

<b>Presenter:</b>	<b>Barnes Sookdeo</b> <i>Senior Lecturer: Department of Quality and Operations University of South Africa</i>
<b>Title:</b>	<b><i>Quality and Workplace Engineering</i></b>

## ABSTRACT

There are a number of parallels between the concepts of both quality and ergonomics. While ergonomics is a separate and distinct tool in a manager's problem-solving kit, the overlap between quality and ergonomics is important. Ergonomics can readily be used to improve quality (McLeod 1995:124).

Terms used interchangeably with workplace engineering are ergonomics, human factors and human engineering. There are numerous definitions of workplace engineering but the one that fits best can be found in the ILO (1995:149), which defines ergonomics as the study of the relationship between a worker and the environment in which he/she works. MacLeod (1995:08) states that in essence, ergonomics is all about understanding human beings and human behaviour.

Ostrom (1993:05) states that injuries that are caused by workplace design have been called a variety of names including cumulative trauma disorders (CTD's), repetitive motion syndromes and musculoskeletal injuries. Researchers have found that workers who work at workstations that are not adjusted to them have a higher potential for developing musculoskeletal injuries than those workers who have ergonomically designed tasks and workstations (Ostrom 1993:03). Workplace engineering aims to design tasks and workstations in order to maximize the efficiency and quality of employees' work.

Workplace engineering leads to improvements in performance and productivity in the workplace. Kroemer, Kroemer and Kroemer-Elbert (1994:649) states that human-factors improvements result in improved quality of work, even if the tempo is machine-paced or in less strain on the person and in better attitude and well-being.

The objective of this paper is to highlight the application of workplace engineering towards the elimination of musculoskeletal injuries and the overall improvement in the quality of life.

**Keywords:** workplace engineering, ergonomics, human factors, human engineering, cumulative trauma disorders, musculoskeletal injuries.

## 1. INTRODUCTION

*(For the purposes of clarity, the term **ergonomics** will be used throughout this paper).*

Ergonomics is currently a hot topic. It has been called the health and safety issue of the 1990's (MacLeod 1995:04). What do we know about the human body and mind at work? Given what we know, how then should we design the work task, tools, and the interface with the machine, and work procedures so that humans can perform safely, efficiently and with satisfaction – perhaps even enjoy working? (Kroemer, et al. 1994: xvii).

These are the main challenges of ergonomics. The solutions are the *why*, and *how* of ergonomics.

Ergonomics is the application of scientific information concerning humans to the design of objects, systems and environment for human use. Ergonomics is commonly thought of as how companies design tasks and work areas to maximize the efficiency and quality of their employees' work. However, ergonomics comes into everything which involves people. Work systems, sports and leisure, health and safety should all embody ergonomics principles if well designed. It is the applied science of equipment design intended to maximize productivity by reducing operator fatigue and discomfort. The field is also called workplace engineering, biotechnology, human engineering, and human factors engineering (*International Ergonomics Association. 2007*).

Although ergonomic research is primarily performed by ergonomists who study human capabilities in relationship to their work demands, it is not limited to them as *you* also can contribute 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. Ergonomics draws on many disciplines in its study of humans and their environments.

***“No matter what the job is, ergonomics plays an important role in preventing injury and illness”.***

## **2. BACKGROUND**

The above introduction begs the following question:

***“So what is ergonomics really and how is it related to quality?”***

Ergonomics is simply "*fitting the job to the person performing the job.*" Many times this involves manipulating an individual's work area so that it fits them better.

Karapetrovic (1999:81) states that ergonomics, almost by default, is implied in quality assurance. Quality assurance encompasses techniques used to provide confidence to customers that their requirements for quality are met. Therefore, by definition, human factors are involved. Assurances in the quality of products and services are provided *to* humans, *by* humans. In fact, ergonomics and quality assurance are so intertwined that it is impossible to say where one starts and the other ends.

Any new being has a date on which it was introduced to the world (*birthday*) and the ergonomics birth date can be pinpointed fairly accurately to 12 July 1949. Later, at a meeting in 1950, the term *ergonomics* (from the Greek words: *ergon* – work; and *nomos* – natural laws) was adopted and the discipline could finally be said to be born (Osborne 1991:04).

Ergonomic interventions assist in providing a more comfortable working life for humans. MacLeod (1995:03) states that ergonomics can save businesses money. By applying the basic principles of this field, employers can reduce costs related to issues like worker's compensation, turnover and absenteeism. Operations can be made more efficient by workplace designs that create fewer errors and product defects and can cause less wasted time. Linked to this, Goetsch and Davis (2006: 47) state that a nation's ability to compete in the global marketplace has a direct bearing on the quality of life of its citizens.

Over the last two decades, organisations have evolved from being "*profit driven*" to being "*quality driven*". Hence the old adage:

***“If you provide a quality product, customer satisfaction and revenue are guaranteed.”***

### 3. PROBLEM STATEMENT

***“In the South African context, very little has been done to create awareness and to curb work-related injuries in a constructive way”.***

According to information gained from the medical profession, people who fall ill or get injured are simply given medication when they visit their general practitioners. There are no investigations into the cause of their respective illnesses. The researchers found that currently, general practitioners cannot divulge information regarding their patients because of the confidentiality and because of the stigma attached to the Aids pandemic. (Sookdeo & Ramdass 2006:01).

Each year, poorly designed products and workplaces account for thousands of injuries and skyrocketing costs. That's why, ergonomics – the human factor in product and workplace design, is fast becoming a major concern for manufacturers (Gross 1996: xi)

### 4. OBJECTIVE

This paper focuses on the basic things in the workplace that you have control over and can successfully change, such as the adjustment of workstations, basic workplace layout, lighting and glare. It highlights the application of ergonomics towards the elimination of musculoskeletal injuries and the overall improvement in the quality of life.

### 5. CONTENT OF THE PAPER

#### 5.1. Demystifying ergonomics:

MacLeod (1995:3/4) states that some have the simplistic impression that ergonomics means providing “cushy” jobs or slowing down production. “*We pay people to work*” goes the expression, “*not to take it easy*”.

Ergonomics may sound like a highly technical field of study and some aspects of ergonomics are, in fact complicated. But much of ergonomics is simple common sense, perhaps a natural reaction. This unfortunate turn of events gives the impression that ergonomics presents just another burden. Managers hear “*ergonomics*” and think “*more costs and more problems*”.

#### 5.2. The aim of ergonomics

Osborne (1991:06) states that ergonomics seeks to increase safety and reduce operator unpredictability, in other words to increase reliability.

Further aims of ergonomics are to focus and improve the following:

- To design workstations, work processes, equipment and tools to fit the worker;
- Preventing injuries by controlling the risk factors such as force, repetition, posture and vibration that can cause injuries to develop; and
- Ensuring a good fit between workers and their jobs, thereby maximising worker comfort, safety, productivity and efficiency.

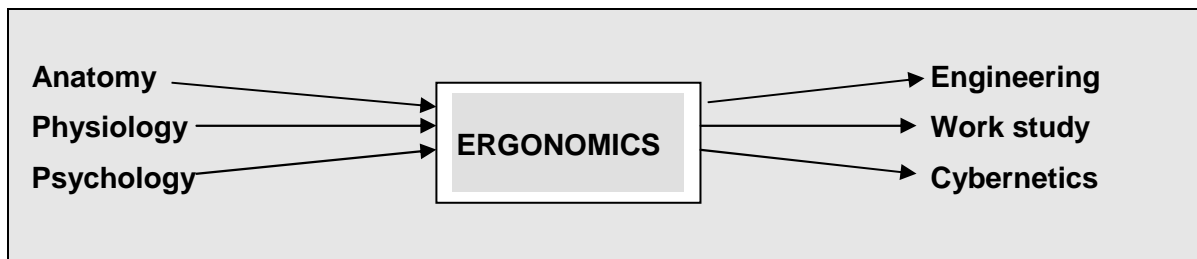
### 5.3. The nature and field of ergonomics

(The following information is sourced from the current Unisa Organisational Effectiveness 3 Study Guides).

Ergonomics is the study of the relationship between man and the working environment with the aim of making it work as effective as possible and to minimize fatigue.

Ergonomics is not limited to one field, but should be seen as a hybrid subject which is the offshoot of the following conventional approaches: work study, engineering, physiology, psychology and anthropology.

**Figure 1:** The nature and field of ergonomics



(Source: Unisa ORE301M Study Guides)

- **Anatomy** consists of the following:
  - Anthropometry which is concerned with the measurement of the human body; and
  - Biomechanics which is concerned with the exertion of power.
- **Physiology** focuses on the way the body functions, whilst
- **Psychology** focuses on the theory of the human mind.

#### 5.3.1. Process conditions:

These are unique and apply to each task which is studied. They cause the worker to become exhausted and this exhaustion can be reduced or cancelled completely. Here we can refer to:

<b><i>Fatigue-causes</i></b>	Minimising these causes and developing methods to enable the worker to recover from fatigue.
<b><i>Seating and work-place-layout</i></b>	The design of suitable layouts including the seats, work-benches tables etc
<b><i>Machinery and equipment</i></b>	Careful design so that the average-sized worker can use it without excessive exertion.
<b><i>Inspection and acute concentrations</i></b>	The study, analysis and improvement of tasks which require concentration and where safety is of necessity an important factor.

**5.3.2. Environmental Conditions:**

The effect of environmental conditions for example:

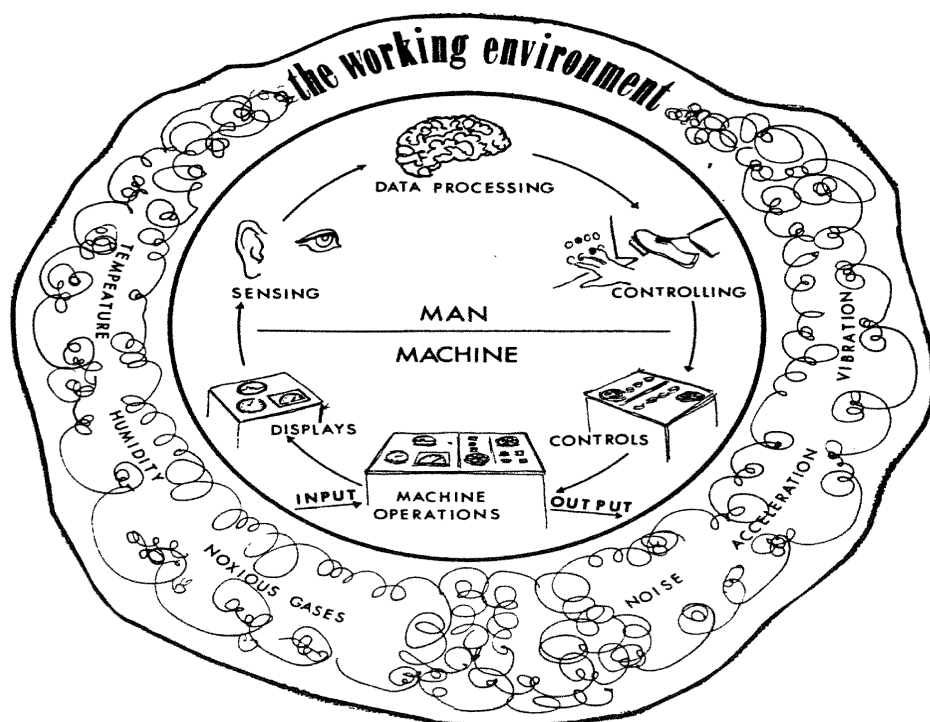
<b>Lights</b>	The intensity, colour and type of lighting for the task concerned
<b>The decor of the room</b>	The colour and general decor of the walls, floors and ceilings as well as the furnishings.
<b>Temperature, humidity and ventilation</b>	Improvement of the comfort of the worker and reducing fatigue by improving general working conditions.

**5.3.3. Social and individual conditions:**

These affect the worker as direct working conditions or merely as personal working conditions, for example:

<b>Shift work</b>	It affects the worker's personal life, socially, physically, and psychologically, but effective planning in this area can limit this effect considerably.
<b>Age</b>	The human senses and fatigue etc. Physical disabilities - these are obviously beyond the control of the ergonomist, but by re-designing the task, this can be provided for

**Figure 2:** The working environment  
(Source: Unisa ORE301M Study Guides)



## **5.4. The fundamental ergonomic principles**

Sookdeo & Ramdass (2006:05) outlines the following fundamental ergonomic principles that should be followed in your workplace:

### **5.4.1. Use proper tools**

Tools should be appropriate for the specific tasks being performed. Your tools should allow you to keep your hands and wrists straight – the position they would be in if they were hanging relaxed at your side.

***“Bend the tool not the wrist!”***

The tool should fit comfortably into your hand. If the grip size is too large or too small it will be uncomfortable and will increase the risk of injury. Tools should not have sharp edges, create contact stresses in your hand, or vibrate.

### **5.4.2. Keep repetitive motions to a minimum**

Our workstations or tasks can often be redesigned to reduce the number of repetitive motions that must be performed. Using a power-driven screwdriver or tools with a ratchet device can reduce the number of twisting motions with the arm. Some tasks can be automated or redesigned to eliminate repetitive movements and musculoskeletal injuries.

### **5.4.3. Avoid awkward postures**

Your job should not require you to work with your hands above shoulder height on a regular basis. Arms should be kept low and close to your body. Bending and twisting of your wrists, back and neck should also be avoided.

### **5.4.4. Use safe lifting procedures**

Avoid lifting objects that are too heavy. Use more than one person or a mechanical device to reduce the load. Your workstation should not require you to lift objects above your head or twist your back while lifting.

Keep the load close to your body and ensure that you have a good grip. Heavy and frequently lifted objects should be stored between knee and shoulder height – not on the ground or above your head.

### **5.4.5. Get proper rest**

You need to rest your body and mind in order to prevent injuries. Give your muscles a rest during your coffee breaks, lunches and weekends by doing something different from what you do in your job. For example, if you stand all day while performing your job you should sit down to rest your legs and feet during your breaks. If you sit down when working you should stand up and walk around during your breaks to give your back a rest and to increase circulation in your legs.

Remember: ***“Musculoskeletal injuries can be prevented”.***

## 5.5. Risk factors

If a job does not fit a worker, the worker is more likely to be exposed to risk factors that may lead to musculoskeletal injury. The main ergonomic risk factors in the office include the following:

- **Repetition:** tasks or body movements carried out over and over again.
- **Awkward postures:** body positions that are not considered neutral or "ideal" such as twisting your neck to view your monitor or reaching forward or to the side to use your mouse.
- **Static forces:** maintaining a position for a long period of time (i.e. prolonged sitting, viewing the monitor with a bent neck, or reaching for the keyboard). Every person responds to ergonomic risk factors in different ways.

For example, one worker may have symptoms of an injury while another worker performing the same tasks may not have symptoms. Ergonomic risk factors should be identified and reduced to lower the risk of injury. When selecting office products, adjustability is the most important feature. Even though a product claims to be "ergonomic" it may not suit your needs.

## 5.6. Quality and ergonomics

Table 1 below lists the twenty elements of the ISO 9001 in the order in which they appear in the standard, illustrates sections and specific requirements which pertain to ergonomics and provides ergonomic implications of the quality system (Karapetrovic 1999:84/85).

**Table 1:** Ergonomic issues and implications of ISO9001: 1994

	<b>ELEMENT</b>	<b>ERGONOMIC ISSUES</b>	<b>IMPLICATIONS</b>
1	<b>Management Responsibility.</b>	Organization ensures that the quality policy is understood at all levels.	Quality system documentation should be designed and implemented using ergonomic {human factors engineering) knowledge.
2	<b>Quality System</b>	Procedures and work instructions are effectively documented/implemented.	“ “
3	<b>Contract Review</b>	Customer requirements are adequately defined and documented.	Ergonomic characteristics of a product, such as environmental conditions, sensory characteristics proper handling and packaging should be determined {see Bergquist and Abeysekera, 1996; Helander and Burri, 1995; Barsky and Dutta, 1997).
4	<b>Design Control</b>	Crucial characteristics for safe and proper functioning of the product are identified.	Products should be ergonomically designed to ensure healthy and safe functioning.
5	<b>Document Control</b>	Appropriate documents are readily available at all locations where essential operations are performed.	Quality system documents should be accessible.
6	<b>Purchasing</b>	Purchasing documents adequately address specified	Ergonomic techniques can be used to ensure clear understanding of

		requirements.	documents.
7	<b>Control of customer supplied Product</b>	Adequate procedures for storage and maintenance of the product are in place.	Safe and risk-free storage and maintenance of products is emphasized.
8	<b>Product Identification and Traceability</b>	Product is adequately identified and traceable.	Identification of products should be performed according to ergonomic guidelines regulations.
9	<b>Process Control</b>	Suitable equipment and working environment are used. Criteria for workmanship are stipulated in the clearest practical manner.	For identification and maintenance of the suitable working environment and hardware, ergonomic analysis and evaluations must be performed.
10	<b>Inspection and Testing</b>	Records clearly illustrate the results of inspection and testing activities.	Identification of products and equipment should be performed according to ergonomic guidelines and regulations {for example, see Sanders & McCormick, 1993 {part 2}, and Harris and Chaney, 1970 {chaps. 6-11}.
11	<b>Inspection and Test Equipment</b>	Suitable indicators of calibration status are identified.	“ “
12	<b>Inspection and Test Status</b>	Inspection and test status of the product is identified by suitable means.	“ “
13	<b>Nonconforming Product</b>	Nonconforming products are adequately identified and segregated.	“ “
14	<b>Corrective and preventative action</b>	Appropriate sources of information are used to detect and eliminate potential/ existing causes of defects.	Ergonomical analysis of human-information interaction is helpful {for instance, see Sanders and McCormick, 1993 {part 2}.
15	<b>Handling, Storage...., Delivery</b>	Adequate handling, storage, packaging, preservation and delivery of the product is identified and maintained.	Ergonomical design and analysis of handling and packaging of products should be used.
16	<b>Control of Quality Records</b>	Quality records are adequately identified, indexed, filed and stored. Quality records are easily accessible.	Ergonomic techniques can be used to ensure clear understanding of documents, and accessibility of records.
17	<b>Internal Quality Audits</b>	Quality audits are performed to examine the suitability and <i>effectiveness</i> of the quality system.	Ergonomic audits/evaluations, identifying areas for possible improvement of human-machine-product -environment interactions are performed.
18	<b>Training</b>	Training needs are identified and adequate training provided.	Ergonomic training should be emphasized.
19	<b>Servicing</b>	Appropriate identification of	Ergonomic characteristics of a product,

		servicing needs and customer feedback is performed.	such as environmental conditions, sensory characteristics proper handling and packaging should be determined {see Bergquist and Abeysekera, 1996; Helander and Burri, 1995; Barsky and Dutta, 1997}.
20	<b>Statistical Techniques</b>	The need for the application of statistical techniques is identified.	Statistical tools and techniques are used in ergonomic analysis and evaluations.

(Adapted from Karapetrovic 1999:84).

The implications range from adequate identification of customer ergonomic requirements, ergonomic suitable design of products, service and processes, to identification and maintenance of appropriate working environment and equipment. Such analysis of the ISO9001 quality system shows that virtually every element of the system includes at least some ergonomic and/or health and safety aspects.

This statement is not surprising, since; ultimately, quality is created **by people** and **for people**.

### 5.7. Main areas for improvement

Each of these areas are discussed individually as shown below:

#### 5.7.1. Administrative work:

"Preferred" sitting posture for computer work:

- Wrists: Naturally straight position; not bent up, down, or from side to side
- Elbows: Bent approximately between 90 and 100 degrees (right angle), close to your body, and supported if possible
- Shoulders: Relaxed (not slouched or raised)
- Neck: Facing forward and not looking up, down, or to either side
- Hips: Bent around 90 degrees with your thighs roughly parallel to the floor

Many short breaks are better for the body than fewer, long breaks. These breaks often called "Micro-Breaks", last from 2 to 95 seconds and should be taken throughout the day.

#### 5.7.2. How Should I Sit at my Computer Workstation?

Try to alternate your computer work with other tasks.

For example, rather than typing continuously for an hour, stop and deliver a fax or do some filing.

When you break up computer work with other office tasks, eyes and muscles in your arms, neck and back can rest.

#### 5.7.3. Your chair

Your chair is the most important part of your office workstation. The chair has to fit you and suit the tasks that you do. One chair may not suit every worker so make sure you try it out before you buy. For example, the "average" chair is designed in some instances to fit the average male and may not suit some female users.

***“The chair is one of the most expensive pieces of office furniture”.***

#### **5.7.4. Your Workstation**

It is often possible to add adjustable accessories to your desk. If you are purchasing a new desk you may want one with adjustability included. There are several methods of achieving adjustability.

If you have shelves above the workstation, ensure they do not interfere with adjusting the monitor height or block overhead lights.

- Sit with your arms hanging straight at your side.
- Adjust the writing surface to be level with your elbows
- Raise forearms to create approximately a 90-degree angle at the elbow.

#### **5.7.5. Your personal computer**

Your keyboard and your mouse should be slightly below elbow level and close to your body. The mouse should be right beside the keyboard, and in front of your “mousing” hand. To use your keyboard and your mouse in the “neutral” position, you should adjust your keyboard or your chair.

And remember, the most important issue before you buy any office product:

**“TRY BEFORE YOU BUY.”**

#### **5.7.6. Your monitor**

- The monitor and keyboard should be directly in front of you.
- The top of the monitor and document holder should be around eye level when you are sitting comfortably.
- The monitor should be about arm's length away from you at a comfortable reading distance.
- The monitor should be angled slightly up toward your eyes. Angling the monitor up too high can increase glare (see the lighting section).

#### **5.7.7. Laptops**

The use of laptops is increasing as prices decrease. Originally designed for easy transport and short-term use, the portability of laptops is a popular feature. Since many people now travel as part of their job, the laptop is starting to replace the traditional computer in some offices. There are a variety of problems that can arise from prolonged laptop use.

#### **5.7.8. Office Lighting**

Lighting is important in offices where computers are used. The amount of light affects eye strain and postures.

Light levels must be high enough for paper work, but not too bright for computer work.

If light levels are too low for paper work, muscles of the eyes are strained and you are more likely to work in an awkward posture to see the paper. When light levels are too high for computer work, you may be forced into an awkward posture in order to see the screen.

### **5.7.8.1. Glare:**

Glare is a common problem with lighting in offices. It makes it difficult to see the computer screen and strains the eyes. In order to see the screen when there is glare, you may move into awkward postures. There are two forms of glare: direct and indirect.

### **5.7.9. Muscle Recovery**

It is important to stand up and get away from your desk and/or computer regularly throughout the day even if your work station is designed to suit your body. A five minute break away from the computer every hour allows your eyes, neck, back, shoulders, and arms to rest.

You should not remain in any one position (seated or otherwise) for long periods of time. Changing positions throughout the day will help to reduce the stress and strain that builds up from staying in one position for a long time.

### **5.7.10. Arranging your office**

- Printers, faxes etc. should not obstruct movement.
- Adequate space should be available for maintenance on any piece of equipment.
- You should use filing cabinets with a locking system so that no more than one drawer can be opened at once. If more than one drawer is opened there is a risk of the cabinet tipping.

#### **5.7.10.1. Short Term Fixes**

Various boxes can be used as footrests. For example, an empty orange crate can be turned upside down. If you are creative, it can even be padded for a more comfortable rest.

#### **5.7.10.2. Indoor Air Quality**

Other office environmental concerns include indoor air quality, thermal comfort, electromagnetic fields, and noise. Poor indoor air quality can cause many health problems.

#### **5.7.10.3. Electromagnetic Fields**

Electromagnetic fields (EMFs) are invisible lines of force that occur wherever there is electricity. They are made up of electric and magnetic fields. Electric fields can be blocked, but you cannot block magnetic fields. There is no conclusive evidence that EMF emissions from a computer cause negative health effects.

#### **5.7.10.3. Noise**

Noise is any unpleasant sound. We tend to call it "sound" when it is not annoying and "noise" when it is! Noise levels in your office are probably not high enough to damage your hearing, but noise may still cause problems.

Noise may:

- Interfere with communication.
- Annoy or distract people nearby.
- Increase the level of concentration required and in turn, increase the level of

- fatigue.
- Cause stress.

### **5.7.10.3. Stress**

Is your head pounding? Stomach upset? Feeling cold and clammy? You may be experiencing stress.

Stress is a serious workplace problem. You may experience stress as you drive through traffic to get to work, when you look at your "to do" list, or after your boss asks you to finish typing a letter which must be faxed immediately. It is no wonder you may be feeling tired by the end of the work day.

## **5.8. POINTS TO REMEMBER**

- Ergonomic equipment is only ergonomic if used correctly.
- Learn how to use your equipment.
- Reduce repetitive movements, awkward postures and static forces.
- Be conscious of your body positions and movements!
- Take a break away from your computer at least once every hour.
- *Remember to keep moving!*
- All aspects of your office interact to affect your health (workstation design, stress, air quality noise, etc.).
- Keep the communication lines open!

## **6. CONCLUSIONS AND RECOMMENDATIONS**

Management commitment, in terms of attitude, managing in a diversified workplace, and the allocation of resources, is essential to the process of ergonomic management in SA. Through simple, innovative and creative thinking, the status in commerce and the industry can be improved by the application of ergonomic principles. The implementation of ergonomic improvements in the workplace must take the form of a project by project approach using a systematic method of application.

It is envisaged that after reading this paper, you will be able to walk through your workplace, detect basic workplace design problems, and correct many of them yourselves in order to prevent musculoskeletal injuries and cumulative trauma disorders (CTD's) and the accompanying pain and disability among employees, improve employee performance and reduce basic costs associated with these injuries and illnesses (Ostrom 1993: xix).

## **7. BIBLIOGRAPHY**

Allnoch, A.1997. *IE knits productivity with ergonomics tool*. IIE solutions 29:16-17.

Alexander, DC. and Pulat, BM. 1991. (Ed). *Industrial Ergonomics: Case Studies*. Industrial Engineering and Management Press. Georgia

Anshel, J. 1998. *Visual ergonomics in the workplace*. Taylor and Francis. London. EC4A 3DE.

Bernard, B. 1997. *Musculoskeletal disorders and workplace factors*. National Institute for Occupational Safety and Health. Publication no. 97-141.

- Dekker, SWA. Nyce, JM. 2004. *How can ergonomics influence design? Moving from research findings to future systems*. Journal: Ergonomics. Volume 47. Number 15. Pages 1624-1639.
- Desnoyers, L. 2004. *The role of qualitative methodology in ergonomics: a commentary*. Journal: Theoretical issues in Ergonomics Science. Volume 5. Number 6. Pages 495-498.
- Galer, IAR. 1989. *Applied ergonomics handbook*. London: Butterworths.
- Goetsch, DL. and Davis, SB. 2006. 5<sup>th</sup> Edition. *Quality Management: Introduction to Total Quality Management for Production, Processing and Services*. Pearson International Edition.
- Gross, CM. 1996. *The right fit: The power of Ergonomics as a competitive strategy*. Productivity Press. Portland. Oregon.
- Gryna, FM. 2001. *Quality Planning and Analysis – from product development through use*. 4<sup>th</sup> ed. McGraw-Hill. New York.
- Karapetrovic, S. 1999. *ISO9000, Service quality and ergonomics*. MCB University Press. Volume 9. Number 2. pages 81-89.
- Kogi, K. and Kawakami T. 1997. *Environmental Management and Health*. MCB University Press. 8(5): 188-190.
- Koningsveld, E.A.P., 2005. *Enhancing the impact of ergonomics interventions*. Journal: Ergonomics. Volume 48. Number 5. Pages 559-580.
- Kroemer, KHE., Kroemer, HB., and Kroemer-Elbert, KE. 1994. *Ergonomics: How to design for ease and efficiency*. Prentice Hall. International Editions.
- Lee, KS. 2004. *Ergonomics in total quality management: How can we sell ergonomics to management?* Journal: Ergonomics. Volume 48. Number 5. Pages 547-558.
- MacLeod, D. 1995. *The Ergonomics Edge: Improving safety, Quality, and Productivity*. Thompson Publishing. New York.
- National Institute for Occupational Safety and Health, Publication No. 97–141.
- Osborne. DJ. 1991. 2<sup>nd</sup> Edition. *Ergonomics at work*. John Wiley and Sons Ltd.
- Ostrom, Lee T. 1993. *Creating the ergonomically sound workplace*. Jossey-Bass Publishers. San Francisco.
- Sookdeo, B and Ramdass, KR. 2006. *The role of ergonomics towards performance improvement*. A workshop presentation at the 16th International Conference of the Southern Africa Institute of Management Services (SAIMAS). Bela Bela. South Africa.

[www.healthycomputing.com](http://www.healthycomputing.com)  
[www.ergonomics.com](http://www.ergonomics.com)  
[www.armscorbusiness.com](http://www.armscorbusiness.com)  
[www.usernomics.com](http://www.usernomics.com)

