", it becomes necessary to consider what is meant by "the whole of the work situation". The dimensions of the work situation will be considered as levels of interaction. For an ergonomist the central component to any work situation is the human work performer. In order to formulate the first level of interaction in the work situation it is necessary to acknowledge that it is quite rare to find humans engaged in work of any kind which would not be alleviated by the use of some man-made job aid, tool, piece of equipment or machinery. These are referred to as machines. Machines can be designed to facilitate human use by fully considering the necessary interaction between human and machine, and the demands that this interaction places upon the known constraints and capacities to the human to perform work (e.g., anatomical, physiological and psychological limitations). The objective is to facilitate human use by making the design of machines more appropriate to these human performance parameters. More appropriate, however, is not the same as more simplified.

If this line of thought is further extended, it should be obvious that the human using machines to perform work will require a certain amount of three dimensional workspace. The amount and layout of this workspace will depend in part upon the dynamic anthropometric characteristics of the human, in part upon the design characteristics of the machine, and in part upon the nature of the task itself e.g., materials to be handled transformations to be undertaken, etc). Again this workspace may be more or less well designed to facilitate human involvement in task performance, depending on the extent to which these interacting factors are considered

Any workspace must be further supported within a larger environment with thermal, mechanical (acoustic, vibratory, impact and acceleratory), visual and bio-chemical physical aspects as well as social psychological and wider societal aspects. Again these factors may be controlled or designed in order to optimise the interactions between human, machine and workspace and so facilitate task performance.

At this point it becomes pertinent to review a number of environmental factors which may become hazards to the worker in the industrial setting.

The physical environment in which the work is performed may contribute to undue fatigue and may have other injurious industrial consequences. It should be readily apparent that certain environmental conditions may be either directly or indirectly responsible for accidents. Such factors as improper illumination or temperature may either act directly as causes of accidents by making it virtually impossible for the worker to perform with any degree of safety or may act indirectly by making the job unpleasant and the worker incautious (Ramdial, 1981). This has special

significance with regards to the catering industry where worker's often work in an extremely hot environment.

These environmental factors will be reviewed under the title of industrial hygiene

Industrial hygiene has been defined as that science and art devoted to anticipation, recognition, evaluation and control of those environmental factors of stresses, arising in or from the workplace, which may cause sickness, impaired health and well-being, or discomfort and inefficiency among workers or among the citizens of the community.

The term "industrial hygiene" refers not only to industry and to hygiene. In fact the term covers all the workplaces (not only in industry) and the stresses and nuisances that can be objectively and scientifically measured. Thus, industrial hygiene can be seen as the science of the occupational environment.

There are a number of factors which can be viewed as part of industrial hygiene: Chemical factors including things such as gases, vapours, fumes, dust etc., physical factors such as noise, lighting, vibrations, heat radiations and biological factors including micro-organisms (Guillemin, 1982).

A number of chemical factors and physical factors will now be expanded upon as these are relevant to this study.

Chemical factors

Dust

Every operation and action in the workplace releases a certain amount of dust into the air. Movement of people can release dust from clothing and skin. Dust that has settled on floors and flat surfaces is made airborne by air currents as people move about their work. Windborne dust enters buildings particularly in dry weather and more so in densely populated areas. Together with particles released by the operations within a workplace such as handling of materials, machining, cutting, drilling, grinding, milling, sanding and planning of items being manufactured, a dusty working atmosphere can be produced. Although most dust particles are harmless, in sufficient quantities dust can cause discomfort and unpleasantness. At such levels it is termed a "nuisance dust". However, some dusts are distinctly harmful, giving rise to carcinoma, chronic lung disease, asthma, bronchitis and other disorders (Gill and Aston, 1982).

Not only does the chemical composition of the material and its airborne concentration determine its detrimental effects, but also the particle size influences the part of the lungs where the material is deposited. Large particles are collected in the nose and throat whilst smaller ones are deposited further into the lung, the next stage of collection being in the upper airways, i.e. the bronchi and bronchioles, where self-clearing action by the ciliary movement takes place. Some particles are breathed out again and some are removed by body fluids but others remain and cause physical and chemical reactions which can be harmful in both the short and long term, sometimes leading to permanent lung damage (Gill and Aston, 1982).

Physical Factors

Noise

In modern environments it is difficult to find a situation where noise does not occur. Even people in offices and computer rooms experience noise levels which may cause concern and many industrial situations are noted for their continuous sound output. In order to assess the health hazard of a noisy working environment it is necessary to measure the worker's exposure "dose" of noise. This means assessing the sound intensity, the duration of exposure and the pitch of sounds produced in the workplace (Gill and Aston, 1982). Noise has become such a pervasive aspect of working situation and community life as to be referred to as noise pollution and to be considered a health hazard (McCormick and Sanders, 1983). Although noise has commonly been referred to as unwanted sound, a somewhat more definitive concept is the one proposed by Burrows (1960), in which noise is considered as "that auditory stimulus or stimuli bearing no informational relationship to the presence or completion of the immediate task" (Burrows, 1960).

Permanent hearing loss is the consequence of physiological damage to the mechanisms of the ear. The onset of a loud noise will cause a startle response, characterised by muscle contractions, blink, and a head-jerk movement. In addition, larger and slower breathing movements, small changes in heart rate, and dilation of the pupils occur. There is also a moderate reduction in the diameter of blood vessels in the peripheral regions, particularly the skin (Burns, 1979). All these responses are relatively transient, and settle back to normal or near normal levels very quickly.

The physiological reactions to noise usually would not be regarded as being of a pathological nature if the noise occurred only a few times.

However, there is an accumulating body of evidence that indicates that exposure to high noise levels acts as a stressor and that over a period of years it may produce pathological side effects and thus may constitute a health hazard (Jansen, 1969; Burns, 1979; Gulian, 1974).

Gulian (1974) reports on several European studies which show that people working in high levels of noise have more somatic complaints than workers in low levels of noise. "High-noise" workers complain more of irritability, headaches, tiredness, bad sleep and heart pains (Gulian, 1974).

The particular effects of noise on performance depends on, among other things, the characteristics of the noise itself and the nature of the task being performed. A few generalisations, however, can be made about the effects of noise on performance. With the possible exception of some memory tasks (Hockey, 1978), the level of noise required to obtain reliable performance effects is quite high. Performance of simple, routine tasks may show no effect and often will even show an improvement as a result of noise. The detrimental effects of noise are usually associated with difficult tasks which require high levels of perceptual or information processing, or both (Eschenbrenner, 1971).

Although there is beginning to be some consensus on the effects of noise, there still remains considerable controversy over why, or how, noise has the effect it does.

In addition to affecting performance noise can be annoying. Loud noises are usually more annoying than soft noises, however, there are exceptions. Annoyance is measured by having subjects rate noises on a verbal scale,

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In addition to affecting performance noise can be annoying. Loud noises are usually more annoying than soft noises, however, there are exceptions. Annoyance is measured by having subjects rate noises on a verbal scale,

such as: noticeable - intrusive - annoying - very annoying - unbearable. There are a host of factors both acoustic, (such as sound level and frequency), and non-acoustic, (such as listener's activity, past experience with the noise and time o day), that influence the annoying quality of a noise (McCormick and Sanders, 1983).

Ventilation

Where natural ventilation does not provide an adequate exchange of fresh air, mechanical devices such as fans may be provided to supply or extract air locally or to ventilate an environment in general. Mechanical ventilation may take the form of an exhaust system (extraction of air from the factory), an induction system (blowing of air) or by using plenum ducting (conducting of air to where it is wanted, or a combination of both extraction and blowing in). The advantage of plenum ducting is that a better control of the air movement is possible (I.L.O., 1971). Ducting may be of considerable length and contain bends, changes of section, branch pieces and other fittings. Together with the capacity to draw in fresh air or to recirculate it, the system may contain filters, heaters, coolers, humidifiers or a combination of these and, to prevent atmospheric pollution from the discharge of dirty air, dust collectors and various air cleavers may be used. The performance of these ventilation systems requires that they be checked from time to time to ensure their satisfactory operation. This may involve measuring air volume flow rates, velocities and pressures inside ducts and the tracing of airflow patterns around ventilation terminals such as : extraction hoods, slots, enclosures and fume cupboards (Gill and Aston, 1982).

Clean fresh air should be supplied to closed work places at such a rate as to effect a complete change of air a number of times per hour which

may vary from six for sedentary workers to ten for active workers (I.L.O., 1971). This is of special importance when looking at the catering industry.

Temperature

The human body generates heat as a result of the burning of fuel. If that heat is dissipated too slowly deep body temperatures will rise, the opposite occurring if the outward heat flow is too fast. The rate of heat transfer between the body and its surrounding depends upon the thermal environment in contact with the skin.

Many indoor workplaces display unsatisfactory thermal environmental conditions for example: high radiant sources can be found in steelworks and glass making, high humidities in laundries, kitchens and deep wet mines, and cold conditions in deep-freeze stores and warehouses (Gill and Ashton, 1982).

The temperatures to which industrial workers are exposed in the course of their work vary from time to time during the course of the working day. Moreover, the workers are exposed to extremes in temperatures during summer and winter. In some industries, such as the catering industry, the workers are exposed to extremely high temperatures, while in other industries they are exposed merely to climatic temperatures. The level of heat that can be tolerated without adverse performance effects, depends on the type of work that is carried out. In the case of heavy physical work, temperatures should be somewhat lower than in the case of light work, because of the increased metabolic rate brought about by heavy work.

In a study by Vernon (1943), it was found that fewest accidents occur when the temperature is in the vicinity of 21 degrees Celsius. The rate is considerably higher when the temperature is below 18 degrees Celsius or above 24 degrees Celsius. Wyndham, Strydom, Cook and Mauetz (1959) studied gold-miners filling mine cars in South Africa and found that performance deteriorated with higher temperature.

Excessively high or excessively low temperature and inadequate ventilation reduce productivity through sickness, discomfort and lowered vitality of the workers. The main cause of discomfort caused by working in a poorly ventilated factory is not the greater concentration of carbon dioxide in the air, but the reduced rate of heat loss from the body to the surroundings (Ramdial, 1981). Heat may effect, amongst other things, mental activities and performance in industrial settings (McCormick and Sanders, 1983).

Lighting

In a 1953 edition of a publication entitled American Standard Practice for Industrial Lighting, the Director of the Bureau of Labour Standards expressed how good lighting speeds production. It is essential to the health, safety and efficiency of workers. Without it eye damage will occur, accidents and spoilage of material will increase, and production slows down (Viteles, 1962).

It is important that workplace lighting is maintained at a good standard, that is, lighting levels must be sufficiently high to enable workers to clearly see their tasks but not too high as to cause glare or dazzle. Poor workplace lighting not only creates eye strain, particularly if the

task to be performed contains small detail, but can cause fatigue leading to errors in the work and an increased accident risk.

Sources of illumination can be divided into natural (daylight) and artificial (usually by means of electric lamps). Very few workplaces rely solely upon daylight whereas many are entirely artificially illuminated. Different levels of illumination are required for different tasks, thus workplace lighting must be designed for the type of work to be undertaken. However, work patterns change, sources of illumination deteriorate with age particularly in industrial situations, that is, windows and light fittings accumulate dirt which reduces the amount of light emitted and surfaces become dirty, reducing the amount of light reflected from them. This often occurs so gradually that it goes unnoticed. Therefore it is necessary for workplace lighting levels to be measured from time to time and the results checked against recommended standards.

However, it must be stressed that the presence of the correct level of illumination does not necessarily mean that the workplace is properly lit. The position of the source of light in relation to the worker and the workpiece may seriously affect the way the task is seen. The appearance of solid objects will be influenced by the direction from which the light comes and unshielded sources of light will cause glare if they appear within the field of view. Also if the work involves the identification of different coloured materials then certain sources of light can alter colours, sometimes making two different colours appear the same (Gill and Aston, 1982).

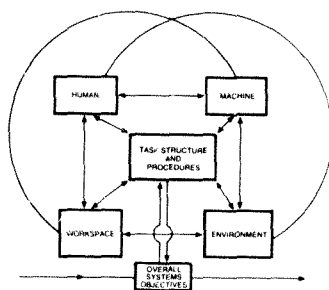
When it is not practical to modify extreme environmental conditions in order to make it tolerable for people to work, then alternative actions

must be taken such as rotating workers and establishing rest periods (Randial, 1981). The efficiency of lighting depends on its quantity and quality. Factors which determine the quality of lighting include glare, diffusion, direction and uniformity of distribution, colour and brightness (Randial, 1981).

It must be remembered that these represent only a sample of environmental factors which may become hazards to the worker in the industrial setting, especially in restaurant kitchens.

Each of these components of the "work situation" (human, machine, workspace and environment) will thus be influenced and shaped by the demands made upon them by each of the other components as well as by the demand characteristics of the task in terms of the materials and transformations to be handled. This relationship is expressed in Figure 2.

Fig 2. The components of the "human-machine-system" (After Fisher, 1986).



Clearly the potential combinations of these interacting factors are many and complex. In essence then these are the intertwined components of what

has become known as the "man-machine system" (Singleton, 1974). Finding the optimal structure for any chosen human-machine system is the concern of ergonomics.

As mentioned previously, optimal human-machine systems will require that the interfaces between all interacting elements are properly engineered to take account of the individual elements (Edwards, 1981; p114). In this context the "human" part of the "human machine systems" refers to the fundamental work-supporting characteristics of human beings, anatomical, physiological and psychological- including cognitive information processing.

It is important to note that the man-machine interface is subject to a number of constraints which originate from the machine as well as the man. These consist of elements such as technical constraints and perceptual constraints. When attempting to match man and machine, a number of interface constraints arise as well. Thus, the adequacy of the design will depend on the extent to which these constraints can be overcome. The interface between man and machine in the design of complex systems has always been of concern to ergonomists. The recent trend has been to recognise the shifting nature of this interface, with much attention being concentrated upon the design of communications across the interface. With the unprecedented rate of technological development over the past ten years, which has enabled almost unlimited provision of cheap powerful computing for information processing and machines control, this interface can be placed almost anywhere we choose. Almost any system can now be automated and the consequent constraints upon our choice of how to allocate functions between man and machine are in danger of becoming merely economic (O'Brien, 1983). There are many situations and equipments in

industry where ergonomics could greatly improve the operational usage and minimise the waste, which is often attributed to operator error or ignorance. The commercial kitchen will be shown to represent such a situation.

When considering man-machine interaction, it is useful to think of them in terms of a complete information flow loop, all parts of which must be functioning properly and not causing delays in the flow of information if successful, safe and efficient working is to be achieved i.e. the communication between man and machine can be viewed as an information flow loop connecting their respective inputs and outputs (McCormick and Sanders, 1933).

Machines communicate with people but this communication is a two way process as the user often has to do something e.g., pressing a knob to obtain or to respond to the information. The efficient operation of a machine depends on the ease of this two-way communication. Owing to the limits placed on modifying the capacities of the human being, it is necessary to fit the machine to the user. Thus, the designer does not achieve complete success if the user has difficulty in reading the displays or operating the controls, and the information is not passed on quickly and accurately. It can therefore be seen that the human-machine interface can be conceived simply as consisting of a two-way communication between man and machine. Information about the machine process state needs to be "displayed" to the human who will eventually need to communicate his "action" requirements to the machine by way of "controls" (Murrel, 1976).

It has been found that errors tend to occur in man-machine systems when the tasks are greater than the user's mental capabilities (Michaelis, Miller and Hendler, 1982). Both man and machine need to be geared toward satisfying the requirement of reliability. Man, however, seems not to be meeting the requirements that are necessary for successful operation under these situations (Rolfe, 1973). In determining how hard a man has to work it should be borne in mind that the reliability of the man is related to the load that is placed upon him (Rolfe, 1973). The possibility of overloading and underloading always exists and these stresses can have adverse effects on the quality of the operators response. Thus, measures of workload become increasingly important especially due to what may result from "human error".

Rook (1962) developed a scheme to be used in the classification of errors in an operating system. This formulation consists of A (intentional), B (unintentional), and C (omission). In this formulation intentional does not refer to intentional errors but rather to acts which the individual performed intentionally, thinking that he/she was doing the right thing when in fact he/she was not (McCormick and Sanders, 1983).

There is a common sequence of psychological functions that is basic to all behaviour namely stimulus, organism and response. Meister (1966) points out that human error occurs when any element in this chain of events is broken, such as a failure to perceive a stimulus, inability to discriminate among various stimuli, misinterpretation of meaning of stimuli, not knowing what response to make to a particular stimulus, physical inability to make a required response, and responding out of sequence. (Identifying errors is a first step in developing intuitions about how to reduce the likelihood of errors).

At present, psychological research is suggesting that our cognitive processes are such that "actions-not-as-planned" (ANAP's) are an inevitable and natural feature. Ergonomics research reveals that work can be tailored to suit human parameters. It may be that a different understanding of "accident" is becoming possible. In order to gain a clearer understanding of this, it is necessary to look at ANAP's in more detail.

From the recent work of psychologists on the cognitive (mental) structures which govern or guide behaviour some important clues to the fundamental relationships between ongoing behaviour and the occurrence of an accident have emerged. Norman (1981) and Reason (1975, 1976, and 1979) have focused research upon those particular incidents which occur when a well prepared mental "plan" or intention goes wrong in the execution phase. These can be viewed as an ANAP or action-not-as-planned. "I intended to phone a friend in Durban, but I started to dial my home phone number in Pretoria", is an example of an ANAP (Reason and Mycielska, 1982). Clearly an ANAP in itself is not an accident unless the circumstances penalise it (Reason, 1975). The unit of study then should not be simply the occurrence or a reported accident, but rather the ongoing sequence of events surrounding an ANAP.

ANAP's can be divided into 4 types (Reason, 1975); viz. storage errors, in which the original cognitive plan was incorrectly stored in memory during the required action sequence; test errors, in which the operator incorrectly checks the progress and outcomes of a sequence of action; discrimination errors, in which the "initiating stimulus" or cue which tell the operator to carry out the sequence of actions is wrongly identified; and selection errors, in which an incorrect or inappropriate response is selected and carried out. Thus, there is evidence for the human

disposition for lapses in the performance of cognitive intentions. Research illustrates the flexibility and complexity of the cognitive processes that support the planning and execution of even the apparently straightforward behaviour. Although most ANAP's are harmless with trivial consequences, when ANAP's occur in situations which penalise, its consequences may be labelled as an accident (Reason 1975).

This evidence suggests that, given the perceptual, physiological, and cognitive limitations of human beings, lapses, action slips or ANAP's are an integral part of the human condition. This being so, it follows that if, as Reason (1975) suggests, accidents are ANAP's in circumstances which penalise, then accidents will continue to occur unless and until operating or task performance conditions are more purposefully constructed around human parameters, and are constructed in such a way as to minimise the probability of an ANAP being penalised.

Psychological research is implying that human cognitive capacity is such that ANAP's are an inevitable feature. In addition ergonomic research suggests that the work can be tailored to fit human parameters. These two points enable a new understanding of "accidents" to evolve.

The probability of an accident increases when there is a fundamental mis-match between the capabilities and performance dimensions of the individual and the demand characteristic of the task. The accident is still determined by its consequences but it may be more accurately identified as being a subset of overall events brought about by a mis-match in work design.

Edwards (1981) suggests that the design of work should concentrate on four interacting components: "hardware" (machinery and equipment), "liveware" (employees/people), "environment" (all aspects of the workplace) and "software" (the procedures by which the other elements are linked). This she terms the SHEL model. The resulting system should be designed in such a way that the interfaces between all interacting elements are properly engineered to take account of individual elements (Edwards 1981).

Thus, according to Edwards (1981) system malfunction will result from a failure in any single component, but in practice is much more likely to result from a badly designed interface. Accidents, then, are symptomatic of a failure in the system and as such provide clues about the location of the source of failure, indicating where the mismatches occur and what kind of action is likely to be effective in reducing these mismatches.

Thus, the individual is no longer the focal point for all events but rather an integral component of an operating system. The accident is thus identified as an indicator of system malfunction which may result either from the breakdown or failure of any system component or due to badly designed interfacing of components. By recognising the importance of focusing upon mismatches between components it becomes pertinent to investigate all incidents which may offer symptomatic evidence of malfunction and not merely those incidents identified as accidents through punitive consequences such as damage or injury.

A first step in reducing the probability of such mismatching is by paying close attention to ergonomic principles at the design stage for all aspects of the task under focus. Thus, at this point ergonomic data relevant to the design of displays, controls and machine layouts will be

discussed as these have direct bearing on the present study where these areas of ergonomic design will be investigated when looking at kitchen equipment and layout.

DISPLAYS

The purpose of a display is to transmit information from machine to man in a manner appropriate to the system and task requirements. Functionally a good display is one which allows the optimum combination of speed, accuracy and sensitivity when transferring the necessary information from machine to the man (Shackel and Whitefield, 1974). Thus, the purpose of a display is to transmit information from machine to man in a manner appropriate to the system and task requirements.

Examples of task requirements could be the skills and capabilities which need to be contained within the task system, the role of technology and the role of the human (Fisher, 1986).

Information flow from a machine is essential for the operator to make efficient use of that machine. In order to decide upon areas such as the general type of display requirements and upon the specific features for display design, Shackel (1974) suggests certain basic facts about the proposed information transfer which need to be established.

1. The total range to be indicated of the variable about which information is to be transmitted.
2. The maximum accuracy and sensitivity required in the transfer of information.
3. The speed required in the transfer of information.
4. The maximum equipment error of the unit about which information

is to be transmitted.

5. The normal and maximal distance between the display and the users of the information to be transmitted"

(Shackel and Whitefield, 1974; p 18).

These considerations will lead to the choice of one of three types of displayed information: qualitative, quantitative or representational (Fisher, 1986).

Qualitative Displays

Such displays are suitable where the user needs to distinguish between a small number of different conditions (Shackel, 1974). Here the user is primarily interested in the approximate value of some continuously changeable variable (e.g., temperature, speed) in its trend or rate of change (McCormick and Sanders, 1983). The main requirement of qualitative displays is that the indicators for each of the conditions be as distinctive as possible. Auditory indicators such as bells and buzzers are useful in that they are able to attract immediate attention from any direction which is an important feature for warning indicators. However, they cannot convey detailed information (McCormick and Sanders, 1983 and Shackel, 1974). Visual indicators are essential for representing three or more conditions because they can be made distinctive through differences in position, colour, shape and size. Very important visual displays e.g., warning devices, can be made more effective by the use of flashing lights, or by combining visual and auditory indicators (Shackel, 1974).

On the basis of research and experiences, Heglin (1973) offers a number of recommendations regarding the use of signal and warning lights:

They should be used to warn of actual or potential dangerous conditions. Ordinarily only one warning light is used. In deciding whether to use a steady-state or flashing light, flashing lights should be reserved for exterior emergencies, since they are distracting. A flashing light should flash from 3-10 flashes per second (4 being the optimal number) with equal intervals of light and dark. The light should be at least twice as bright as the immediate background. The warning light should be within 30 degrees of the operation line of sight. Warning lights are normally red as this colour is associated with danger for most people (Heglin, 1975).

Quantitative Displays

Quantitative displays are more valuable as the information needed about the machine state becomes more complex or requires greater accuracy in transmission (Fisher, 1986). Quantitative displays are used to provide information about the quantitative value of some variable, either one which is a dynamic changeable variable e.g., measurement of length. In most uses of such displays there is an explicit or implicit level of precision that is required or desired such as measurement to the nearest millimetre (McCormick and Sanders, 1983). Quantitative displays are essential where the user requires numerical information from the instrument (Broadbent, 1977). The information may be presented in two forms: analogue or digital. A wide range of analogue or digital displays may be used depending upon factors such as the required legibility, whether it is best to present the accurate information in the context of the possible range, or whether discrete data are best (Fisher, 1986).

Analogue Indicators

These indicators are so called because the position of the pointer on the scale is analogous to the value it represents. In addition they include

the meters and gauges with which most people are familiar. An analogue indicator can also be used to convey qualitative information e.g., when a red portion of a scale signifies danger (Shackel, 1974).

Digital Indicators

Such indicators present the information directly as a number.

Each of these two forms of display has its disadvantages and advantages. The designer should relate these to the kind of information the user requires e.g., if precise readings are required, digital indicators are more suitable. However, analogue indicators are most appropriate for conditions which require quick check readings. Rate and direction of change are better indicated by analogue indicators (Shackel, 1974).

Representational Displays

These displays provide the user with a "working model" or "mimic diagram" of the process or machine (Shackel, 1974; p 20). They are most suitable for large remote control systems as they enable the user to observe the functioning of each part in relation to the whole, and to locate faults or delays quickly. The basic requirement is to make the display as simple in its logical scheme as possible. All irrelevant detail should be omitted. A representation rather than a complete simulation is required (Shackel, 1974).

CONTROLS

The term "control" relates to any aspect of machine design which facilitates the direct control activity of the human operating at the human-machine interface (Fisher, 1986). Elements such as knobs, switches, pushbuttons, levers, or cranks must be designed to match man's capabilities and limitations in order for man and machine to work at maximum ef-

iciency. The positioning of a machine control will depend on its function. However, it should also depend on factors such as the sex and age of the operators who are going to use it, because of differences in sizes of men and women, and differences in strength. In addition the layout should be designed in terms of the country in which it will be used because of differences in conventions between countries and also because of differences in physique between communities (Shackel, 1974).

Thus, the design of controls can be seen to be directed primarily at suiting the physiological and anatomical characteristics of the human. Good design will depend upon the establishment, in functional terms, of the kind of information the human needs to transmit to the machine via the controls (Fisher, 1986).

More detailed design criteria come into effect according to the level and type of technology being used as well as the force, speed, range and accuracy requirements inherent within the control movements (Fisher, 1986). Shackel (1974) expands on these requirements.

Force

Controls which require the operator to apply relatively large forces should be those which are for emergency use only, those which are used only occasionally, and those which are operated by hand-tools during maintenance work.

The maximum force which can be exerted on a particular control varies from person to person and is generally related to body size and muscular development. Consequently, an emerging control should require less force to operate than the weakest person can exert, although it should not be

so light as to be operated by an accidental knock. One of the most important factors affecting the steady force which an operator can apply to a control is its position relative to his body.

Speed and Range

The speed at which an operator can make a control movement depends on features or the situation such as accuracy and force required, the range or amplitude of the movement, the type of control etc. for example, knobs are recommended where the range of movement is relatively small.

In general, the greater the range of the movement required, the longer it is likely to take to complete. An operator is likely to delay starting a movement if the response involves a decision of some sort e.g., choosing between alternative actions.

Accuracy

The accuracy with which a control movement can be made depends not only on the limitations of the operation and the characteristics of the control, but also on the clear presentation of the information which the operator needs (Shackel, 1974).

The various types of controls, such as switches, knobs and pushbuttons, enable the user to select information or to govern a process. The designer should first analyse exactly what information the user needs to transmit to the machine via the control. Once this has been done, the designer is in a position to make use of the recommendations about control design. An example of this is that the control should be well adapted to the fingers or hand and should be easy to manipulate (Shackel, 1974).

In considering controls and displays, Fisher (1986) points out that there are two fundamental principles which need to be considered:

(i) perceptual stereotyping and (ii) display control compatibility

Perceptual stereotyping

This is the manifestation of broad expectations about the symbolic meaning of things, which may often be specific in meaning on a societal or cultural basis. Such stereotypes should not be contravened (Fisher, 1986). An example of a stereotype is that the clockwise turn of a control is associated with a clockwise turn of the pointer, and such rotation generally indicates an increase in value in question (McCormick and Sanders, 1983).

Display Control compatibility

The essence of this principle is to ensure that the rate, direction, etc of control action is reflected appropriately in terms of displayed feedback to the operator by way of movement compatibility or spatial arrangement (Chapanis and Lundenbaum, 1959) or gearing (Jenkins and Connor, 1949).

These factors assume greater importance when considering the integrated layout of interfaces:

Layout of panels and machines

The range of potential interface format is very wide - stretching from the simple single indicator to a complex format involved in control rooms (Fisher, 1986).

The positioning of individual displays and controls in relation to each other and to the operator and the layout of panels and machines, are important both for clear identification, ease of operation and avoidance

of error, especially in emergency conditions. Even if the displays and controls are well designed their arrangement on an instrument panel may be confusing unless planned for the user. The designer should first make a study of how the instrument will be operated, controls and displays should then be arranged to guide the user.

According to Shackel (1974), two principles can usually be applied to the design of a panel:

1. If the operation always follows a fixed sequence, the controls and displays should be laid out in that order. However, many instruments do not always have to be operated in a fixed sequence.
2. Controls and displays should be grouped according to their functions, with the important and frequently used groups being placed in the most convenient positions. Functional groups can be distinguished by making use of differences in size, shape and colour of displays and controls.

Several principles exist to facilitate optimal placement of components in an interface layout (Fisher, 1986).

Shackel (1974) sets out these principles:

1. Operational importance (i.e. the items considered most important for the task involved).
2. Frequency of use (i.e. items used most frequently in regular operation).
3. Functional clustering (i.e. items related to each other by function).
4. Sequence of use (i.e. any items used together in sub-sequences).

These principles, however, cannot be seen as mutually exclusive, and several items may appear in more than one category.

In designing the layout those items which fall under the categories of operational importance and frequently used, should be placed near the centre of the console or machine, in easily accessible and well differentiated positions. The items in sub-sequences should be placed together e.g., in a row or column, and the functionally related items are similarly placed in groups together, with some visual and spatial separation from other items (Shackel, 1974).

If a large panel contains a large number of dials, the user may have difficulty in choosing the correct one. Thus, the colour of dial faces should provide a good contrast with the panel, and it also assists if the dials are arranged in a distinct pattern rather than in one large group.

Most controls should usually be operated equally well by either hand. The preferred hand is better for fine, accurate adjustment, and such controls should be placed in a central position, to cater for both right and left-handed users. Labels should be placed above their respective displays. The user must be able to respond to an emergency quickly and accurately, and this often depends on the arrangement of controls and displays (Shackel, 1974).

Thus, the chief objective for the ergonomist, in terms of interface layout, is to provide a spatial and physical layout of interface components which will adhere to the general constraints placed upon the information flow control loop by human parameters. Such constraints are functional reach for activation of controls, visual acuity for display location, attentional parameters which restrict temporal and spatial monitoring. In addition there are constraints imposed by wider considerations such as limitations imposed upon workspace by other design factors (Fisher,

1986). One must also recognise that the human component of the system varies greatly in terms of individualistic as opposed to "typical needs" (Rich, 1983) and in terms of function and orientation (McCormick and Sanders, 1983). Factors such as the layout of work space, seating conditions, thermal comfort, noise, lighting, etc are all important considerations.

Hand Tools and devices

Hand tools are crafted for uncounted specific applications as well as for general purpose activities. However, until recently human factors had largely ignored the design of hand tools and other devices with emphasis being placed on more sophisticated equipment. The result is that many hand tools and devices are not designed for efficient safe operations by humans - especially for repetitive operation (McCormick and Sanders, 1983). Improperly designed tools and devices have several undesirable consequences such as accidents and injury. The proper design of hand tools and devices requires an understanding of technical, anatomical, kinesiological, anthropometric, physiological, and hygienic considerations. Tools cannot be designed in isolation. The design of hand tools is of special significance in the catering industry.

Principles of Hand Tool and Device Design

1. A straight wrist should be maintained. Terrel and Purswell (1976) report that grip strength is reduced if the wrist is bent in any direction. Reductions in grip strength may increase the likelihood that the user will lose control of the tool or drop it, leading to an injury or poor-quality work. Attempts to maintain a strong grip will increase fatigue.
2. If possible, handles should be designed to have large contact

surfaces to distribute the force over a larger area, and to direct it to less sensitive areas of the hand such as the tough tissue between the thumb and index finger.

3. Designing tools and devices for safe operation would include eliminating pinching hazards and sharp corners and edges. It is important to bear in mind that each type of tool or hand held device presents its own set of safety considerations. The designer must consider in detail how the tool will be used by the operator, as well as the potential of the user to misuse it.
4. According to Barsley (1970) women constitute approximately 50% of the world population and left-handers constitute approximately 8-10% of the world population. Despite this fact, many hand tools and devices are not designed to accommodate these populations. In addition, the grip strength of women is on average only about two thirds that of men (Konz, 1979) and most women have smaller hands than most men. These differences have obvious implications for tool and device design (McCormick and Sanders, 1983). With women assuming a greater role in occupations which have traditionally been male dominated, the design of hand tools and devices must take into consideration the anthropometric and ergonomic differences that exist between men and women (McCormick and Sanders, 1983). Tools should be designed in order to facilitate use in the operator's preferred hand

These ergonomic principles will be closely followed when considering kitchen equipment, design and layout.

At this point it is important to stress that a significant amount of research has been conducted in the area of designing tasks to fit human

capabilities. Additionally, several well documented taxonomies of human ability have been developed. (Barret, Dambrot and Smith, 1975; Dunnette, 1982; Fleishman, 1975; Wygant, 1983). However, a major shortcoming of these approaches is that they usually refer to the ability level of a "typical" individual, in this way ignoring the inherent variability of individuals. A system that objectively measures individual functional abilities using a taxonomy that both differentiates among individuals and is directly applicable to the task design process is needed. Such a system must be capable of providing reliable ability data for a particular individual or for a well defined population (Rahimi and Malzahn, 1984).

Thus, it is important to keep in mind that in the final design, the man and machine must emerge as an integral unit, for the capacity of the system to work effectively is restricted by the limitations imposed by man, machine, displays and controls. For efficiency in operation and for the satisfaction of the man, good design of the machine, its designs, and controls must be finalised by a suitable and harmonious layout (Shackel, 1974). The human component of any system varies greatly in terms of individualistic as opposed to "typical" needs (Rich, 1983), in terms of function and orientation (McCormick and Sanders, 1983), and over time, as levels of expertise rise (casual or first time user compared with regular or expert user) (Cuff, 1980).

However, it must be borne in mind that no matter how carefully ergonomic aspects are considered at the design stage, it is unrealistic to suppose that a perfect match will always result or last in the face of changing work practices and task demand characteristics. It is essential that any work design is constantly monitored for symptoms of malfunction with the

intention that, once clearly identified, any inadequate aspects of the system may be improved through redesign.

The ergonomics approach to accidents is based on the premise that what people do in a work situation is determined not only by their capabilities and limitations but also by the machines they work with, the rules and procedures governing their activities and the total environment within which the activity takes place i.e. the physical and social environment.

Edwards (1981) suggests that effective system operation requires that the interfaces between all the interacting elements are properly designed to take account of the characteristics of the individual elements. System malfunction occurs as a result of a failure in any single component, but in practice is more likely to be as a result of a badly designed interface. Thus, accidents are viewed as a failure in the system and as such provide clues as to the location of the source of failure, indicating where the mismatches occur and what kind of action is likely to be effective in reducing these mismatches. In designing a solution it is necessary to consider features of the accident information system which are not amenable to change such as legal aspects, organisational aspects, and of the characteristics of those likely to use such methods (Edwards, 1981).

Many occupational environments, such as the catering industry, are excluded from traditional sources of statistics on occupational injuries. Because of the lack of a single data source, work-related injuries are seldom subject to thorough investigation, and the true magnitude of the problem of occupational injuries is difficult to determine (Baker, Fisher and Van Buren, 1982). In order to understand occupational hazards it is

important to note that there is an agent which causes the hazard or disease and which interacts with the person and the environment. This agent may take the form of thermal energy (causing burns), electricity, radiation, chemical or mechanical. The majority of injuries, including occupational injuries, are due to mechanical objects which cause injury through moving parts of machinery or falling objects (Smith, 1987). Thus, the appropriate design of safe equipment in order to prevent injuries is perhaps the most important prevention strategy possible (Baker, Samkoff, Fisher and Van Buren, 1982).

Obtaining accurate and relevant data regarding accidents, as has been previously discussed, is however a complex task. Report completion and analysis may take up a considerable amount of time, and resulting data is often difficult to interpret (Pimble and O'Toole, 1982). Reported information should be collected in such a way as to enable the identification of all factors which may be used for both the redesign process and the planning of injury prevention programmes.

There is no complete system for reporting all non-fatal accidents. In an article in the British Medical Journal of 1897, the following philosophical approach was taken to the problem of accidents in the community: Men must work and accidents will happen... Notification is so incomplete that the total number of fatal accidents to workmen is unknown. Although accidents which are non-fatal must be far more numerous, there is no uniform system of reporting them (Cliff, 1984; p218-219).

In addition industrial accidents are classified by reference to a very simple list where many thousands of accidents are squeezed into thirteen groups which are:

machinery, transport, explosives and fire, poisonous or hot corrosive substances, electricity, falls of persons, stepping on or striding against objects, falling objects, falls off ground, handling without machinery, hand tools, animals, miscellaneous (ILO, 1970).

A report by the British Health and Safety Executive in 1976 commented on the "haphazard" nature of accident investigation in industry (Edwards, 1981). Adams (1974) has observed that the information about injury collected in industry does not enlighten one as to the rate of injury or on how the absolute numbers of injuries may be reduced. Hartwell and Adams (1977) concluded that accident reporting systems have grown in a relatively unplanned manner and have not been designed as information systems. Much effort is expended in seeking or avoiding responsibility and blame for accidents (Hartwell, 1977). Powell, Hale, Martin and Simon (1971) concluded that there was an incentive not to report any but the most serious accidents and that the factors contributing to this were primarily loss of time, suspicion, acceptance of minor injuries, and the reporting system itself. Often insufficient time is allowed for the completion of reports and insufficient care is taken to ensure that coding is accurate (Pimble and O'Toole, 1982).

Typically industrial injuries are reported on forms which were not designed to extract much information of ergonomic significance. While there is usually a requirement to describe the event which produced the injury, there is no direction to the report about specific ergonomics aspects of the incident. This is true of accident report forms found in the catering industry. As a result the analysis is restricted to facts such as names of body injured, type of injury, location and time of day or shift (Barlow and Hiddlestone, 1981). The aim seems to have been to describe

explicitly the effects, rather than to determine the causes of the accident (Barry, 1971). It therefore becomes imperative to collect data in a structured way, looking at not only accidents but at all "reportable events". From this data one can identify mismatches and institute a redesign intervention. Recently, effort has been made to define more fully in the initial report "accident causation fault categories" (Hartwell, 1973).

In a recent report of a five year programme of a monitoring/redesign system, Adams, Barlow and Hiddlestone (1981) give details of, inter alia, a 50% reduction in the injury rate in a large strip and sheet metal processing plant by using a structured injury report form. It was found that the kind of injury usually noted as a "slip", "trip", or "fall", which accounted for 7.42% of all injuries, was a function of floor surface. In addition 9.1% of injuries were directly related to uneven, slippery or greasy surfaces. The improvement of surfaces where practicable and/or the provision of appropriately studded boots should minimise this significant contribution to injuries (Adams, Barlow and Hiddlestone, 1981). This is of special importance with regard to the present study. The report form, designed to meet the criteria for good questionnaires suggested by Gray (1975) and Osborne and Clarke (1975), takes the appearance of a purposefully designed check list, intended to minimise the demands upon the respondent's time and ability whilst providing information that is already categorised to produce data about the source or agent of injury, the movement preceding the injury and the immediate cause of injury etc. Whilst such check lists are often rather daunting in appearance they are in practice quickly and easily completed.

From the analysis of accumulated questionnaires Adams, Barlow and Hiddlestone (1961) report that it is possible to plan improvement programmes in a number of ways:

- by indicating the needs for better procedures, job training and supervision (obtainable from the "movement preceding injury" information).
- by pinpointing significant agents of injury or poor design
- by revealing temporal or periodic patterns in the occurrence of events, e.g., in relation to rest periods, time of day, shift onset etc
- by identifying inadequacies in safety equipment whether based upon deficiency in the equipment itself or upon misuse or rejection (refusal to use) by employees (Adams, Barlow and Hiddlestone).

Minor adjustments to the process adopted by Adams, Barlow and Hiddlestone (1961) in terms of technique and design would be required to extend data collection to include all "reportable incidents" i.e. an event which produced an unplanned happening of potential danger even though it did not necessarily result in an injury.

By utilising the report form, information of ergonomic significance can be extracted. By looking at all "reportable events" data is generated from which mismatches can be identified leading to a design intervention. Prevention of injuries depends on reliable systems of accident reporting and implementing safety standards. Reliable accident and injury reporting is crucial to allow early recognition of hazardous situations to evaluate the effectiveness of preventive measures, and to advise management appropriately on safer systems of work (Edwards, 1987).

Among ergonomists, occupational injuries can and should be prevented primarily through improvements in the working environment. Even if improved skills and safer behaviour can be achieved through education and training of workers exposed to risk, the permanent elimination of common risk factors requires changes in equipment design and in work organisation. This philosophy is widely accepted for the study of occupational diseases and corresponding contributing factors (agencies) in the environment such as improper working postures, vibration, noise, pollutants and radiation. However, despite the dominating numbers of occupational accidents in occupational injury statistics, occupational accidents are often looked upon differently as being a result of "human error" or "poor workmanship". As a result, one does not consider contributing factors in the working environment such as poor visibility, slippery surfaces, deceptive machine dynamics and superhuman task demands (Strandberg, 1983). This attitude is probably reinforced by learning effects: one or a few risk factors may be present in a job or task without any accident occurring the first thousand times (Swain, 1972). Thus, accident potentials may be strongly under-represented. Consequently, if the ultimate goal is to reduce injuries in general, possible requirements for accident prevention must be taken into account by the ergonomist (Strandberg, 1983). The appropriate design of safe equipment to prevent injuries is perhaps the most important prevention strategy available. While occasional "human failure" is inevitable and predictable in any work environment, whether it results in injury depends on how the job and the equipment are designed (Baker, Samkoff, Fisher and Jan Buren, 1982).

This study will attempt to isolate the causes of accidents in restaurant kitchens which are thought to be caused mainly through bad design of kitchen equipment. The present research will involve the amalgamation

of safety and ergonomic data in order to develop an appropriate and rigorous conceptual framework to analyse activity and kitchen safety in industrial kitchens. Within this framework mismatches in interface design will be identified via a questionnaire, which will be formulated in a manner similar to that administered by Adams, Barlow and Middlestone (1981). The use of this questionnaire will yield information that is already categorised in terms of injury agent, activity surrounding the incident, immediate cause of injury and interface matching. The major advantage to using this questionnaire is that the accumulated data, which can be easily analysed and interpreted will reveal redesign needs. By recognising the importance of focusing on mismatches between components of the system it becomes imperative that all incidents which may offer symptomatic evidence of malfunction be determined.

The problem of accidents and safety in the catering industry and commercial kitchens has been brought to the attention of the present researcher by the industry who wish to investigate the causes. However, the incidents of accidents in the catering industry, specifically in commercial kitchens, are difficult to define. From the nature of the industry accidents are likely to be small scale and as a result won't necessarily require reporting. Thus, there is severe underreporting and the full extent of accidents is therefore not known despite the fact that the problem is a continuous one. Due to the small scale nature of accidents, there is very little available data from which to work.

It is strongly suspected that from analysing the data, poorly designed equipment, poor procedures, and poorly prepared individuals will be identified. From this generated data further recommendations will be made regarding alternative designs.

It is therefore now necessary to consider safety in the catering industry in South Africa with special attention being focused on ergonomic perspectives.

CHAPTER 4

Safety in the Catering Industry

Development of the Safety Movement:

According to Dr Nico Stutterheim, Chairman of Noriston, there has never before, in South African history, been a greater need for the introduction of an all-embracing programme to improve safety efficiency (Stutterheim, 1978).

The National Occupation Safety Association was incorporated as a non-profit company under Section 21 of the Companies Act (Act 46 of 1952) on 11 April 1951. This Act was superseded by the New Companies Act of 1973.

The Safety Association was formed as a result of the large number of accidents in industry and the resulting drain upon the national economy and the labour force, especially the skilled labour force. At that time the Mine Safety Committee was established by the Chamber of Mines, which made safety propaganda material available to the mine members of the Chamber. In Cape Town, the South African Red Cross Society established an Industrial Safety division to serve the Cape Town industrial area (NOSA Yearbook, 1976).

Initially employers could not obtain information or assistance in accident prevention from any local source. As a result a committee was appointed to investigate and report on ways and means to slow down the increasing injury rate. The committee gathered information from various sources, including the Industrial Accident Prevention Association of Ontario, Canada (I.A.P.A.), the National Safety Council, Chicago, USA

(N.S.L.) and the Royal Society for the Prevention of Accidents, UK (ROSPA).

During 1950 the Workmen's Compensation Commissioner visited various overseas countries as well as safety organisations. On his return, the information gathered was incorporated into the original committee's report and recommendations were made to form a South African Safety Association. The Association was launched as an employer - employee organisation and incorporated as a non-profit company on the 11 April 1951.

In South Africa today there are two main acts which apply to safety. These are the Machinery and Occupational Safety Act (MOSA) (No 6 of 1983) which is supplemented by the Basic Conditions of Employment Act (BCEA).

The Machinery and Occupational Safety Act which was promulgated in 1983 replaced the provisions of the 1941 Factory, Machinery and Building Works Act. This statute has brought about a significant change in attitude towards health and safety. For the first time safety legislation covers a range of activities which has never before been covered. Previously safety legislation covered activities in factories, shops and offices. The new act (MOSA) incorporated the agricultural and domestic sectors as well. However, MOSA does not apply in respect of any premises to which the Mines and Works Act applies, and in any explosive factory, or explosives magazine, which falls within the meaning of the Explosive Act. Another major provision of MOSA is that employees themselves can be involved far more closely in the day to day management of safety and the planning of safety standards, than was the case in terms of the previous legislation (Paton, 1986).

One of the most important provisions of MOSA is the provision which relates to the designation of safety representatives. Safety representatives must be appointed for every 100 employees and where there are two or more safety representatives, a safety committee must be established. The safety representatives are designated for a period determined by the employer and the safety representatives must be acquainted with the conditions at the workplace and must work for the employer in a full-time capacity.

Safety representatives have three important functions. Firstly they must inspect the workplace, equipment and machinery at least once a month with a view to the safety of the workplace and the machinery and equipment. Secondly, safety representatives must bring to the attention of a safety committee or the employer any threat or potential threat to the safety of the employee. Thirdly, any accident must be reported to the Department of Manpower Inspector where the accident caused the death of the worker, could have caused the death of the worker, resulted in a worker losing consciousness, injury or the loss of a limb, or resulted in the worker becoming ill and remaining off work for at least fourteen days.

The safety committees are required to make recommendations to the employer on safety matters, compile reports for the inspector on fatal or injurious accidents, and carry out any tasks relating to safety matters.

MOSA also prohibits the sale of any machinery and equipment where the safety requirements have been stipulated but have not been complied with.

However, as Fisher (1986) points out, there are certain areas which are not as clear as they may appear. Firstly as has been pointed out in

previous chapters, the factors contributing to the design of safe work are more complex than just the simple responsibility of the employer and employee. They call for specific technical expertise in both design and developments. Thus, the kind of employer/employee contract promoted by the Act is rather a limited one. Employers are directly responsible for almost all procedural compliance, including ensuring proper working of safety committees and safety representatives, thus preserving and maintaining the "management prerogative" for safety and health. The employees role is to "work carefully" and to respond immediately if a threat to his or her well-being comes to his or her notice. If such a threat is detected before any injury or damage occurs it is then left to the employer to ensure remedial action.

A second area which is not as clear as it may appear is the apparent invitation for employee participation through the role of safety representative. MOSA confuses "representative" with delegate (Fisher, 1986). The only requirement for technical expertise in the role is familiarisation with "his own" workplace. No technical knowledge is laid down as a prerequisite. In addition, should the safety representative or safety committee fail to do anything required of them by the Act they will not incur civil liability. The compulsion for a safety representative to note or report anything, thus becomes weaker than might be implied by the manifest intention of MOSA.

Myers and Steinberg (1986) see the new legislation as not providing significant concessions to workers. The legal provisions can be seen as reinforcing the mutually beneficial state/management relationships and their joint domination of labour. Management's productivity concerns are evident in that the new laws do not permit work stoppages over unsafe

work, do not promote workers organisation in connection with health and safety issues and attempt to exercise control over health and safety training and other activities at work. The Act's new features, together with the weak character of workers' rights contained in it, serve to undercut shopfloor safety activity and to divert conflict into bureaucratic management-dominated channels. Accident statistics will drop artificially in the future, as only accidents resulting in loss of more than fourteen days work-time will be reportable (Myers and Steinberg, 1986). In addition the Machinery and Occupational Safety Act is seen to be without essential regulations. That part of the Act and its regulations which are in force provide only the fundamentals of a legislative framework. The detail, criteria and instances which will define the parameters of acceptable safety conditions and standards are yet to be established through the courts. Furthermore, workers who have been excluded from the BCGEA are generally isolated and unorganised such as seasonal workers who are important in the context of the food industry (Myers and Steinberg, 1986).

An area which demonstrates one of the potential costs of accidents is that of workmens compensation. Because accidents may occur in kitchens which may give rise to claims for compensation, it is necessary to review the law regarding workmens compensation.

One of the greatest costs to industries of all types is the evergrowing cost of paying workmen's compensation to workers who become injured on the job (Strobl, 1984). The Workmen's Compensation Act, 1941, made provision for financial support to workmen who sustain injuries or contract industrial diseases arising from their employment or that take place in the course of their employment and that give rise to medical expenses

an or temporary or permanent disablement or death. In cases of a fatal accident or death caused by an occupational disability, compensation is paid to the workman's dependant(s). Compensation and medical expenses in respect of injured workmen are paid out of the Accident Fund, which was established in terms of Section 64, with the exception of payments in respect of employees of the state and other employers who are, in terms of Section 70, exempted from contributing to the Fund and are themselves responsible for payments as prescribed in the Act (Report of the Department of Manpower, 1986).

The Act provides for a number of benefits - temporary total disablement, permanent disablement, amount of compensation when a workman dies and medical expenses (Report of the Department of Manpower, 1986). Compensation for temporary total disablement in respect of absence from work as a result of an accident is payable to all workmen in the form of periodic payments calculated at 75% of a workman's monthly earnings up to R600 per month plus 50% of such earnings in excess of R600 up to R1 300 per month. The maximum compensation for temporary disablement is therefore R800 per month. Compensation in respect of permanent disablement for all workmen is paid as a lump sum if the degree of such disablement is 30% or less. The amount of compensation for 30% permanent disablement is R9 000 if the workman was earning R600 of his earnings. Where the degree of permanent disablement is less than 30% the lump sum is reduced proportionately. If the degree of permanent disablement is more than 30%, compensation takes the form of a monthly pension. The maximum monthly pension for 100% damage permanent disablement is R800. If the degree of a workman's permanent disablement is less than 100% but more than 30%, a pro rata pension is payable.

If a workman dies as a result of an accident, his widow, if he leaves one, is entitled to the payment of a lump sum of R600 or twice his monthly earnings, whichever is the lesser, and a monthly pension equivalent to 40% of the pension that would have been awarded to the workman had he been totally and permanently disabled. Each child under eighteen years of age is entitled to a monthly pension equivalent to 20% of the pension that would have been awarded to the workman had he been totally and permanently disabled, provided that the pensions payable to the widow and children in total do not exceed the amount of the pension that would have been awarded to the workman had he been 100% permanently disabled. If the widow remarries, her pension continues unchanged and only terminates at her death. A child's pension continues until the age of eighteen years. An allowance not exceeding R650 may be paid towards the necessary burial expenses from the Accident Fund. The fourth benefit provided for by the Act is that all reasonable expenses incurred by or on behalf of a workman in respect of medical treatment necessitated by an accident may be defrayed from the Accident Fund (Report of the Department of Manpower, 1986).

The Industrial Aid Society makes a number of comments regarding the Workmen's Compensation Act. The main criticism is that most of the people who have accidents are labourers who earn very little. As a result their compensation will be very little as the compensation is based on the wages a person was getting at the time of the accident. The Act, in addition, excluded people such as domestic workers, casual workers, self-employed people and high earners. Other areas which are not covered by the Act are the following:

- The Act does not make provision for the payment of full wages for the

period of illness.

- The Act does not compensate workers for pain and suffering.
- Compensation is not paid according to the worker's ability to find another job in the future due to injury which he/she has incurred e.g., loss of an eye.
- Pensions paid are not in line with the cost of living.
- The Act does not promote health and safety at work.

(Industrial Aid Society, 1986)

The area of safety within the catering industry will now be expanded upon bearing in mind ergonomic considerations.

According to the Catering Association of South Africa (Casa), the local catering industry consisted, in terms of a recent count, of 1 373 hotels, 856 hospitals, 2 450 canteens, 1 840 restaurants, 7 325 fast-food independents (including cafes) and 650 fast-food chain outlets. Indications were given, in a report by Business Marketing Intelligence, that the total annual catering expenditure was approximately R1,5 billion. The hotel industry is estimated to be responsible for approximately R11 million turnover per annum, restaurants R115 million, cafe and fast-food independents R172 million, shebeens R15 million, canteens R295 million and the mining industry R317 million per annum.

Thus, it is clear that the food service industry in South Africa is likely to be one of the fastest growing in the next decade. Hence it can be assumed that there will be a large amount of accidents in this industry (Fedics Corporate Report, 1985).

The provision of food in the catering industry shows a variety of scope. The various types of catering establishments may be listed as follows: hotels, hospital catering, residential schools, colleges, hostels, luncheon clubs, railway catering, restaurants, school meals service, industrial canteens, aircraft catering, catering out at sea, licensed houses. These may be grouped as

- (a) hotels and restaurants
- (b) welfare and industrial catering
- (c) transport catering
- (d) other aspects of catering.

It is with the first group that this study concerns itself. Therefore, certain areas of the first will be briefly expanded upon (Kinton and Ceserani, 1978)

Hotels and Restaurants

Hotels are residential and most of them will provide breakfasts, lunches, teas and dinners. Restaurants will vary with the kinds of meals they serve. Some will serve all types of meals while others will be restricted to the service of lunch and dinner. There are many concerns having catering establishments spread over wide areas and in some cases over the whole country. These are chain-catering organisations and are prevalent in South Africa. These restaurants often serve lunches, teas, dinners and morning coffee. In addition they serve as snack bars and cafeterias (Kinton and Ceserani, 1978).

In the construction of buildings for catering purposes a wide range of structural methods and materials are employed. When it is clear that the building fulfils its primary function as a shell or impervious box, the internal arrangements which could be suitable for food premises can be

considered. It is obvious that a kitchen should be on the same story as and adjoin, the dining room, although this is not always the case. The delivery of stores and refuse removal is easier from ground floors, however the natural lighting, ventilation and outlook are usually better on upper storeys (Hobbs and Gilbert, 1982).

The design, construction and equipment of a commercial kitchen should satisfy two basic criteria - first, the proposed menu and scale of operation, and second, the intended method of cleaning the premises and equipment (Hobbs and Gilbert, 1982). In addition one must consider the safety and health of workers as accidents do happen in kitchens (Lian, 1981).

The Johannesburg City Health Department, for example, sets out a number of regulations regarding kitchen layout and design of equipment for cafes, restaurants and eating houses. (See Appendix 1)

There is certain equipment which is generally used in large scale commercial kitchens as well as restaurant kitchens. For the purposes of the present research this will be expanded upon.

Kitchen equipment may be divided into three categories:

1. Large equipment consisting of items such as steamers, boiling pans, fish fryers, sinks and tables.
2. Mechanical equipment consisting of items such as peelers, mincers, mixers, refrigerators and dishwashers.
3. Utensils and small equipment consisting of items such as pots, pans, whisks, bowls, knives and spoons. (See Appendix 2)

(Kinton and Ceseran, 1978)

This kind of equipment can be potentially hazardous. Thus, care must be taken in the design and subsequent use of the equipment.

It is significant at this point to note what constitutes the South African Bureau of Standards criteria for preparation of a specification. "National standard specifications are drafted by committees of experts representative of manufacturers, consumers and other interested organisations, who decide on a basis of consensus on aspects such as quality, material, composition, safety, durability, performance and testing. The committee strives, by the elimination of unnecessary variety and the selection of the optimum value level, to specify a product that will ensure best value for money" (SABS, 1985; p5). The question immediately arises of how safety aspects can be decided on a basis of consensus. In addition, ergonomic considerations in general do not form a part of SABS appliance standards (Fisher and Levin, 1987).

The general requirement of the compulsory standard specification is that such appliances; - "shall be free from electrical and mechanical hazards, including sharp edges, burns and similar defects that might cause injury to a user... shall be so designed and constructed that the risk of fire, or of mechanical damage or of both, that impairs safety as a result of abnormal or careless operation, is so reduced... shall be so constructed that accidental changing of the setting of a... control device is not possible if this can result in a hazard" (Government Gazette, No.7464, 1981)

It may be then, that there is considerable scope for the development of ergonomic guidelines within standards for design of electrical appliances in general. An important feature of such guidelines would be the psy-

chological components of control stereotypes and display-control compatibility (Fisher and Levin, 1987)

In the design of kitchen equipment, a number of recommendations can be made. In an interview with Gordon Tuckett, Director of Foodservice Design (FEDICS), a number of design suggestions were made (1987). Regarding tilt pans and fryers, a thermostat should be incorporated in order to control food temperature. An overriding thermostat should also be included to control the thermostat should it wear or break, thus cutting off the power. Liquid oil or fat equipment should also always have this feature. In any tilting equipment, special attention must be paid to the area of pour. The tilt should start as close to the equipment as possible in order to avoid spillage. A floor drain should always be designed to suit the equipment which will be used. Drains should ideally be stainless steel and grids should be no more than 1m in length in order to facilitate easy handling for cleaning purposes.

Equipment should be designed in such a way that there should be no large projections. Taps and control knobs should be flush with the equipment, especially with potentially hazardous boiling water urns. Here, a good safety feature would be the tap springing back as soon as it is let go.

Another potentially dangerous piece of equipment is the conventional oven which has a drop down oven door. This has two clear disadvantages, according to Tuckett. Firstly, the door may be used as a surface when dropped. In such a position it can also be the cause of a fall because it is below the natural eyeline.

Another potential hazard in kitchens is hot pots. Chefs should be trained to advise the kitchen workers that the pot is hot. A traditional way of doing this is by sprinkling flour over the handle. Perhaps a thermostat could be incorporated into the design of kitchen pots which would glow red to indicate heat, and revert to blue or green to indicate a return to room temperature.

Tuckett advises that wherever possible steps should be avoided in kitchens. These are only a few of the hazards introduced through the design of equipment (Tuckett, 1987).

Personal injury in kitchens may result from cuts, burns, scalds, (the difference between the two being that burns are caused by dry heat, hot fat or oil and scalds are caused by moist heat), lifting injuries causing strains, falling objects, electrical shocks and falls.

The causes of a number of these injuries will now be expanded upon. Cuts can be caused mainly through factors such as blunt knives and broken glass. Burns and scalds can be caused mainly through faulty electrical equipment, faulty lighting or gas equipment, as a result of fire, hot water from gas or electric water heaters and spilt boiling liquids (NOSA).

The causes of fires in kitchens is an area of concern. Fires are caused by faulty electrical wiring, open flames, overheating of equipment, spontaneous combustion, (oil soaked waste), and inadequate precautions in the vicinity of combustible materials and flammable gases (NOSA pamphlet no. 350). In addition, lack of fundamental ergonomics in the design of domestic cookers for the South African user population, creates unnecessary problems for the user (Fisher and Levin, 1987). The devices

are not straightforward to use and incorrect selections and control actions pose a potential hazard (Wilson and Kirk, 1980). Reports of fire statistics within the Republic of South Africa published by the Fire Protection Association of South Africa (FPASA) show that cooking accidents caused 22.6% of fires in flats; 13.1% of fires in hotels and boarding houses; and 11.5% of fires in other dwellings (FPASA, 1986).

In order to prevent fires automatic systems such as alarms, sprinkle gas or dry powder should be considered where the degree of fire hazard is high. These systems are triggered off by switch mechanisms or valves released by excessive heat. In the case of fire fighting equipment there are two types to consider. The first is the fire hose. This is a canvas, rubber or a plastic hose with water under high pressure. The second type is the fire extinguisher. This is a metal canister, in varying sizes, which contains either water, gas vaporising liquid or chemicals (dry or wet) and an inert gas under pressure to discharge the contents through a nozzle. It is essential that the correct type of fire extinguishing equipment suit the particular needs of the area in which it may be used. Extinguishing equipment should be positioned as close as possible to the fire hazards for which they are intended without being made inaccessible by a fire, should it occur. Canister type extinguishers should be hung from brackets mounted on the wall or column with the top of the extinguisher not higher than 1.5m from the floor level (NOSA). In 1986, a total of 67 people were fatally injured in accidents involving electricity (Report of the Department of Manpower, 1986).

With regards to falls, in the annual report of the Department of Manpower for the year ending 31 December 1986, the inspectorate found that many injuries were caused by persons falling, treading on or bumping against

object or being hit by flying, sliding, falling or moving objects or machines. The report continues to state that "these types of injuries can largely be prevented by working more carefully and by better supervision" (*Report of the Department of Manpower*, 1986; p 108).

However, when reviewing the ergonomic literature on slips trips and falls it becomes apparent that there are a number of other variables which must be considered beside personal care and supervision.

Slipping, tripping and falling are the commonest cause of injuries, and can account for up to 40% of lost-time accidents (Davis, 1983). Slipping can take a number of different forms (Manning, 1983).

1. Slipping of one or both feet when friction between the shoe and underfoot surface is low or when the surface is contaminated with water, ice, oil, food scraps or small objects. Also slipping of the foot off the underfoot surface such as off a step, kerb, rung, platform or scaffolding.
2. A trip or stumble which is a sudden arrest of movement of a foot with continued motion of the body. Projecting flagstones, kerbs, steps, stair nosings and objects on the floor frequently contribute to these events.
3. Twisting of the foot or ankle on an object or uneven surface or edge of a surface.
4. Movement of the underfoot surface, such as a slide of a doormat, a breakage of the underfoot surface such as floorboards, asbestos roofs and ladder rungs.
5. Unintentional stepping off the underfoot surface, platforms and ladders or missing steps are common events.
6. Stepping into a hole on the underfoot surface. Holes in floors,

- including open grids and manholes, frequently cause accidents. They may be found on catwalks and elevated surfaces.
7. Collision with a person, animal or object causing loss of balance.
 8. Loss of balance from careless or rapid movement or from disease, alcohol and drugs.
 9. Loss of hand hold from slipping of the hand or breakage of the support.
 10. Collapse of the supporting structure such as scaffolding, ladders or breakage of climbing ropes. A proportion of these first events will result in complete loss of balance and a fall against some object or the underfoot surface, thus causing injury. A few will cause the victim to fall and strike an object or surface at a lower level resulting in more serious and frequently fatal injury due to the higher gravitational forces (Manning, 1983).

Statistics published by the Health and Safety Executive and on home accidents by the Department of Trade in Britain show that in 1979, 69 417 falls causing absence from work of three or more days were reported. Falls were the most important type of lost-time accident in six out of eight occupational groups listed. In a study conducted by Andersson and Lagerlof (1983) in Sweden, it was found that a larger proportion of trippings resulted in falls than slipping. In addition it was found that slipping accidents and falls occur just as often indoors as outdoors but tripping accidents occur more often indoors. Falls on the same level were also found to be the most frequent (Andersson and Lagerlof, 1983). Grieve (1983) in a study conducted in Britain, found that a person is most at risk from slipping during maximum exertion of strength (Grieve, 1983).

Very little is known about these kinds of accidents for three main reasons. Firstly, there is the *inadequate accident classification*. For example, industrial accidents are classified by reference to a very simple list where many thousands of accidents are squeezed into thirteen groups which are:

1. machinery
2. transport
3. explosions, fire
4. poisonous, hot or corrosive substances
5. electricity
6. falls of persons
7. stepping on or striking against objects
8. falling objects
9. falls off ground
10. handling without machinery
11. hand tools
12. animals
13. miscellaneous

(ILO, 1970)

A second reason for the dearth of information is that bystanders often laugh and joke about falls. As a result the general public does not regard them seriously. Victims tend to struggle to their feet feeling foolish of embarrassed and witnesses may not understand that there has been a severe injury. Although immediate pain sometimes occurs, the onset of pain may be delayed in many sprains, strains, back injuries and even fractures. The third and most important reason for the shortage of information is that there is no national system for collecting and analysing information about the causes of all injuries (Manning, 1983). Andersson

and Lagerlöf (1985) add that serious accidents with many persons injured produces a much greater effect upon the mind than a lot of less dramatic single incidents. Therefore accidents with tripping or slipping which are very frequent, will often be neglected compared to other accidents which are more rare and dramatic. In order to identify and evaluate the risks, one therefore requires a system which covers information for all kinds of accidents and all cases occurred.

Among ergonomists, occupational injuries are seen as being prevented primarily through improvements in the working environment. The permanent elimination of common risk factors requires changes in equipment design and in work organisations (Strandberg, 1983). If the ultimate goal is to reduce injuries in general, possible requirements for accident prevention must be taken into account by the ergonomist. The prevention strategy is strongly dependent on the analysis techniques and on the accident description models that are used for data collection and for comparisons of contributing factors (Strandberg, 1983).

Successful prevention in practice requires measurement techniques and criteria for the objective selection of satisfactory slip-resistant shoes, and walking surfaces. Such safety standards are generally required for products frequently involved in accidents. Standardisation of product design is often a safety prerequisite in man-machine systems as operator "errors" are more likely to occur if similar products vary. However, design standards may prevent sound product development. Therefore, safety performance standards should be preferred whenever possible (Strandberg, 1983). The problem is to identify such safety-relevant performance qualities and to develop reliable, objective procedures for their measurement (Ingoff, Segel and Evin, 1971).

Unfortunately, this problem has been underestimated by many investigators of slipping accidents, who did not consider slips and falls to be complicated phenomena. Therefore, the literature exhibits a number of slip-resistance measurement methods which demonstrate how a new approach can be invalidated or seriously damaged by inattention to basic principles of research methodology (Haddon, Suchman and Klein, 1964).

A number of developments have taken place with regards to the testing of slip resistant shoes. Research is being undertaken to develop a more realistic test for measuring the slip resistance of complete shoe soles and thus determine the effectiveness of sole patterns as well as sole materials and floor surfaces (Perkins and Wilson, 1983; James, 1983; Harrison and Malkin, 1983).

It is suspected that results in the present study will yield information regarding the importance of a safe kitchen surface. It is therefore necessary to expand on the research regarding this subject. From research conducted by Perkins and Wilson (1983) it was found that in the majority of experiments carried out, a slip occurred in a forward direction having started shortly after the heel contacted on oil-covered surface. In some cases the shoe only slipped a few centimetres and then stopped, so the subjects were able to retain their balance and continue walking. In other tests, slip was more severe and subjects lost their balance. Any slip which extended more than 10-15cm resulted in loss of balance and a dangerous slip. Experiments were conducted by reproducing slip conditions in walking as closely as possible. Using this test it has been found that slip severity depends on how friction changes as the shoe moves. Furthermore, it appears that a single measurement of friction may not be

sufficient to completely predict the slip resistance of a shoe sole (Perkins and Wilson, 1983).

It is universally recognised that slippery surfaces are dangerous (James, 1983). Hunter (1930) recognised the influence of contaminating substances such as dirt, water and oil. Sigler, Geib and Boone (1948) emphasised the importance of wear and contaminants. Jablonsky (1978) has recently drawn attention to the influence of floor polishes and treatments on the safety of floors. It has been reported by Brough, Malkin and Harrison (1979) that cleaning methods considerably affect the friction properties of ceramic floors. Thus, although slippery floors are hazardous, care must be taken to ensure that cleaning materials themselves do not create a further hazard (James, 1983).

Harrison and Malkin (1983) conclude that wherever there is a risk of water lying or of water spillages, relief surfaces should be used to reduce the chance of slipping. Design of the floor texture has to be tempered by foot comfort and ease of cleaning. Grip soles and heels are also effective. Where high relief on the floor and/or shoes is not feasible an improvement can be produced by inclusions on the floor surface. These are usually particles of silicon carbide in the case of ceramics. Some improvement can be obtained by choosing suitable shoe materials. Ideally, the most effective system demands that a combination of the floor and shoe materials and surfaces should be decided.

Perhaps, beyond the very important questions of coefficients of friction and foot-floor forces, the most important generalisation is that no sole or floor combination is safe if they are not cleaned regularly with proper materials. The number of deaths and injuries resulting from underfoot

incidents, the causes of the accidents and the nature of the injuries have not been established, although they are the commonest disabling accidents afflicting mankind (Davis, 1983).

Unlike occupational diseases, occupational accidents are unfortunately often considered to be caused solely by human error. Therefore, accident prevention is particularly dependent on ergonomists, who are aiming at improvements in the working environment, instead of unsuccessful attempts to reduce natural variations of human behaviour. The large number of accident hazards in the working environment require proper techniques to identify the most relevant safety qualities and to develop objective procedures for their measurement (Strandberg, 1983).

The present research will involve looking at safety and ergonomic data and through this developing an appropriate conceptual framework in which to analyse kitchen activity and kitchen safety in commercial kitchens.

A questionnaire will be formulated in a manner similar to that administered by Adams, Barlow and Hiddlestone (1981). Through this questionnaire work mismatches in interface design will be identified. Research will incorporate incidents which are identified as accidents through consequences such as damage or injury as well as all incidents which may offer symptomatic evidence of malfunction.

It is strongly suspected that from these analysis poorly designed equipment, poor procedures and poorly prepared individuals will be identified. In this way a whole sequence of events that lead up to the occurrence of an accident can be analysed using the accident report form.

Thus, the general aim of this research will be to utilise information from the areas of applied psychology and ergonomics in order to investigate the problem. From this information, procedural and hardware design recommendations, based on psychological and ergonomic principles, will be promoted.

CHAPTER 5

Conceptual Overview

As has been shown in the previous chapters, accidents can be seen to present a major problem to all communities throughout the world. Advances in technology, communications and increased industrialisation bring with them economic and social changes with many consequences both positive and negative (Cliff, 1984). Accidents have been seen to be a prominent feature in respect of the negative factors as many workers die or suffer injury on account of occupational diseases and accidents every year all year round.

Early studies in the field of accident research and safety utilised large quantities of data drawn from accident and other records, and attempted to categorise events and search for common factors by using standardised statistical techniques (Dunn, 1971). This research began to identify a wide range of potential 'personal' factors as well as 'environmental' characteristics which were thought in some way to underlie accident proneness (Surry, 1971 and Dunn, 1971). However, when looking at these factors, it must be realised that none of these factors alone can adequately explain all accidents in all situations.

There have been many problems associated with the notion of 'accident proneness' for a number of reasons. To highlight the most important problems the suggestion that a fixed group of people are responsible for a majority of accidents, or are more prone to all types of accidents (Kerr, 1950; Newbold, 1926; Farmer and Chambers, 1926), has no unequivocal experimental support (Arbus and Kerrick, 1951; Froggat and Smiley, 1964;

Radon, Suchman and Klein, 1964; Shaw and Sichel, 1971). In addition many of the factors singled out for research simply do not reflect the essential criteria for accident proneness (Surry, 1971). Furthermore, it is held that the concept of accident proneness has received far more attention than it deserves (Kirchner, 1961).

Factors which could be responsible for an individual having more accidents than another could be factors which are not the individual's fault such as lack of training or no training at all, or because the area in which the person is working is badly illuminated, thus restricting his/her vision. Poor supervision or unfavorable attitudes toward accident prevention could also lead to accidents as well as a tolerance of poor work and safety conditions.

Thus, without carefully investigating the circumstances surrounding an accident which a person has, it would be unwise to label him/her as accident prone, as what at first may appear to be accident proneness, could upon closer examination reveal other factors or conditions, which have been highlighted above, which are causes of accidents (Ramdial, 1981).

Safety research, particularly over the past 50 years, has lacked a theoretical framework necessary for both predicting accidents before they happen and for acting as a cohesive force for drawing together the vast amount of information available (Dunn, 1971). Shortcomings of this early research included problems with data collection and analysis such as the fact that events which were recorded in one industry or organisation may not have been recorded in another, as well as limitations in determining what constitutes an accident which presented fundamental problems in terms of both definition and conceptual relationships.

Perhaps the major drawback to early work has been the omission of any attempt to analyse a whole sequence of events that lead up to the occurrence of an accident.

From the information set out in Chapter 2 it can be seen that in order for any research into accidents to be meaningful, the definition of the term has to be decided upon in such a way that will allow for purposeful investigation. This is extremely important because of the emphasis which is placed on the consequence and cost of accidents. Thus, it becomes necessary to establish what constitutes deliberate, calculated and avoidable events.

The task of building in safety and health at the design stage of new equipment and technology depends on the engineers', designers', and technicians', knowledge of ergonomics and occupational safety and health.

Thus, at all stages of accident research it is important to consider the problems involved such as the central problem of an accident only being labelled an accident after the event (Suchman, 1961). When determining which events truly constitute an "accident" and which do not, still remains open to complex attribution processes which will vary according to the decision maker's involvement in the event (Kelly, 1979).

For the purposes of the present research, an accident will be defined as "an unexpected, unintended but not necessarily damaging or injurious event that disrupts the completion of (a planned) event" (Dunn, 1971; p7). It is essential to broaden the definition of "accident" to include contributing factors such as health and safety and to demonstrate how they

interact with personal or environmental factors as it is not sufficient to consider only personal or environmental factors.

As technology has evolved, humans have been progressively separated from primary work transformations through the introduction of equipment, machinery and procedures. This more complex situation makes it more difficult to isolate and identify hazards. Thus, a more sophisticated approach to maintaining safety, other than mere intuitive intervention, is therefore required. Initially this would involve the careful design of interacting elements by considering ergonomic principles. These ergonomic considerations must however be constantly monitored for system malfunction and any malfunction which is detected must be constantly re-designed (Fisher, 1986).

Finding the optimal structures to meet the criteria encompassed in the definition of ergonomics, which is the study of the relation between man and his occupation, equipment and environment, and particularly the application of anatomical, physiological and psychological knowledge to the problems arising from them (Shackel, 1966), necessitates recognising the dynamic relationship between interacting components of any human-machine system which are the human, machine, workspace, environment, task structure and procedures. Thus, a general statement of the ergonomics perspective would be to consider the whole of the human in the whole of the work situation. A highly complex and variable image of the "whole of the human" and the "whole of the work situation" is expanded upon in Chapter 3.

When reviewing ergonomic principles it becomes apparent that malfunctions which occur are likely to result from badly designed interfaces. Edwards

(1981) suggests that the design of work should concentrate on four interacting components: 'hardware' (machinery and equipment), 'liveware' (employees/people), 'environment' (all aspects of the workplace) and 'software' (the procedures by which the other elements are linked).

Accidents, thus, are symptomatic of a failure in the system and as such provide clues about the location of the source of failure, indicating where the mismatches occur and what kind of action is likely to be effective in reducing these mismatches. Thus, the individual is no longer the focal point for all events but rather an integral component of an operating system. The accident is thus identified as an indicator of system malfunction which may result either from the breakdown or failure of any system component or due to badly designed interfacing components. By recognising the importance of focusing upon mismatches between components, all incidents which may offer symptomatic evidence of malfunction should be investigated, and not merely those incidents identified as "accidents" through consequences such as damage or injury.

A first step in reducing the probability of such mismatching is by paying close attention to ergonomic principles at the design stage for all aspects of the task under focus. Ergonomic principles relevant to the design of displays, controls and layouts are set out in Chapter 3. However, it is important to note that in the final design, the man and machine must emerge as an integral unit, for the capacity of the system to work effectively is restricted by the limitation imposed by man, machine, displays and controls (Shackel, 1974).

Among ergonomists, occupational injuries can and should be prevented mainly through improvements in the working environment. Even if one can

improve skills and promote safer behaviour through education and training of workers exposed to risk, the permanent elimination of common risk factors requires changes in equipment design and in work organisation. However, despite the dominating numbers of occupational accidents in occupational injury statistics, occupational accidents are often looked upon as being a result of "human error" or "poor workmanship". Consequently, contributing factors in the working environment such as poor visibility, and slippery surfaces are not considered (Strandberg, 1983). The appropriate design of safe equipment to prevent injuries is perhaps the most important prevention strategy available. While occasional 'human failure' is inevitable and predictable in any work environment, whether it results in injury depends on how the job and the equipment are designed (Baker, Sankoff, Fisher and Van Buren, 1982)

This study will attempt to isolate the causes of accidents in restaurant kitchens, which are hypothesised to be caused mainly through bad design of kitchen equipment.

According to the Catering Association of South Africa, it is clear that the food service industry in South Africa is likely to be one of the fastest growing in the next decade. Therefore, it can be assumed that there will be a large amount of accidents in this industry (Fedics Corporate Report, 1985)

When looking at the catering industry, it can be seen that the design, construction and equipment of a commercial kitchen should satisfy two basic criteria- firstly, the proposed menu and scale of operation and secondly, the intended method of cleaning the premises and equipment

(Holbs and Gilbert, 1982). In addition one must consider the safety and health of workers as accidents do happen in kitchens (Lian, 1981).

Personal injury in kitchens may result from cuts, burns, scalds, lifting injuries causing strains, falling objects, electrical shocks and falls.

When looking at falls, the annual report of the Department of Manpower (1986) stated that many injuries were caused by persons falling, treading on or bumping against objects or being hit by flying, sliding, falling or moving objects or material. The report continues to state that "these types of injuries can largely be prevented by working more carefully and by better supervision" (Report of the Department of Manpower, 1986; p108). However, when reviewing the ergonomic literature on slips, trips and falls, as has been done in Chapter 4, it becomes apparent that there are a number of other variables which must be considered beside personal care and supervision.

Slipping, tripping and falling are the commonest cause of injuries, and can account for up to 40% of lost time injuries (Davis, 1983). However, very little is known about these kinds of accidents for three main reasons. Firstly, there is the inadequate accident classification, secondly bystanders often laugh and joke about falls with the result that the general public does not regard them seriously. Thirdly, and possibly most importantly, there is no national system for collecting and analysing information about the cause of all injuries (Manning, 1983). Thus, although such accidents are very frequent, they will often be neglected compared to other accidents which are more rare and dramatic. In order to identify and evaluate the risks, one therefore requires a system which

covers information for all kinds of accidents and all cases occurred (Andersson and Lagerlof, 1983).

It is suspected that results in the present study will yield information regarding the importance of a safe kitchen surface as it is universally recognised that slippery surfaces are dangerous (James, 1983). Slippery kitchen surfaces may be due to dirt, water, oil and floor polishes.

The large number of accident hazards in the working environment require proper techniques to identify the most relevant safety qualities and to develop objective procedures for their measurement (Strandberg, 1983).

It is for the above reasons that the present research is involved with the amalgamation of safety and ergonomic data in order to develop an appropriate and rigorous conceptual framework to analyse activity and kitchen safety in commercial kitchens. Within this framework mismatches in interface design will be identified via a questionnaire which has been formulated in a manner similar to that administered by Adams, Barlow and Middlestone (1981). By recognising the importance of focusing on mismatches between components of the system, it becomes imperative that all incidents which may offer symptomatic evidence of malfunction be determined. Research will not be confined to merely those incidents identified as accidents through consequences such as damage or injury. Variables to be considered will include safety equipment relevant to the injury such as aprons, gloves, etc; primary cause of accident such as action of injured employee; source or agent of injury such as greasy surface or material; movement preceding injury such as handling material; and immediate cause of injury such as employee's grip on tool or material too lax, allowing it to slip or drop. However, these above variables are by

no means exhaustive. They only serve to illustrate the kinds of variables to be considered in the study.

It is strongly suspected that from analysing the data, poorly designed equipment, poor procedures, and poorly prepared individuals will be identified. From this generated data further recommendations will be made regarding alternative designs.

By following such a scheme the basic shortcomings of previous research will be overcome, as a theoretical framework necessary for both predicting accidents before they happen and for acting as a cohesive force for drawing together the vast amount of information available, will be developed. By drawing on research such as that of Adams, Barlow and Hiddlestone (1981) a whole sequence of events that lead up to the occurrence of an accident can be analysed using the accident report form. In addition, such a scheme can enable the identification of factors which may be used for both the redesign process and the planning of injury prevention programmes.

Although it could be argued that small kitchens will not generate sufficient numbers of reports to produce meaningful analysis, this will be overcome by pooling together all the data from each individual restaurant. Adams, Barlow and Hiddlestone (1981) suggest that report forms with commonly useful checklists could be designed to provide cumulative data which may be shared to mutual benefit by a number of participant organisations.

Aims of the present research

The general aim of this research will be to utilise the information and knowledge in the areas of applied psychology and ergonomics to investigate the "problem" of accident and safety in commercial kitchens and to promote procedural and hardware design recommendations based on psychological and ergonomic principles.

The pilot study

Subjects for Pilot Study

The subject for the pilot study was one restaurant. In this restaurant there were twenty six kitchen staff who's duties included chopping vegetables, cutting meat, frying food, grilling food, preparing drinks, washing selected dishes, stacking dishes in a dishwasher, serving food, serving drinks and cleaning the general kitchen area (floors, grillers, sinks, tables etc.) as well as the general restaurant area. The output of the restaurant was approximately 160 meals per day. The restaurant was open for lunch and dinner six days a week.

Experimental task for pilot study

In order to assess the number of reportable incidents, if any, occurring in restaurants, a checklist was formulated, based on that presented by Adams, Barlow and Hiddlestone (1981) as well as a NOSA incident (accident) report and investigation form (1984). A copy of the checklist is at Appendix 3.

The Adams, Barlow and Hiddlestone checklist is designed in such a way that a considerable proportion of the items is of direct or indirect ergonomic significance. These items include the source or agent of injury, the movement preceding the injury, and the immediate cause of injury. It is hoped that this checklist will identify the significant agents of injury.

The "agent of injury" refers to that element of the environment which directly produced the trauma or injury, or which precipitated the injurious movement (e.g., a slippery floor may be the "agent" in the case of a slip resulting in a sprain).

The present checklist consists of five sections. Section A involves the primary cause of accident, section B involves body injuries, Section C is the source or agent of injury, section D is the movement preceding the injury and Section E is the immediate cause of injury. Under each section is listed a number of possible responses. The respondent is required to place a tick in the appropriate box/es for each section. It is possible that more than one box will be ticked in each section.

Procedure for pilot study

The manager of a restaurant in the East Rand was approached. He was informed that the researcher was currently doing a Masters thesis in the field of Industrial Psychology on the subject of safety psychology and the ergonomics of commercial kitchens. The manager was told that his assistance was required to complete the checklist each time he observed an incident, or one was reported to him. Great emphasis was placed on explaining that an incident did not necessarily have to result in an injury in order to be reported. When the manager agreed to participate in

the study, he was asked to go through the checklist himself, in the presence of the researcher, and any queries were answered and noted by the researcher. It was then established that the manager completely understood what was required of him. The researcher assured the manager of complete anonymity of the restaurant.

The pilot study began on the 18 of November 1987 and from then on the restaurant was contacted on a regular basis. Once it was established that incidents were occurring, the suitability of the checklist was assessed through speaking to the manager and thus, the appropriateness of such a checklist in the restaurant industry was confirmed. There were no changes made to the checklist as the manager was able to report incidents without encountering any problems. At no point did the manager report that the categories were insufficient or not broad enough to cover all types of accidents occurring in his kitchen. The restaurant was then incorporated into the larger study.

The main study

Subjects for the main study

The subjects included in this study were fourteen restaurants (including the pilot study) in the East Rand and Johannesburg areas. In the table below the number of staff in each restaurant as well as the number of meals produced per day are listed.

TABLE 5.1 Staff and meals per day produced in every restaurant.

<u>Restaurant number</u>	<u>meals per day</u>	<u>number of staff</u>
1	180	30
2	100-120	9
3	40	10
4	100-150	14
5	220	24
6	300	30
7	50	15
8	50	21
9	160	26
10	80-100	19
11	110	14
12	200-300(small meals)	6
13	20	15
14	75	9

The staff in all these restaurants included the kitchen staff as well as waiters/waitresses and managers/manageresses who entered and exited from kitchens on a regular basis. The duties and tasks of the kitchen staff included chopping vegetables, cutting meat, frying food, grilling food, preparing drinks, washing dishes, serving food, serving drinks and cleaning the general kitchen areas (floors, grills, sinks, tables etc.) as well as the general restaurant area.

When looking at the accident data generated by individual restaurants, it is unlikely that sufficient numbers of reports will be generated to

produce meaningful analysis. Thus, all the data from individual restaurants were pooled together in order to gain meaningful results (Adams, Barlow and Hiddlestone, 1981). In this way cumulative data was obtained.

Experimental tasks for the main study

In order to obtain data on reportable incidents a checklist was constructed based on that formulated by Adams, Barlow and Hiddlestone (1981) (See Appendix 3). The checklist was identical to the one used in the pilot study.

The checklists were presented to the fourteen restaurants. Each checklist consisted of four pages, each checklist representing a single reportable incident. All the restaurants who received checklists participated in the study.

Procedure

Each restaurant was approached individually. Once access had been obtained, the restaurant manager was informed that the researcher was currently doing a Masters thesis in the field of Industrial Psychology on the subject of Safety psychology and the ergonomics of commercial kitchens. The restaurant manager was further told that his/her assistance was required to complete the checklist each time he/she observed an accident, not necessarily leading to injury, or each time an accident was reported to him/her. Great emphasis was placed on this point. It was further stressed that the duration of the research would be between three months to a year. The restaurant manager was required to go through the checklist himself/herself and the researcher answered any queries. All res-

restaurant managers approached agreed to participate in the research and the complete anonymity of the restaurant was promised.

Every three to four weeks each restaurant was contacted by the researcher in order to keep a check that the research was still in progress and to find out if the restaurants required more checklists.

At the end of the study the checklists were collected from each of the fourteen restaurants and the restaurant manager/ess was thanked for his/her participation in the study.

CHAPTER 6

RESULTS

Analysis is based on 135 reports collected over an eleven month period. The presentation of these results indicates that firstly the data are worthy of consideration by ergonomists, and secondly the data serve to illustrate the usefulness of the mode of reporting, which may be adapted or appropriately redesigned to suit any specific set of work environment and ergonomic demand conditions.

Attention is given to the incidence of accidents according to the number of restaurants participating in the study, the number of kitchen workers per restaurant and the number of incidents.

Frequency distributions are shown as they indicate how often a particular characteristic occurs as well as providing the range and variation of its occurrence within a population. Social surveys, such as the use of the questionnaire, are usually the most effective methodology for isolating the frequencies and distributions of characteristics within a population (Williamson, Karp, Dolphin and Gray, 1982).

In this study 135 questionnaires were collected from fourteen restaurants in the East Rand and Johannesburg areas over a period range of eleven months. Table 1 represents the restaurant and the number of workers in each restaurant.

Table 1

Number of staff in each restaurant.

Restaurant no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
no. of staff	30	9	10	14	24	30	15	21	26	19	14	6	15	9

Restaurant no. N=14

No. of staff N=242

The time period over which the accidents were reported in each restaurant is demonstrated in Table 2 below.

Table 2

Time period over which incidents were recorded in each restaurant.

	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											

The number of incidents per restaurant is set out in Table 3.

Table 3

Number of incidents per restaurant.

restaurant no.	no. of incidents	incidents per month
1	10	2.5
2	24	8
3	10	3.3
4	14	4.7
5	6	1.5
6	11	2.75
7	5	0.6
8	5	1.25
9	5	0.5
10	13	3.25
11	9	2.25
12	6	1.5
13	4	0.8
14	13	4.3
N=14	N=135	N=37.2

Tables 2 and 3 show that the period of time over which the study was carried out in each restaurant did not correspond with an increased number of incidents in each restaurant. Restaurant number two displayed the highest number of incidents, however the study was only conducted in this restaurant over a period of three months. Restaurant number nine was responsible for five accidents, yet this restaurant participated in the study for the longest period of time (nine months). Thus, time was not

the sole determining factor. Incidents are thus proposed to be a function of factors such as ergonomic design, insufficient training, lack of supervision etc. The possibility of under-reporting can also not be ruled out. It is possible that because the restaurant managers knew that their restaurants were being observed for the occurrence of incidents, they were reluctant to report all incidents. The possibility of under-reporting will be discussed in greater detail in Chapter 7.

Because a considerable proportion of the items on the checklist are of direct or indirect ergonomics significance, the frequency of the responses will be tabulated below according to the source or agent of injury, the movement preceding the injury, the immediate cause of injury and the injury itself.

Distribution of injuries according to the source or agent of injury

The "source" or "agent of injury" refers to that element of the environment which directly produced the trauma or injury or which precipitated the injurious movement (as for example, a greasy floor might be the "agent" in the case of a slip resulting in an injury to the back). Sixteen such agents are listed to which is added item 17, 'any other - please describe.' Table 4 lists these agents in their order of frequency of use over the research period. Only sixteen agents appear below as there were no responses to item 7 - "sharp objects such as nails not being used by worker", and item 17 - "aggravation of a disability already present".

Table 4

Frequencies according to the source or agent of injury.

source or agent of injury	frequency	percent
1.Tools or equipment being used	56	27.3
2.Hot surface	33	16.1
3.Any other: please describe	30	14.6
4.Slippery surface	28	13.7
5.Manually moved tools being used	17	8.3
6.Greasy surface	8	3.9
7.Mechanically moved tools being used	6	2.9
8.Uneven surface	6	2.9
9.Mechanically moved material	4	2.0
10.Stationary equipment not being used	3	1.5
11.Falling objects	3	1.5
12.New task	3	1.5
13.Stationary, but out of place material or equipment	2	1.0
14.Flying objects	2	1.0
15.Gas	2	1.0
16.Mechanically moved tools not being used	1	0.5
17.Chemicals other than gas	1	0.5
Total	205	

It is of interest to note that the first two items, "tools or equipment being used by worker" and "hot surface or material", contribute nearly 45% of the responses in this category. This means that the worker injures him/herself on the tool or equipment with which he/she is working as well

as from a hot surface or material. This suggests that a focus on the handling methods and the behaviour of the worker is necessary and the ergonomic designs of such equipment need to be investigated.

The next highest category, which is in this case "any other please describe", will be discussed in Chapter 7 by drawing examples from the open ended section of the questionnaire. However, it must be noted that this category included mostly written repetitions of what had been ticked in the checklist.

"Slippery surface" is another high item. This means that slippery surface or material is a source or agent of injury which needs to be expanded upon. This is done in detail in Chapter 7.

Movement preceding injury

In this category fifteen of the most common of the movements preceding the injury are listed as well as item sixteen of the questionnaire "engaged in more complex movement: please describe". "Walking without carrying anything upstairs" is excluded from this table as there were no responses to this item. Table 5 lists these movements preceding injury in their order of frequency.

Table 5

Frequencies of movements preceding injury

Movement preceding injury	frequency	percent
1. Handling a tool or equipment	58	29.4
2. Engaged in more complex movement: please describe	43	21.8
3. Walking without carrying anything on a level surface	18	9.1
4. Lifting material or equipment	16	8.1
5. Carrying or wheeling material on a level surface	16	8.1
6. Taking hold of material, equipment or tool	10	5.1
7. Standing still and upright	8	4.1
8. Pushing material away from him/herself	6	3.0
9. Pulling material towards him/herself	5	2.5
10. Jumping or stepping on to an elevated surface/position	4	2.0
11. Reaching for material, equipment or a tool	3	1.5
12. Carrying material upstairs	3	1.5
13. Jumping or stepping down from an elevated surface/position	2	1.0
14. Standing still, leaning over material or equipment	2	1.0
15. Carrying material downstairs	2	1.0
16. Walking without carrying anything downstairs	1	0.5
Total	197	

"Handling a tool or equipment" accounted for almost 30% of the responses in this category. "Engaged in more complex movement: please describe" accounted for almost 22% of the responses in this category. However, most of the written responses were simply repetitions of the responses in the

checklist in this category. Approximately 9% of the movement preceding the injury was accounted for by "walking without carrying anything on a level surface". This has bearing on the importance of floor surface which will be expanded upon at the discussion stage. Taken in conjunction, "lifting material or equipment" and "pushing and pulling" movements accounted for almost 14% of responses in this category. This figure indicates the need for better training and/or supervision and/or the use of more mechanical aids for these sorts of physical actions. The low number of injuries resulting from walking downstairs carrying anything and without carrying anything may indicate that because such movements are inherently hazardous, workers will be much more careful when walking downstairs. Secondly, only two of the participating restaurants actually had steps and for this reason the frequency of this response is low.

The immediate cause of injury

In checking the immediate cause of injury the manager is indicating what in his/her opinion, was the most important of the factors producing the injury. The attempt has been made, through the checklist, to specify a number of particular sorts of "error judgement", as well as defining other possible injury producing behaviours or situations.

In this category eleven of the most common immediate causes of injury are listed as well as a twelfth item "any other cause: please describe". The items "over reliance on protective equipment by worker" and "worker's bodily reaction to new task or equipment" are excluded as no responses were recorded for these items.

Table 6

Frequencies of immediate causes of injury

Immediate cause of injury	frequency	percent
1.Placing part of body in position of risk	51	27.6
2.Any other cause: please describe	51	27.6
3.Slip, trip or fall by worker	37	20
4.Failing to allow for physical properties of material	20	10.8
5.Grip on tool or material too loose allowing it to slip or drop	8	4.3
6.Failure to use protective equipment	7	3.8
7.Misjudging position of material	4	2.2
8.Over-estimating movement space in a confined area	3	1.6
9.Misjudging own strength or physical ability	1	0.5
10.Movement of poorly stocked or placed material	1	0.5
11.Over-reaching with tool, material or part of body	1	0.5
12.Misjudging speed of moving material	1	0.5
Total	185	

Once again, as in the previous two categories, "any other cause: please describe" conveyed written repetitions of what had been ticked as items.

Many of the minor injuries associated with "placing part of body in position of risk" were minor nicks and burns. However, there were some serious injuries which will be discussed further on. It is important to note that this item accounted for almost 28% of the responses in this

category. "Slip, trip or fall" accounted for 20% of the immediate cause of injury. This kind of immediate cause of injury is very much a function of floor surface. Clearly the improvement of surfaces, where possible, as well as the provision of safety shoes should minimise this significant contribution to injuries. This item is of particular importance and will be further expanded upon in Chapter 7.

The other causes which contribute to this category are "failure to allow for physical properties of material" (10.8%), "grip on material too loose allowing it to slip or drop" (4.3%) and "failure to use protective equipment" (3.8%). "Failure to use protective equipment" suggests that there is a greater readiness to work unprotected on jobs which are considered by the worker to have a relatively low injury potential. It is also possible that many of the workers who are injured while, and perhaps partly because of, not wearing protective equipment, may be among the more experienced and the more able to minimise, if not totally avoid, an injury (Adams, Barlow and Hiddlestone, 1981). Finally failure to use protective equipment may be due to the fact that workers are not aware of the importance of such a practice. Thus, there may be a definite need for training in this area. An investment of both time and effort in the observance of safety procedures is necessary for the elimination of unsafe acts in the workplace (Fisher and Parry, 1965).

Frequency of injuries

The questionnaire made provision for the reporting of specific injuries. The table below sets out these injuries according to their frequency of occurrence. There were no reported incidents of poisoning or suffocation.

Table 7

Frequency of inj -

Injuries	frequency	percent
1.finger/s	58	30
2.burn bx	38	20
3.hand/s	31	16
4.head	16	8.2
5.strain/sprain	10	5.1
6.arm/s	7	3.6
7.back	7	3.6
8.leg/s	5	2.6
9.neck	4	2.1
10.ey/s	4	2.1
11.amputation	4	2.1
12.chest	3	1.5
13.foot/feet	2	1
14.confusion	2	1
15.internal wound	2	1
16.fracture	1	0.5
Total	194	

The majority of injuries are made up of injuries to the finger/s (30%), hand/s (16%), head (8.2%) and burns (20%). Although there are items which report very low frequencies, it must be remembered that an injury such as amputation (freq=4) cannot be discarded because of its low frequency. Such an injury should not be occurring at all in restaurant kitchens, and the fact that such an injury occurs is a cause for concern.

It must be noted that in tables 4, 5, 6 and 7 the total exceeds the 135 questionnaires because on some reports more than one item is ticked per category.

As has been pointed out by Adams, Barlow and Hiddlestone, (1981) pairings or groupings such as agent plus movement preceding injury, agent plus immediate cause, could all be used to obtain more detailed and useable sets of data than those presented above. "It is possible, and of potentially more ergonomics value, to analyse the data in terms of two or more criteria simultaneously" (Adams, Barlow and Hiddlestone, 1981; p7).

In order to analyse the data in terms of two or more criteria simultaneously the statistical technique of correlation is employed. Correlation methodology is a valuable research tool which serves an important function in organisational research. Much of the research conducted in organisational settings uses correlational techniques to infer relationships among variables of interest (Mitchell, 1985).

The correlational approach enables one to accomplish the goals of prediction. If a reliable relationship is found between two variables then not only has the relationship between these two variables been described but one variable can now be predicted from a knowledge of the other variable. However, it must be noted that causation cannot be inferred from correlational studies. The fallacy of assuming causation is not inherent in the correlational study, only in the user of the results of such a study (Christensen, 1980).

Correlations are complex computations that measure the degree of relationship between two variables by utilising exact scores instead of

rough categories. The computation produces a single number, called a correlation coefficient which summarises the relationship (Williamson, Karp, Dolphin and Gray, 1982). The correlation coefficient expresses quantitatively the extent to which two variables are related. The values of the correlation coefficients vary between +1.00 and -1.00. Both extremes represent perfect relationships between the variables, and 0.00 represents the absence of a relationship. A positive relationship means that individuals obtaining high scores on one variable tend to obtain high scores on a second variable. This is also true of the converse where individuals scoring low on one variable tend to score low on a second variable. A negative relationship means that individuals scoring low on one variable tend to score high on a second variable. Conversely, individuals scoring high on one variable tend to score low on a second variable. These characteristics are true for correlation coefficients that measure linear relationships, but not for all correlation coefficients.

The present study contains nominal data as the respondent was asked to mark his/her response with a tick next to the appropriate item. The data is therefore binary data of responses in the form of yes (1) or no (0). Thus, there are two dichotomous variables and under such conditions the phi coefficient (r_{ϕ}) is the correlation coefficient employed (Runyon and Haber, 1985).

The Fisher exact probability test is an extremely useful nonparametric technique for analysing discrete data (either nominal or ordinal) when the two independent random samples are small in size. It is used when the scores from two independent random samples all fall into one or the other of two mutually exclusive classes. Thus, every subject in both groups obtains one of two possible scores. In this study the two possi-

bilities are either yes or no. The scores are represented by frequencies in 2x2 contingency tables.

Table 8

Contingency table

	-	+	Total
Group 1	A	B	A+B
Group 2	C	D	C+D
Total	A+C	B+D	N

The test determines whether the two groups differ in the proportion with which they fall into the two classifications. For the data in Table 8 (where A, B, C and D stand for frequencies) it would determine whether Group 1 and Group 2 differ significantly in the proportion of pluses and minuses attributed to them (Siegel, 1956). Thus, Fishers exact test yields the probability of observing a table that gives at least as much evidence of association as the one actually observed, given the null hypothesis is true (SAS, 1985).

The chi-square test is employed to determine whether two variables are related or independent. If the chi-square value is significant, it may be concluded that the variables are dependent or related. For the purpose of this research the discussion of chi square is restricted to the 2x2 contingency table (Runyon and Haber, 1985).

When the data of research consist of frequencies in discrete categories, the chi-square test may be used to determine the significance of differences between two independent groups. The measurement involved can include nominal data. The hypothesis being tested is usually that two groups differ with respect to some characteristic and therefore with respect to the relative frequency with which group members fall in several categories. To test this hypothesis the number of cases from each group which fall in the various categories are counted. These are compared with the proportion of cases from one group in the various categories with the proportion of cases from the other group. Chi-square requires that the expected frequencies in each cell should not be too small. When this requirement is violated, the results of the test are meaningless. Chi-square tests are insensitive to the effects of order when the degree of freedom > 1 . When the frequencies are in a 2×2 contingency table, the decision concerning the use of chi-square should be guided by these considerations:

When $N > 40$ use chi-square.

When N is between 20 and 40 chi-square may be used.

If the smallest expected frequency is less than 5 use the Fisher test.

When $N < 20$ use the Fisher test in all cases (Siegel, 1956).

In this research when any of the cells have expected counts less than 5 the Fisher exact test is used as in such cases chi-square may not be a valid test. The significance test employed will be illustrated each time.

The significance level

The level of significance for inferring the operation of nonchance factors in this present research is taken at the 0.05 significance level ($\alpha = 0.05$). The level of significance is the probability of making a Type

1 error (rejecting a null hypothesis which is in fact true). At the 5% significance level the null hypothesis is rejected and the probability that the null hypothesis is true is 5% (or less). Thus, when the event or one or more deviant would occur 5% of the time, or less, by chance, the results are seen to be due to nonchance factors. The 0.05 level of significance is routinely used in the social and behavioural sciences (Runyon and Haber, 1985).

Emergent sequences of action

The data are set out below according to three major accidents which have been identified from the analysis of the data. These are slips, trips and falls; burns and cuts.

1. Slips, trips and falls

In drawing up the questionnaire, and from previous research, one of the expected relationships was that between "slippery and greasy floors" and "slips, trips and falls". The results indicated the following:

The frequency of "slips, trips or falls" was thirty seven (20%). This was the second highest item chosen in the category of immediate causes of injury. This immediate cause of injury is very much a function of floor surface and it is therefore necessary to see the relationship between "slips, trips and falls" and floor surfaces as well as with other items related to "slips, trips and falls".

"Slippery surface" correlated with "slip, trip and fall by worker", yielding a correlation of 0.669 at the 0.0001 significance level. "Greasy surface" correlated with "slip, trip or fall by worker", yielding a correlation of 0.408 at the 0.0001 significance level. The frequency of

"slippery surface or material" was twenty eight (13.7%) and the frequency of "greasy surface or material" was eight (3.9%). If these figures are combined then the source or agent of thirty six of the 135 reported incidents were accounted for by "slippery or greasy surface or material".

When looking at the immediate cause of injury a "slip, trip and fall" is seen to be related to injuries to the back and to result in strains or sprains. This relationship is demonstrated in the table below.

Table 9

Relationship between "slip, trip and fall by worker" and injuries.

	back	strain/sprain
slip, trip and fall	phi=0.342 Fisher=0.0001	phi=0.397 Fisher=0.0001

N=135

These relationships indicate that "slips, trips and falls" lead to accidents with injurious results.

From looking at the movement preceding injury a relationship was found. This result was analysed within the category of "slip, trip or fall by worker". A significant relationship was found between "walking without carrying anything on a level surface" and "slippery surface or material".

Table 10

Correlation between "walking without carrying anything on a level surface" and "slippery surface or material".

	walking without carrying anything on a level surface
slippery surface or material	$\phi=0.338$ $\chi^2=0.040$ square

N=37

"Carrying or wheeling material on a level surface" constituted a high frequency in the category of movement preceding injury (freq=16, 8.1%).

This movement correlated significantly with "greasy surface or material" and "slip, trip and fall by worker".

Table 11

Correlations between "carrying or wheeling material on a level surface" and "greasy surface or material" and "slip, trip or fall by worker".

	greasy surface or material	slip, trip or fall by worker
carrying or wheeling material on a level surface	$\phi=0.340$ Fisher=0.0001	$\phi=0.350$ Fisher=0.0001

N=135

In addition "slips, trips and falls" also correlated with an "uneven surface or material" as well as with "jumping or stepping down from an elevated surface or material".

Table 12

Correlations between "slip, trip and fall" and "uneven surface or material" and "jumping or stepping down from an elevated surface or material".

	uneven surface or material	jumping or stepping down from an elevated surface or material
slip, trip or fall by worker	$\phi=0.190$ Fisher=0.048	$\phi=0.245$ Fisher=0.019

N=135

"Jumping or stepping down from an elevated surface or material" also showed a relationship with injury to the back. The ϕ correlation coefficient was 0.235 with the fishers test of significance being 0.014.

From the above two tables it can be seen that "uneven surfaces or material" are related to "slips, trips and falls" in the kitchen environment. This indicates that steps are not to be incorporated in kitchens. This point will be expanded upon in Chapter 7.

The following injury was related to "uneven surface or material".

Table 13

Correlation between "uneven surface or material" and injury to the leg.

	leg injury
uneven surface or material	$\phi=0.387$ $Fisher=0.0001$

Thus, there is a definite relationship between slippery, greasy and uneven surfaces or material and between slipping, tripping and falling as a result of these surfaces or materials. In addition, such sources or agents of injury often result in injury. It is therefore necessary to improve the working environment in terms of equipment redesign. Recommendations for such redesign will be made in Chapter 7.

2. Burns

A second area of concern, when undertaking the present research, was the area of burns and scalds. These seemed of extreme importance, especially in the catering industry where a large amount of the work centres around hot equipment and takes place in a hot environment.

The frequency of burns was thirty eight (20%). This injury represented the second highest injury in this category and it is therefore of importance to identify significant relationships in this area.

Relationships were found between burns and injuries to the hand/s and eye/s. These relationships are expressed below

Table 14

Relationship between burns and injuries to the hand/s and eye/s.

	hand/s	eye/s
burns	phi=0.559	phi=0.182
	chi=0.0001	chi=0.034
	square	square

N=135

As mentioned above the occurrence of burns was one of the most frequent injuries reported, however this is also true of injuries to the hands

which had a frequency of thirty one (16%). Injuries to the eye/s had a frequency of four (2.1%).

From these injuries it can be seen that burns are a definite hazard in the catering industry. In attempting to isolate relationships between burns and the source or agent of injury, the following relationships were yielded. Burns correlated significantly with "material being moved manually by worker", and "hot surface or material". These relationships are expressed below in Table 15.

Table 15

Correlations between burns and "material being moved manually by worker", and "hot surface or material".

	material being moved manually by worker	hot surface or material
burns	phi=0.209 Fisher=0.019	phi=0.717 chi=0.0001 square

N=135

When looking at burns in relation to the movement preceding injury the following relationships were found. Burns correlated significantly with "lifting material or equipment", "pulling material towards him/herself", and "taking hold of material, equipment or a tool". These correlations are expressed below.

Table 16

Correlations between burns and "lifting material or equipment", "pulling material towards him/herself", and "taking hold of material, equipment or a tool".

	lifting material or equipment	pulling material towards him/herself	taking hold of material, equip- ment or tool
burn	phi=0.178 Fisher=0.042	phi=0.226 Fisher=0.022	phi=0.389 Fisher=0.0001

N=135

From the nature of the movement preceding the injury it can be seen that the worker is operating in an environment which could be improved upon from an ergonomic point of view. In many cases burns were caused through taking hold of material, equipment or a tool which unbeknown to the worker was hot.

When isolating the immediate causes of injury, in this case those causes which resulted in burns, the following relationship was found. Burn correlated with "worker failing to allow for physical properties of material" "Worker failing to allow for physical properties of material" accounted for 10.8% of the immediate causes of injury (freq=20). This relationship is expressed below.

Table 17

Relationship between burn and "worker failing to allow for physical properties of material".

	worker failing to allow for physical properties of material
burn	phi=0.342 chi=0.0001 square

N=135

When the data was sorted out in terms of those individuals who had sustained burns and those who hadn't, the following results were yielded from the data of those who had sustained burns.

"Tools or equipment being used or moved by the worker", the source or agent of injury, correlated with "handling a tool or equipment", the movement preceding the injury. This relationship is expressed below.

Table 18

Correlation between "tools or equipment being used or moved by worker" and "handling a tool or equipment".

	handling a tool or equipment
tools or equipment being used or moved by worker	phi=0.476 chi=0.003 square

N=38

A correlation was found between the workers failure to use protective equipment (immediate cause of injury) and an injury to the finger. This relationship is expressed below.

Table 19

Correlation between "worker's failure to use protective equipment" and injury to the finger/s.

	workers failure to use protective equipment
injury to the finger	phi=0.505 Fisher=0.007

N=38

"Material being moved manually by worker", (source or agent of injury) correlated with "lifting material or equipment" (movement preceding the injury). This relationship is presented below.

Table 20

Correlation between "material being moved manually by worker" and "lifting material or equipment".

	lifting material or equipment
material being moved manually by worker	phi=0.320 chi=0.049 square

N=38

These above three tables were all correlation coefficient of data which had been sorted into the group of "burns". All these correlations make "logical sense" as it can be clearly understood how these relationships could result in burns if the material is hot. "Failure to use protective equipment will be discussed further on."

3. Cuts

A third area of concern in the catering industry was the occurrence of cuts. It was suspected that cuts, due to the perception that they are too minor to constitute an injury, and thus would not be reported, would be prevalent once investigated.

When attempting to yield information in this area "handling a tool or equipment" was looked at as the movement preceding injury. One of the most frequent movements preceding injury was "handling a tool or equipment". The frequency was fifty eight which was 29.4%.

A number of relationships were found when looking at this item's relationship with other items.

An immediate cause of injury which correlated with "handling a tool or equipment" was "worker placing part of body in position of risk".

Table 21

Correlation between "handling a tool or equipment" and "worker placing part of body in position of risk".

	worker placing part of body in position of risk
handling a tool or equipment	phi=0.609 chi=0.0001 square

N=135

"Handling a tool or equipment correlated with injury to the finger/s. The frequency of injury to the finger/s was fifty eight (30%). However, not all cuts resulted in injuries to the finger/s. This item includes other sources or agents of injury.

The relationship between "handling a tool or equipment" and injury to the finger/s is set out in Table 22.

Table 22

Correlation between "handling a tool or equipment" and injury to the finger/s.

	injury to the finger/s
handling a tool or equipment	phi=0.475 chi=0.0001 square

N=135

When the data were sorted out in terms of a group of those who had "handled a tool or equipment", a number of relationships were yielded within this group.

"Material being moved manually by worker", the source or agent of injury was shown to correlate with three movements preceding injury. These were "lifting material or equipment", "pulling material towards him/herself", and "taking hold of material, equipment or tool". These correlations are set out below.

Table 23

Correlations between "material being moved manually by worker" with "lifting material or equipment", "pulling material towards him/herself" and "taking hold of material equipment or tool".

	lifting material or equipment	pulling material towards him/ herself	taking hold of material, equip- ment or tool
material being moved manually by worker	phi=0.635 Fisher=0.0001	phi=0.441 Fisher=0.022	phi=0.441 Fisher=0.022

N=58

These movements all apply to manual movements, and thus include those movements which the worker him/herself has made. They do not include machinery. This will be discussed further on.

"Mechanically moving tools or equipment" was found to correlate with "pushing material away from him/herself". This relationship is set out in Table 24.

Table 24

Correlation between "mechanically moving tools or equipment" and "pushing material away from him/herself".

	pushing material away from him/herself
mechanically moving tools or equipment	$\phi=0.551$ Fisher=0.011

N=58

A significant correlation was found between injury to the finger/s and "placing part of body in position of risk". This correlation is expressed below.

Table 25

Correlation between "placing part of body in position of risk" and injury to the finger/s.

	placing part of body in position of risk
injury to the finger/s	phi=0.632 Fisher=0.0001

N=58

Thus, from the above tables, it can be seen that handling a tool or equipment can result in injuries and do in fact lead to injuries to the finger/s in the restaurant kitchen setting.

The above results were based on expectations from this research. In other words, the areas of slips, trips and falls; burns and scalds; and cuts were all areas where it was hypothesised that these accidents and injuries would be prevalent in the commercial kitchen environment. The results will be discussed in detail in chapter 7.

In addition there were other significant analyses which were non-expected findings. When looking at the source or agent of injury the frequency of many of the categories was low. This can be seen in Table 26.

Table 26

Frequencies of selected sources or agents of injury.

	frequency	percent
material moving mechanically and handled by worker	4	3%
stationary equipment or tools in correct place not being used by worker	3	2.2%
stationary equipment or tools in incorrect place not being used by worker	2	1.5%
falling object	3	2.2%
flying object	2	1.5%
mechanically moving tools or equipment not being used by worker	1	0.7%
chemicals other than gas	1	0.7%
new task	3	2.2%
gas	2	1.5%

Although this represents a low response rate, these results may be indicative of severe accidents which do not occur regularly. When one looks at the injuries associated with these sources or agents of injury it becomes clear that the injuries are quite severe e.g. amputation.

The sample size was too small to render the correlations meaningful. However, if one undertakes a phenomenological examination of the data it becomes clear that these agent or sources of injury were responsible for injuries to the neck, feet, chest, arms, head, eyes as well as causing strains/sprains, burns, confusion and in some cases necessitating amputation. Thus, these sources or agents of injury cannot be ignored.

"Mechanically moving tools or equipment being used by worker" accounted for six responses (2.9%). Although this is not a high frequency, it is significant to note that this source or agent of injury resulted in amputations.

Protective equipment

"Worker failure to use protective equipment" produced a frequency of seven (5.2%). Although this is a low frequency when comparing it with other immediate causes of injury, it is still worthy of investigation as it yields informative results. In addition, this factor appears to be responsible for serious injuries. This will be further discussed in chapter 7.

"Workers failure to use protective equipment" correlated with injuries to the finger/s as well as resulting in amputation. These correlations are set out in Table 27.

Table 27

Correlation between "workers failure to use protective equipment" and injury to the finger/s and amputation.

	injury to the finger/s	amputation
workers failure to use protective equipment	phi=0.202 Fisher=0.025	phi=0.353 Fisher=0.013

N=135

The sources or agents of injury with which "workers failure to use protective equipment" correlated were "mechanically moving tools or equipment being moved or used by worker" and "chemicals other than gas". These correlations are tabulated below.

Table 28

Correlations between "workers failure to use protective equipment" and "mechanically moving tools or equipment being moved or used by worker" and "chemicals other than gas".

	mechanically moving tools or equipment being moved or used by worker	chemicals other than gas
failure to use protective equipment	phi=0.274 Fisher=0.031	phi=0.369 Fisher=0.050

N=135

The movements preceding injury with which "workers failure to use protective equipment" correlated was "pushing material away from hem/herself" and "taking hold of material, equipment or tool".

Table 29

Correlations between "workers failure to use protective equipment" and "pushing material away from him/herself" and "taking hold of material, equipment or tool".

	pushing material away from him/herself	taking hold of material, equipment or tool
workers failure to use protective equipment	$\phi=0.274$ Fisher=0.031	$\phi=0.317$ Fisher=0.009

N=135

The remaining immediate causes of injury produced frequencies which were too small to obtain any meaningful results from the correlations. However, from observation the following points were noted. They will be highlighted as their small frequency of occurrence may indicate the possibility of a severe accident which may not occur that often, but whose potential can nevertheless not be ignored.

"Worker misjudging speed of moving material" was shown to relate to "mechanically moving tools or equipment used or being moved by worker". This could have severe consequences.

"Worker misjudging position of material" resulted in amputation. Once again, although the frequency of amputations was low it is not a factor which can be ignored in the commercial kitchen.

"Workers over-estimating movement space in a confined area" resulted in injuries to the chest and arms as well as causing confusion. This is also an injury whose occurrence cannot be ignored in a commercial kitchen setting. This kind of factor should be eliminated through sound ergonomic design.

The questionnaire was designed to elicit information regarding the time in which accidents were most likely to occur. However very few respondents filled in this category (N=15). In addition it was hoped that information regarding the use of kitchen equipment such as apron, boots or shoes, hat and gloves, would be extracted from the analysis. The categories for this section were presented in the form of whether the equipment was necessary for the job, whether it was being worn at the time of the accident, and whether the worker was shown how to use it. The frequencies of these results are set out below.

Table 30

Frequencies of use of protective equipment.

	necessary for job		was being worn		was shown how to use it	
	frequency	percent	frequency	percent	frequency	percent
apron	69	51.1%	67	49.6%	63	47%
boots or shoes	50	37%	47	34.8%	44	32.6%
hat	17	12.7%	15	11.2%	14	10.4%
gloves	3	2.2%	3	2.2%	1	0.7%

From the above table it can be seen that regarding aprons, approximately half the respondents wore aprons where necessary and were shown how to use them. With boots and shoes, approximately one third of the respondents wore them as protective equipment and perceived them as being necessary for the job. In the case of hats, approximately 10% of the respondents wore hats and perceived them as necessary for the job. As regarding gloves approximately 2% of the respondents saw them as necessary for the job, wore them and were shown how to use them.

From the results of the study regarding slips and falls, it can be seen that the correct boots or shoes should have been worn by more than one third of the respondents. The wearing of these boots would not automatically imply a decrease in the rate of accidents as it is important that they be non-slip.

In the case of gloves, the response rate was extremely poor. From the results concerning cuts, it could be hypothesised that the use of gloves would decrease the incidence of cuts. These two points will be expanded upon in the discussion section.

The above safety equipment did not correlate significantly with any of the variables. In the case of boots or shoes there was no relationship between this variable and slip, trip or fall by worker. However, this can be due to the fact that the boot or shoe being worn was not designed so as to be non-slip. In the case of gloves, the sample of responses was too low to render any analysis meaningful.

Finally Table 31 sets out the respondents in terms of the primary cause of accident being attributed to the action of the injured worker, the action of a fellow worker or due to unforeseeable mechanical failure.

Table 31

Frequencies of primary sources of accidents.

	frequency	percent
action of injured worker	121	89.6%
action of fellow worker	10	7.5%
unforeseeable mechanical failure	3	2.2%

(N=134)

From the above table it is apparent that the primary cause of accident was due to the action of the injured worker. For this reason it is of great necessity that ergonomic recommendations be presented in order to create a safer working environment and in this way reduce the likelihood of accidents in commercial kitchens. This will be dealt with in chapter 7.

CHAPTER 7

Discussion of results

Part of the fundamental rationale of this research, set out in chapters 1, 2, 3, 4 and 5, has, as suspected, led to information being yielded regarding the importance of a safe kitchen design. Through the design of the questionnaire, mismatches in interface design have been identified as incidents which offered symptomatic evidence of malfunction have been determined. It has become apparent that in the commercial kitchen there exist poorly designed equipment, poor procedure and poorly prepared individuals.

The results will be discussed firstly in relation to the frequency of accidents in restaurant kitchens. Once this field has been investigated, the three major areas of accidents which have been identified, will be expanded upon in detail with recommendations being made at each stage. Finally, other significant results will be discussed.

1. Frequency of accidents in restaurant kitchens

Reported incidents do not occur with the same frequency in each restaurant. The time period over which the incidents were monitored demonstrates this point. The restaurant in which the study was undertaken for the longest period of time did not record the greatest number of incidents. In fact the incidents reported in this restaurant were amongst the lowest recorded. It is therefore clear that there are a number of factors, other than time, which effect the number of incidents in restaurant kitchens. Incidents are proposed to be a function of factors such as ergonomic design, insufficient training, lack of supervision etc. An

issue which could also be responsible for the low frequency of incidents may be that of under reporting.

One of the shortcomings of early research identified by Dunn (1971) was the issue of under reporting. Under reporting may lead to serious underestimates of the size of hidden consequential costs which are attached to accidental events. It is suspected that, in this research, many incidents were not reported. This may be due to a number of reasons. At the time of the incident the manager may have been too busy to record the incident and as a result the incident went unrecorded. Furthermore, although it was stressed by the researcher that all incidents, even if they did not result in injury, should be recorded, managers found it difficult to understand that an incident such as a slip constituted an "accident". As such there may be differential recording of events resulting in a possible non-inclusion of relevant information. The researcher impressed upon managers that all incidents must be recorded regardless of whether the manager him/herself perceived the incident as constituting an "accident" or not and regardless of whether the "accident" resulted in injury. As stressed at the outset of this research, the emphasis was on the accident and not on the injury. In industrial practice attention tends to be focused primarily upon accidents that cause injuries. But injury prevention should be accident prevention as well. The present study defined an accident as "an unexpected, unintended but not necessarily damaging or injurious event that disrupts the completion of (a planned) event" (Dunn, 1971; p7).

This research was undertaken because it was suspected that accidents in commercial kitchens are likely to be small scale therefore not necessarily requiring reporting by law. Thus, there is severe underreporting in the

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