Introduction

Occupational hygiene can be considered as the fundamental process skill required to achieve good health outcomes in workplaces where there are chemical, biological and physical agents. This chapter commences by showing how difficult it often is to recognize hazards to health in workplaces and how difficult it has been historically to control workplace conditions to achieve acceptable health outcomes, even when the problems are identified. Some common examples from everyday workplaces and historical events both national and international demonstrate the extent of these problems with some classic occupational health hazards.

1.1 Historical background:

Today’s workplaces are full of materials and processes which are potentially hazardous to health. Industry depends on a large range of naturally occurring and synthetic materials, many of which can adversely affect the health of workers handling them if they are excessively exposed.

The histories of many trades and workplaces have included traumatic injury, disease and death. The industrial revolution changed the fortune of the worker from one of agrarian poverty to one of working in new trades created with little or no understanding of the hazards they imposed. Mining the coal needed to fuel the powered factories and under primitive conditions produced accidents and fatalities on an unprecedented scale. Many of those who survived injury or escaped death became ill from dust diseases. In the mines, mills and factories, inexperienced workers, including children as young as 6 years, faced injury or death from machinery which was designed for output, not safety.

The pace of control of workplaces has been comparatively slow. Despite the perils of industrial life of the late 18th and early 19th centuries, it was not until 1833 that the first real labour laws and Factory Inspectorate were established in the United Kingdom.

Some factory and mill owners operated exemplary establishments which took accounts of the general safety and health and welfare needs of their workers, but these were in the minority. With the development of chemical-based industries through the latter part of the 19th and early 20th centuries, many new occupational diseases
emerged, some of which continued unchecked until more recent times. This was despite readily available evidence of the hazards. Occupational disease such as those of miners (pneumoconiosis or dust diseases), fur carroters (mercurialism) and chimney sweeps (scrotal cancer) became accepted as part of the workplace landscape. It was not until relatively recent times, following the First World War, that significant technical medical resources become available and were brought to bear on a wide range of occupational diseases. Workplace legislation has been slow to catch up with the identification of occupational diseases. Workplace legislation has been slow to catch up with the identification of occupational health hazards. Tillman (2008)

1.1 A. The Serious Problem of Underestimation ofOccupationally Related Disease:

Reliable data on the contributions of the workplace to ill health in the community have traditionally been in difficult to assemble, and this is a worldwide problem. Compensation data regarding work related ill health under-represent the prevalence of work related ill health. However the greatest proportions of work related cases of ill health have not been the result of traumatic accidents (falls, high-energy impacts, crushing or piercing injuries, etc.) but have been caused by hazardous sustains or other exposure. The evidence revealed through epidemiological studies, sometimes years after exposure first commenced, has confirmed the need for those widespread controls demanded by regulations. Consider the evidence provided by the following examples which indicate the scope for delayed work-related ill health and death from chemical or radiation exposure:

World’s worst single-event industrial disaster (with the probable acceptance of Chernobyl)

- Bhopal in 1984, involving the inadvertent release of methyl isocyanate (a component in pesticide manufacturing) and resulting in the deaths of 2000-2500 persons and injuries caused subsequently to some 17000 more who lived in the environs of the factory. Though the cause from chemical exposure was soon evident, the scale was not so immediately obvious.
America’s worst individual industrial accident

- Hawk’s Nest Tunnel, built for water diversion in the early 1930s, in which more than 600 men died within a period of 2-5 years from silicosis. In this case, neither the cause nor the scale was obvious at the time of the work.

Australia’s worst industrial accident

- Wittenoom blue asbestos meaning (which commenced in the 1940s), Western Australia, from which a probable 2000 persons will die from asbestos-related diseases, including mesothelioma. The cause and scale of the disaster were totally underestimated.

The world’s incidence of mesothelioma and lung cancer associated with asbestos exposure, unfolding through the letter part of the 20th and the start of the 21st centuries will probably reach several hundreds of thousands.

All these “accidents” were related to exposures arising from a workplace. They all demonstrated that exposure to hazardous substances can cause severe ill health or death. In the asbestos-related cases, the exposures were not treated as being dangerous at the time.

In today’s workforce, losses incurred from CTDs continue to be a growing problem. According to the Bureau of Labor Statistics (2002), musculoskeletal injuries are among the most prevalent and costly of all lost time injuries in almost every industry. These injuries have been known to cause a great deal of pain and suffering among affected workers that often lead to lost production and poor quality work. An area of study that attempts to address these problems is ergonomics. According to ANSI, ergonomics is “A multidisciplinary activity dealing with the interactions between man and his total working environment, plus such traditional and environmental aspects as atmosphere, heat, light, and sun, as well as tools and equipment of the workplace.” Simply put, ergonomics is the science of fitting the job to the worker. When the combination of the job and worker mesh well and work in harmony, productivity, employee satisfaction, and a reduction in injuries is usually the outcome. In order to proactively address ergonomic issues, it is important to recognize the signs and symptoms of CTDs as well as potential risk factors before they become a problem. When analyzing processes for signs of CTDs, there are numerous instrumentation tools and
analysis methods that can be used. Once potential risk factors are determined and analyzed, a variety of controls can be implemented in order to reduce exposure to these risks. The purpose of this literature review will be to present a variety of case studies, risk factors, signs and symptoms of CTDs, analysis methods, instrumentation and controls, to create a basis for making recommendations at XYZ High School.(Gigstad, 2002)

Food unit is one of the labor intensive units in India. In India, food unit works are running parallel rural and traditional in unorganized sectors than in organized sector. Most of the equipment are handled manually by the food unit laborers working in unorganized sectors. Hence most of the food unit tasks performed in unorganized sectors by the laborers is ergonomically hazardous. In unorganized sectors, the labor contractors recruit the laborers as casual or on temporary basis. The workers do not get any training before recruitment and they do not have any awareness about ergonomic risks related to present work which they are engaged. The labor contractors do not maintain any data about their health hazards and do not pay any compensation for health problems. In India, the cost of manpower is low and therefore manual material handling (MMH) is the cheapest and easiest solution. The manual handling tasks have been studied extensively in developed countries. In India, huge numbers of food unit workers are working in unorganized sectors but very few ergonomic studies have been made on these work force. These workers are mainly coming from poor economic background. There are always high job demands on these work forces even if the workers for in 10 hours of activities on an average working day. In unorganized sectors, the food unit workers have to manually handle a variety of materials and hence it is one of the most physically demanding jobs. These manual material handling tasks require lifting, loading, caring, pushing, and pulling unloading and delivering activities. Most of the time the manual material handling and different equipment handling jobs performed by the workers requires bending, twisting and other stressful. Postural activities. The awkward working postures for prolonged period of time can cause musculoskeletal disorders. The ergonomic risk factors in this job are directly proportional with the performance of heavy, repetitive, postural stressful works without getting adequate rest break opportunities. Therefore the food unit workers have to face various ergonomic health problems and injuries. The ergonomic health problems include feeling of pain and strain in different body
parts which might be a sign of work related musculoskeletal disordered in low back, neck, arms elbows, wrist, legs, and knees. WMSD is one of the most significant work related health problems and most important factor leading to decreased work capacity among food unit workers.

Food work is the highest risk occupation for work related back pain and legs pain occurs frequently among the workers.

1.1 B. Meaning of an unorganized sector

The sector which is not following the prescribed norms and the modus operandi which is standardized and centralized is known as unorganized sector in India using the new definition of informal sector and informal worker proposed by National Commission for Enterprises in the Unorganized Sector (NCEUS).

Existing Definitions of Informal Sector

International Definition

As per SNA (1993), the informal sector consists of units engaged in the production of goods or services with the primary objective of generating employment and income to the persons concerned. These units typically operate at a low level of organization, with little or no division between labour and capital as factors of production and on a small scale. Labour relations - where they exist - are based mostly on casual employment, kinship or personal and social relations rather than contractual arrangements with formal guarantees. The informal sector forms part of the household sector as household enterprises or, equivalently, unincorporated enterprises owned by households.

Definitions used in India

The First Indian National Commission on Labour (1966-69) defined „unorganised sector workforce“ as –“those workers who have not been able to organize themselves in pursuit of their common interest due to certain constraints like casual nature of employment, ignorance and illiteracy, small and scattered size of establishments”.

The National Sample Survey Organization (NSSO), which has been conducting surveys of un-organized enterprises at periodical intervals, generally adopted the following criteria for the identification un-organized sector:
i. In the case of manufacturing industries, the enterprises not covered under the Annual Survey of Industries (ASI) are taken to constitute the un-organized sector.

ii. In the case of service industries, all enterprises, except those run by the Government (Central, State and Local Body) and in the corporate sector were regarded as un-organized.

The NSSO also conducted a separate informal sector survey in 1999-2000 and „all non-agricultural enterprises, excluding those covered under the ASI, with type of ownership as either proprietary or partnership” were treated as informal non-agricultural enterprises for the purpose of the survey.

In the compilation of National Accounts, the term un-organized sector is used to represent the residual enterprises, which are not included in the „organized sector”. The Employment relationship even in the so called organized sector is not formal in a good percentage of cases and many workers working in the formal sector without any protection and social security. At the same time, there are at least a few employees in the unorganized/ informal sector that enjoys formal employment relationship. The National Commission for Enterprises in the Unorganized Sector (NCEUS) took note of these aspects and decided to complement the definitions of unorganized/ informal sector with a definition of informal employment.

„An informal worker consists of those working in the informal sector or households, excluding regular workers with social security benefits provided by the employers and the workers in the formal sector without any employment and social security benefits provided by the employers”. The coverage under „organizational sector”, however, differed across different segments of the economy depending on regular data availability from various administrative sources.

The Directorate General of Employment and Training (DGET) considers all establishments employing ten workers or more as organized sector, though Employment Exchange (Compulsory Notification of Vacancies) Act, 1959”, makes it mandatory to submit employment returns only for those units ordinarily employing twenty five or more persons.
Definition proposed by NCEUS

Informal Sector Worker

As per international definitions, informal sector enterprises are owned by individuals or households that are not constituted as separate legal entities independent of their owners. In the Indian context, the enterprises can be of ownership categories of (i) proprietary (ii) partnership (iii) registered under Companies Act as Companies (iv) co-operative societies registered under Societies Registration Act and (v) Government or Public Sector Undertakings. Out of these ownership categories, the enterprises operated on proprietary and partnership basis do not constitute as separate legal entities independent of their owners i.e. the liabilities of the enterprise fall entirely on the owners.

Another important characteristic in the international definition is that the employment size has to be below a specific threshold to be determined according to national circumstances. It has been seen by the Task Force that the appropriate employment size in the context of India is nine workers.

A detailed analysis has done by NCEUS on 55th Round Survey of Informal Non-agricultural Enterprises (1999-2000), 56th Round Survey of Unorganized Manufacturing (2000-01), 57th Round Survey of Unorganized Service Sector (2001-02), Third All India Census of Small Scale Industries (2002-03) and Fifth Economic Census (2005) by size of employment and found that about 99 percent of workers employed in the enterprises working less than nine workers.

Non-registration under specific forms of national legislation is another characteristic which can be used for identifying informal enterprises as per international guidelines. However, in the case of India, there is no unique form of registration which can be used for such identification though there are several voluntary and mandatory registration systems for specific segments of industrial units. The non-maintenance of complete accounts that would permit a financial separation of production activities of the enterprise is generally satisfied in the case of proprietary and partnership enterprises employing less than ten workers as those enterprises are not under any legal obligation to maintain separate accounts. In view of the above, the following definition of unorganized/informal sector has been recommended:
“The informal sector consists of all unincorporated private enterprises owned by individuals or households engaged in the sale and production of goods and services operated on a proprietary or partnership basis and with less than ten total workers”.

The word enterprise in the above definition has the same meaning as defined in the SNA 93 and refers to an institutional unit in its capacity as a producer of goods and services. An enterprise is classified as proprietary if an individual is its sole owner and as partnership if there are two or more owners on a partnership basis with or without formal registration. It excludes all corporate entities, registered co-operatives, trusts and other legal entities.

Though the above definition does not make any distinction between agricultural and non-agricultural enterprises, the concept of enterprise is so far being used in India only in the context of non-agricultural sector. The use of such a restrictive meaning of enterprise would lead to the exclusion of a large number of workers in the agricultural sector, unless a corresponding unit of enterprise in agriculture is specified and used. It is, therefore, recommended that each operational holding in the crop production, plantation, forestry, animal husbandry and fishing activities may be considered as an enterprise for the purpose of applying the definition of unorganized/informal sector.

In the absence of identification of operational holdings in agriculture as enterprises and collection of the relevant details in the labour force surveys in India, it has not been possible to apply the above definition of informal sector in the field of agriculture so far. Nevertheless, the size of employment in the un-organized informal sector and its distribution need to be estimated and as such all workers in the agricultural sector except those in plantations have been regarded as informal sector workers in agriculture. This approximation has been made on the basis of the following assumptions:

i) Plantations are generally large in size and the workers in the sector are protected under Plantations Labour Act, 1951;

ii) Organized farming is very rare in India and crop cultivation and other agricultural activities are primarily carried out by private households possessing small pieces of land or holdings.
Informal Worker
To estimate the contribution of Informal sector to gross domestic product the definition of informal sector was included in the System of National Accounts (SNA), 1993. The definition is, therefore, in terms of characteristics of the enterprise rather than in terms of the characteristics of the worker. Thus a large number of workers with informal job status were excluded. Some of the reasons for the exclusion are.

(i) The persons engaged in very small-scale or causal self-employment activities may not report in statistical surveys that they are self employed, or employed at all, although their activity falls within the enterprise-based definition.

(ii) Certain groups of persons such as out-workers, sub-contractors, free-lancers or other workers whose activity is at the borderline between self-employment and wage employment are likely to be missed or wrongly classified.

(iii) An enterprise based definition of the informal sector will not be able to capture all aspects of the increasing “informalisation” of employment, leading to various forms of informal employment even in the formal sector.

(iv) Persons employed in private households as domestic servants, gardeners, etc. are likely to be left out in an enterprise based definition. Naik,( 2009)

Food-processing workers may experience fatigue and discomfort when performing highly repetitive tasks, working in repeated and sustained or awkward postures, performing heavy physical work, and using forceful exertion. Continued work under these conditions may result in chronic injuries to muscles, tendons, ligaments, nerves, and blood vessels. Injuries of this type are known as work-related musculoskeletal disorders. Musculoskeletal disorders can increase the cost of doing business. The costs may include medical services, workers’ compensation premiums, employee turnover, absenteeism, and retraining. Productivity, product quality, and employee morale may also suffer. One way to reduce work-related musculoskeletal disorders and to minimize the other problems mentioned above is to use ergonomics in your workplace. Ergonomics is the study of how to improve the fit between the tasks of the job and the employees who perform the work. Ergonomics requires a consideration of the variability in workers’ physical and mental capabilities when one selects, designs, or modifies their tools, equipment, or workstations. Employees’ abilities to perform tasks may vary because of differences in age, physical condition, strength, gender,
stature, and other individual factors. Everyone benefits from ergonomics. By fitting the work tasks to the capabilities of most workers, employers can:

- Reduce or eliminate the contributing factors that can lead to musculoskeletal
- Decrease injuries, illnesses, and workers’ compensation costs.
- Decrease absenteeism and turnover.
- Improve workers’ health outcomes.
- Increase employee morale and productivity.
- Make it easier for workers to do high-quality work.

(http://www.dir.ca.gov/dosh_publications/erg_food_processing.pdf 08/08/11)

1.2 Five aspects of ergonomics

There are five aspects of ergonomics: safety, comfort, ease of use, productivity/performance, and aesthetics. Based on these aspects of ergonomics, examples are given of how products or systems could benefit from redesign based on ergonomic principles.

1. Safety - Medicine bottles: The print on them could be larger so that a sick person who may have impaired vision (due to sinuses, etc.) can more easily see the dosages and label. Ergonomics could design the print style, color and size for optimal viewing.

2. Comfort - Alarm clock display: Some displays are harshly bright, drawing one’s eye to the light when surroundings are dark. Ergonomic principles could re-design this based on contrast principles.

3. Ease of use - Street Signs: In a strange area, many times it is difficult to spot street signs. This could be addressed with the principles of visual detection in ergonomics.

4. Productivity/performance - HD TV: The sound on HD TV is much lower than regular TV. So when you switch from HD to regular, the volume increases dramatically. Ergonomics recognizes that this difference in decibel level creates a difference in loudness and hurts human ears and this could be solved by evening out the decibel levels.

5. Aesthetics - Signs in the workplace: Signage should be made consistent throughout the workplace to not only be aesthetically pleasing, but also so that information is easily accessible.(http://en.wikipedia.org/wiki/ergonomics)
1.3 Ergonomic Risk Factors

There are a number of risk factors associated with the development of cumulative trauma injuries in industry. Among the most prevalent of these risk factors include force, vibration, repetition, thermal stressors, and posture (Putz-Anderson, 1988). A clear understanding of these factors is important when conducting root cause analysis of ergonomic problems as well as assigning proper controls, whether administrative or engineering, to help reduce the severity of loss incurred in an organization.

a) Force

The amount of force required for performing tasks is one of the many risk critical factors in the development of CTDs. According to Ergonext, (2001), force is an effort that is mechanical in nature, which is used to execute or prevent movement. Functions that require forceful exertions place excessive loads on the musculoskeletal system including muscles, joints, ligaments, and tendons. Workers may exert excessive force on work pieces, tools, or against gravity in order to stabilize their bodies (Ergonext, 2001). As a result of these forces and increased muscle effort, circulation is reduced to the muscle causing fatigue to set in more rapidly. Fatigue from excessive force can also be the result of an imbalance of proper recovery and work time. When insufficient recovery time is encountered, soft tissue injuries can occur including sprains and strains (Putz-Anderson, 1988).

b) Vibration

In today’s workforce, it is possible for employees to become exposed to vibration in different forms. According to Grandjean (1988), “vibrations are mechanical oscillations produced by either regular or irregular periodic movements of a body during its resting position.” The most common avenues of vibration transmission include exposure to hand tools such as grinders and sanders as well as powered vehicles including forklifts, trucks and trains. The use of vibrating tools coupled with repetitive motion and force can lead to various CTDs including vibration white finger, carpal tunnel syndrome, and trigger finger (Tayyari & Smith, 1997).

Published literature has shown that there are various types of vibrations. Two general types include free vibrations that result from a system oscillating at its natural frequency and forced vibrations, which are caused by external forces (Chaffin & Anderson, 1991). With respect to the human body, vibration can be broken down
further into whole body and segmental vibration. Whole body vibration is transmitted to the body via a supporting structure such as a truck seat to the buttocks. Results of an experiment conducted by Weaver (1979), conclude that the human body is most sensitive to vibrations between 4 and 8 KHz. with resonance occurring at 5Hz. At these low frequencies, internal organs begin to vibrate which can lead to serious trauma and possible hemorrhaging if not controlled properly (Tayyari& Smith, 1997). Segmental vibration occurs when vibration enters the body through specific body parts such as the feet or parts of the upper extremity. Unlike whole body vibration, segmental vibration can cause injury to the fingers, elbows, shoulders, and wrists. Injuries from this type of vibration are often due to prolonged use of hand tools (Tayyari& Smith, 1997). Thus, a number of different types of vibration can lead to the onset of CTDs. When employees in the workforce are exposed to vibration there are a number of factors that must be taken into account. According to Grandjean (1988), there are four important factors that need to be observed when attempting to control the effects of vibration. These include:

- Point of application to the body
- Frequency of oscillations
- Acceleration of oscillations
- Duration of effect

Common application points where vibration can be transmitted to the body include the feet and buttocks. Frequency oscillations that are close to the natural frequency of the body can cause resonance or whole body vibration. The acceleration of vibrations can contribute to the overall vibrational load. Injuries from vibration can increase at a rapid rate as workers are exposed to long durations. It is important to understand and identify these four factors when developing controls relating to vibration exposure (Grandjean, 1988).

c) Repetition

Repetition is another known risk factor that contributes to the onset of CTDs. Repetition is an important variable to take into account when controlling CTDs because it can act as a modification factor compounding excessive force and improper posture. NIOSH (1997) published their definition of repetition as motions that are repeated over long periods of time, which can lead to fatigue and muscle-tendon strain. Tasks that are highly repetitive in nature require a fast rate of muscle velocity and contraction meaning
that more recovery time is needed between cycles. Normally, tendons and muscles can recover from excessive force and stretching if there is enough time between exertions. However, when these motions are performed with inadequate recovery time and coupled with awkward movements or forceful exertions, muscle fatigue and strain begin to set in (NIOSH 1997). Even though these tasks may require a minimal amount of force, the addition of high repetition can act as a source of trauma leading to CTDs (Putz-Anderson, 1988). When conducting task analyses, there are a number of guidelines that have been introduced to identify repetitive work. NIOSH (1997), has established guidelines delineating quantitative measures of repetitive work. The figure given by NIOSH that constitutes high repetition for a job task is a cycle time of less than thirty seconds. Likewise, a task cycle time of more than thirty seconds is considered low repetition. Estimates of repetition dealing with specific body part manipulations vary depending on the amount of force applied and the area of the body that the force is applied to. The following points in Table 1 depict these guidelines:

**Table No.1. Estimates of repetition dealing with specific body part for a job task.**

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Repetition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands</td>
<td>&gt;20,000 repetitions per 8 hr. work shift</td>
</tr>
<tr>
<td>Shoulder</td>
<td>&gt;2.5 repetitions per min.</td>
</tr>
<tr>
<td>Upper Arm/Elbow</td>
<td>&gt;10 repetitions per min.</td>
</tr>
<tr>
<td>Forearm/Wrist</td>
<td>&gt;10 repetitions per min.</td>
</tr>
<tr>
<td>Fingers</td>
<td>&gt;200 repetitions per min.</td>
</tr>
</tbody>
</table>

Reference: (Ergoweb, 2002)

According to NIOSH, the hands should not exceed 20,000 repetitions per shift. During job tasks, the shoulder should not exceed 2.5 repetitions per minute. The arms and wrists fall into the category of no more than 10 repetitions per minute and the fingers should not exceed 200 repetitions per minute. These guidelines were introduced with the understanding that each body area may have different abilities to tolerate repetitious movements.

d) Thermal Stressors

It appears that the human body has great capacity to adapt to different thermal environments. However, the body does have its limitations. When these limitations
are taxed, exposure to excessive temperatures can cause injuries, illnesses, accidents and a reduction in productivity (Tayyari & Smith, 1997). Thermal stressors fall into two categories that include heat and cold stress. When employees are assigned to work in excessively warm environments, the potential for a condition known as heat stress must be approached with caution. Tayyari and Smith (1997) defined heat stress as the total load of all heat factors, whether internal or external, on the human body. Factors that affect the body internally include metabolic heat, degree of acclimatization, and body temperature. Factors that affect the body externally include air temperature, radiant heat, humidity, and clothing thermal resistance. When the human body is exposed to excessive heat, blood capillaries near the surface of the skin expand to transfer heat from the core of the body to the skin where sweat glands can aid in evaporative heat loss. At the same time, the body works to dissipate metabolic heat by attempting to reach thermal equilibrium with the environment through convection, conduction, and radiation (Grandjean, 1988). When heat stress occurs at lower levels, no health damage is incurred. However, when these stresses exceed a person’s capacity a number of heat-related disorders can occur. Included these disorders include heat stroke, heat exhaustion, heat cramps and prickly heat (Tayyari & Smith, 1997). Thus, it is important to identify and control the factors that are associated with these conditions to protect the health and safety of employees. Cold stress is the opposite of heat stress in that there is a lowering of the body’s core temperature (Ergoweb, 2002). This form of thermal stressor is often not as common on the job as heat stress. Nevertheless, cold stress should not be underestimated due to the lack of productivity and discomfort that often occurs. Exposure to extreme cold conditions causes contraction of the capillaries near the surface of the skin in order to route blood to the core of the body to preserve heat for vital body organs (Ramsey, 1985). Some effects of cold exposure include numbness, weakness, shivering, and low body temperature. According to MacFarlane (1963), a number of injuries can result from excessive cold conditions including chilblains, hypothermia, and frostbite. Just as in heat stress, it is important to be aware of the factors that contribute to cold stress conditions to protect employees.

e) Posture

Posture refers to the position of the body in terms of the angle between two adjacent body segments while performing various work activities (Ergonext, 2001 &
Ergoweb, 2002). Certain jobs require a variety of awkward postures that pose stress to upper extremity joints and soft tissues (Putz-Anderson, 1988). According to Chaffin & Anderson (1991), posture is also one of the major variables that affect static and dynamic strength. Proper posture is very important because it determines how much force and stress will be placed on the joints and muscles of the body. Tasks that add repetition to repeated or sustained awkward postures such as bending of the knees, wrists, hips, or shoulders also imposes increased stress on these joints (NIOSH, 1997).

Risk factors associated with awkward posture are defined by body positions that deviate from the neutral position (NIOSH, 1997). In other words, the more a joint is deviated from its natural position the greater risk there is for injury.

According to Ergonext (2001), awkward postures can be placed into three categories that include:

- Extreme postures - Postures that are close to the end of motion range. These positions require more support from ligaments and muscles. They may also exert compressive forces on blood vessels and nerves.
- Non-extreme postures related to gravitational loading - Postures that expose a joint to gravitational loading increase forces on muscles and tissues. An example of this would be extending an arm out from the body for a period of time.
- Non-extreme postures related to musculoskeletal geometry - Postures that change the geometry of the musculoskeletal system. There are a number of different postures that can adversely affect the body when the limits of motion are reached. As shown in Table 3, flexion, extension, radial/ulnar deviation, bending, and twisting can affect the various parts of the upper extremity.

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Posture associate with injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrist</td>
<td>Flexion, extension, ulnar/radial deviation</td>
</tr>
<tr>
<td>Shoulder</td>
<td>Abduction/flexion, hands above shoulders</td>
</tr>
<tr>
<td>Neck</td>
<td>Flexion/extension, forward/side bending</td>
</tr>
<tr>
<td>Low Back</td>
<td>Bending and twisting of the waist</td>
</tr>
</tbody>
</table>

Reference: (Ergoweb, 2002)
1.4 Prevention and Control of Ergonomic Risk Conditions

Three types of solutions reduce the magnitude of risk factors:

a) Engineering controls

b) Administrative controls

c) Work practice controls

a) Engineering controls

Engineering controls involve altering the physical items in the workplace, including actions such as modifying the workstation, obtaining different equipment, or changing tools.

The focus of engineering controls involves identifying the underlying stressor (risk factor of awkward posture, force, repetition, etc.) and eliminating it through changing the physical environment.

For example, a video display terminal worker who sustains a shoulder/neck complaint from long-term typing may need forearm supports or a keyboard tray to reduce the long-term, static exertion of neck/shoulder muscles. Engineering controls are the preferred method of risk control because they permanently reduce or eliminate the risk.

b) Administrative controls

Administrative controls involve altering work organization. These approaches usually are less expensive than engineering controls but are less dependable.

Examples of administrative controls include:

- Rotating workers
- Increasing the frequency/duration of breaks
- Assigning a second worker to assist in performing select tasks
- Ensuring proper work techniques are followed
- Conditioning workers for the physical exertion of task demands
- Enlarging job responsibilities such that the same task is not repeatedly performed
- Enacting a preventive maintenance program for mechanical and power tools and equipment
- Developing a housekeeping program
- Limiting overtime work
c) **Work practice controls**

Work practice controls involve training and encouraging a specific method of task performance to reduce worker exposure to the ergonomic risk.

An example of work practice control is training workers in proper lifting techniques. ([http://ergo.human.cornell.edu/gradprojects/cheese/cheese.html 09/08/11](http://ergo.human.cornell.edu/gradprojects/cheese/cheese.html))

### 1.5 Justification of the study:

Ergonomic research is performed by those who study human capabilities in relationship to their work demands. Information derived from these studies contributes to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people. Present research would be helpful to the professionals, Interior Designers, Home Scientists, Architects, Family Resources Management Students, Ergonomist, and Physiotherapist for planning workspace of any commercial area as well as to plan out outreach programs, intervention programs to enhance awareness of common mass regarding work and work environment and humanizing the work.

It would also be helpful to the entrepreneurs who want to start his/her own business. The findings would be helpful to the workers of the food unit in performing activity without any obstruction and hazards. Learners and teachers would be benefited by knowing the finding and would be encouraged to plan extension activity to improve working postures. With work efficiency increase, more profit with good health at work will result.

### 1.6 Relevance of the study to the society:

Ergonomics is a scientific discipline that has been around for many years. Traditionally concerned with factory workers and keeping their work environments safe and efficient, ergonomic professionals have expanded their work to include all types of workers from laborers to office workers, students to seniors.

The incorporation of ergonomics principles would decrease the occupational hazards. The application of ergonomics is important in the home as well as in the industry
which is an important issue today. It was not realized that it is the world’s major occupation requiring much human cost. If equipment and techniques used are not according to body need, it increases the human cost of work and it decreases work output. The important concept is that discrepancies between what the environment requires and what the operator is able to give should be resolved by adapting the environment to the operator suit the environment. If such a basic change is made, it is argued, and then the efficiency, safety, comfort and productivity of the total man-machine system will be enhanced.

1.7 Objectives of the study:

**General Objective:** To assess ergonomically the selected activities carried out in food units and suggest ways to improve health and safety.

**Specific Objectives:**

1. To study the different activities carried out by workers in selected food units.
2. To assess the work environment of the workers.
3. To study the postures adopted by the workers in selected food units.
4. To assess the feelings of fatigue (using Body Map) experienced by the workers in selected activities.
5. To study the effect of age, BMI and work experience of the workers and the feeling of fatigue in performing selected activities.
6. To suggest remedies to increase safety at work place.

1.8 Hypotheses:

**HO₁:** There is no significant effect of age of the respondents on feeling of fatigue while carrying out the work.

**HO₂:** There is no significant effect of BMI of the respondents on feeling of fatigue while carrying out the work.

**HO₃:** There is no significant effect of work experience of the respondents on feeling of fatigue while carrying out the work.