ERGONOMICS GUIDELINES

FOR OCCUPATIONAL HEALTH PRACTICE IN INDUSTRIALLY DEVELOPING COUNTRIES

SPONSORS

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International Commission on Occupational Health

Consultants in Occupational Health Safety and Risk Management

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Pat Scott, Kazutaka Kogi and
Barbara McPhee

August 2009

ABOUT THE AUTHORS

Pat Scott

Pat Scott is Emeritus Professor of Ergonomics at Rhodes University where she was on the staff for 27 years. In 1996, as Head of the department, she started the first-full time Ergonomics degree programme in South Africa; a programme including both undergraduate and postgraduate students, and has supervised over 20 postgraduate ergonomics students. She is author of over 150 papers and chapters in books, and is editor of the book "Ergonomics in developing regions: needs and applications", covering the good work being done in IDCs and which has recently been published.

Pat was a founder member of the Ergonomics Society of South Africa, and she has served as both Secretary and Chairperson of the society. As Chief editor of the Journal "Ergonomics: SA" for 12 years, she canvassed papers from Industrially Developing Countries world wide in an attempt to encourage those who are doing such good work in IDCs to publish their research and share their experiences with others.

In 1997, as an executive member of the IEA, she was appointed Chairperson of the IEA's Standing Committee for Ergonomics in IDCs, a position she held for two terms. During this time she travelled extensively to developing countries giving presentations and running ergonomics workshops.

Pat is a Fellow of the IEA and ESSA, and in 2003 was the recipient of the IEA award for the Promotion of Ergonomics in IDCs. In 2007 she received the Distinguished International Colleague award of the HFES in recognition of her work in IDCs.

Kazutaka Kogi

Kazutaka Kogi, Research Adviser of the Institute for Science of Labour (ISL) in Kawasaki, Japan, graduated from the University of Tokyo, Faculty of Medicine in 1957. He conducted applied research at this Institute until 1983 when he joined the International Labour Office as Regional Adviser for Asia and the Pacific, stationed in Bangkok. During 1988-1993, he worked at the ILO headquarters in Geneva as Chief of the Occupational Safety and Health Branch and Director of the Working Conditions and Environment Department. He then served as Director of the Institute for Science of Labour during 1993-1999.

His major areas of interest are workload and fatigue assessment and practical improvement of workplace conditions including participatory ergonomics. Working in technical cooperation projects for developing countries, he has contributed to the development of participatory training for workplace improvements in small enterprises and in agriculture. He is particularly interested in the application of cost-effective safety and health measures including low-cost solutions.

He contributed to the editing of Ergonomic Checkpoints, a joint publication of the ILO and the International Ergonomics Association. He was Treasurer of the IEA during 1997-2003. He has served on the International Commission on Occupational Heath (ICOH) as Board Member from 2000-2006. In 2006 he was elected Vice-President of ICOH. In 2009 he was elected President.

Barbara McPhee

Barbara McPhee is a Certified Professional Ergonomist and Specialist Occupational Health Physiotherapist who has worked in occupational health and safety for over 30 years as a consultant, teacher and researcher most particularly in ergonomics. During this time she has worked in all aspects of the field at every level of industry and government throughout Australia and overseas.

Over the last 15 years she has worked mainly in mining concentrating on reducing risks to employees' health and safety through improved ergonomics design. She also provides specialised ergonomics advice to clients in a range of other industries including light and heavy manufacturing, aviation, retail food and government.

Barbara is a Past President and Fellow of the Human Factors and Ergonomics Society of Australia. She is an Executive Council Member of the Pan Pacific Council on Occupational Ergonomics and is a former Board Member of the International Commission on Occupational Health. She is a Life Member of the Australian Physiotherapy Association and a Fellow of the Australian College of Physiotherapists. She was recently appointed by the NSW Minister for Primary Industries as an Independent Expert in ergonomics and occupational health on the NSW Mine Safety Advisory Council.

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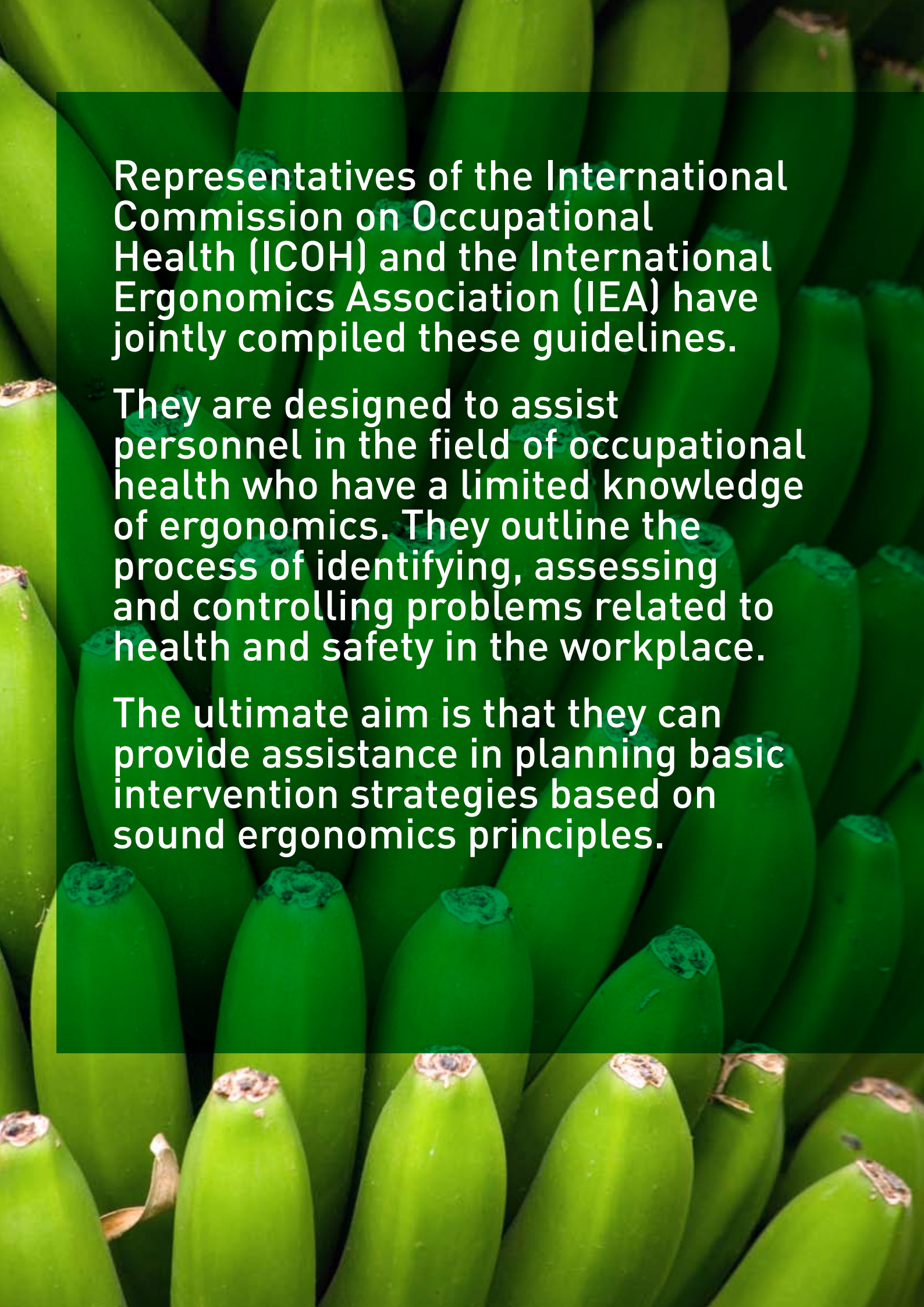


Representatives of the International Commission on Occupational Health (ICOH) and the International Ergonomics Association (IEA) have jointly compiled these guidelines.

They are designed to assist personnel in the field of occupational health who have a limited knowledge of ergonomics. They outline the process of identifying, assessing and controlling problems related to health and safety in the workplace.

The ultimate aim is that they can provide assistance in planning basic intervention strategies based on sound ergonomics principles.

INTRODUCTION

HISTORY OF CO-OPERATION BETWEEN THE IEA AND ICOH

In 1996 ICOH and the IEA signed a Memorandum of Understanding (MOU) which outlined ways in which the two organisations could work together to enhance the impact of their activities. One of the points in the MOU was that both organisations would explore the possibilities of co-operation in promoting the advancement of occupational health and ergonomics in industrially developing and economically emerging countries, referred to here as IDCs.

At the IEA's triennial international congress in San Diego in July/August 2000, a small group representing the IEA and ICOH met to discuss how to implement this project. Those participating were: Jean-Francois Caillard, then President of ICOH, Kazutaka Kogi and Pat Scott, then Members of the IEA Executive and Barbara McPhee, then a Member of the Board of ICOH. The group agreed that, at this time, the most effective method for promoting ergonomics to non-professional ergonomists would be to develop basic guidelines on the practice of ergonomics for personnel in occupational health fields.

OCCUPATIONAL HEALTH

In 1950, a joint Committee of the International Labour Organisation and World Health Organisation defined Occupational Health (objectives) as the:

- Promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations
- Prevention among workers of departures from health caused by their working conditions
- Protection of workers in their employment from risks resulting from factors adverse to health
- Placing and the maintenance of workers in an occupational environment adapted to their physical and mental needs

Therefore Occupational Health services deal with:

1. **Health promotion and maintenance** (Primary Prevention or well people care)
2. **Prevention** of disease and injury, or workers' return to full work duties after injury or illness (Secondary Prevention or threatened people care)
3. **Some treatment or workplace modification** for residual disability (Tertiary Prevention or sick people care)

The workplace affords the best community opportunity for health promotion and maintenance in working adults.

Ergonomics is an essential and integral element of occupational health practice.

ERGONOMICS FOR OCCUPATIONAL HEALTH PRACTICE

At the workplace, ergonomics is applied to the design of work equipment and tasks and to work organisation. It is often referred to as occupational ergonomics as it is an important part of occupational health and safety. As such, it aims to promote health, efficiency and well-being in employees by designing for safe, satisfying and productive work.

Ergonomics can play an important role in occupational health and safety management where the primary aim is to reduce risks of injury or disease while enhancing the quality of working life. Good ergonomics in the workplace can improve productivity and morale of workers and decrease injuries, sick leave, staff turnover and absenteeism.

In occupational ergonomics it is necessary to examine not only the physical design aspects of work or the 'hardware', but also areas such as work organisation and task design, job content and control over workload, support and training. The social and managerial environment is important. Usually these aspects require ergonomics to be integrated into the broader work systems.

Therefore to determine if an optimum solution has been achieved, the people who perform the work (the 'who'), the nature of the tasks (the 'what') and the context in which they are done (the 'where', 'when' and the 'how') need to be considered. This integrated approach in applying ergonomics will be beneficial for improving occupational health practice in IDCs.

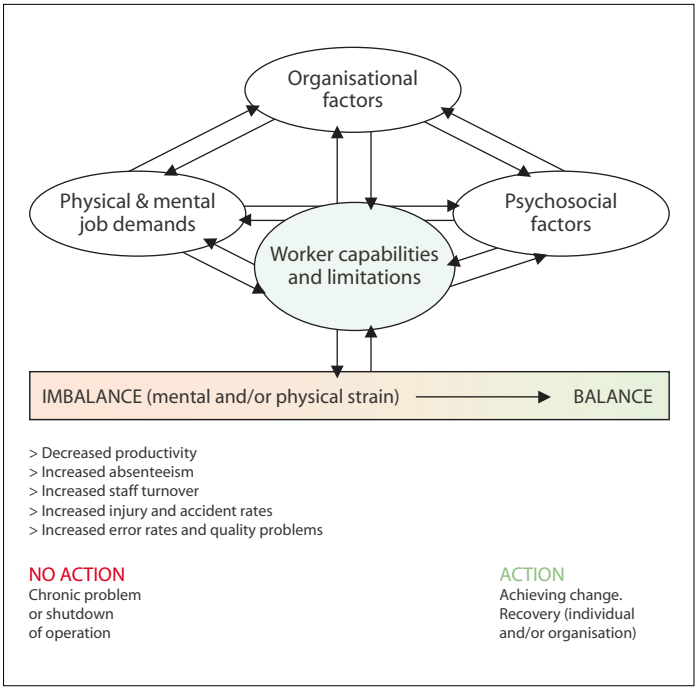


Figure 1 Physical, mental and psychosocial factors influencing workers' health.
From Aickin, Lusted and McPhee 2009

There is strong evidence to suggest that the problems associated with the sub-optimal working conditions so prevalent in IDCs are getting worse despite extensive isolated efforts to improve working conditions.

It is therefore imperative that we establish a collaborative drive to address an area of common concern to us all that is: the health, safety and well-being of the worker.

0.1 AIMS OF THE GUIDELINES

We have compiled these Guidelines to help occupational health personnel in industrially developing countries (IDCs). Most particularly they are intended for those who may be active in the field of health at work and who do not have formal qualifications or training in ergonomics. The Guidelines aim to provide information about the process of identifying and rectifying basic problems associated with suboptimal working conditions by applying ergonomics.

In order to apply ergonomics, we therefore need information about the:

- Human operator
- Task
- Overall work setting including equipment, environment and the organisation of the work

How these elements interact and allow for a good match between workers and their jobs is one of the aims of occupational ergonomics. The other aim is to correct any mismatches so that they do not cause adverse effects such as illness or injury, human error or reduced productivity.

The word 'optimum' is used in ergonomics to refer to the balancing of the abilities of people with the demands of work. This requires careful observation and discussion with workers as well as using any information to hand such as accident, injury and illness statistics, data on productivity and reworking product.

LOCAL SOLUTIONS FOR LOCAL PROBLEMS

There are some generic guidelines produced for general needs but in reality workplace problems may vary substantially from site to site and even department to department. Some ergonomics solutions do not to transfer directly from one industry to another, let alone between different regions or countries. Each set of circumstances is different.

Therefore, to be successful every ergonomics assessment must take into account the socio-economic context ensuring that the solutions are appropriate and acceptable to the local situation. It can be described as 'the way we do things around here' and relates to the culture of the country and the industry and/or company in that country. Simply importing solutions without reference to local issues and resources is very likely to fail; modifications to imported solutions are generally necessary.

TARGET GROUPS FOR THESE GUIDELINES

In most IDCs there is very limited knowledge about ergonomics and there are very few qualified Ergonomists. However, there are often people trained and involved in various sub-sections of occupational health and safety (OHS). While the expertise may differ there are many important common areas of concern, the most important of which is for the well-being of the worker.

The IEA and ICOH take the view that the lack of personnel formally trained in ergonomics should not be a barrier to the application of basic ergonomics principles in the workplace. These Guidelines should be useable by anyone who has an interest in improving work conditions.

Therefore, we have compiled them for people without formal ergonomics education but who may have a basic working knowledge of ergonomics and its benefits.

Professionals such as Occupational Health Nurses, Occupational Physicians, Physiotherapists, Occupational Hygienists and Safety Officers can promote ergonomics as they look for opportunities to improve working conditions. Ideally, ergonomics professionals should be involved in the training of the OHS personnel and are encouraged to help others use these Guidelines in their work.

PRINCIPLES

These Guidelines concentrate on the application of ergonomics principles to improve working conditions with the view to protecting and promoting the health and safety of working people. It is not a cookbook of menus to solve particular problems. Rather it describes a general approach and way of thinking needed for on-going assessment and improvements of working conditions in IDCs.

Section 7 lists the range of areas within occupational ergonomics and outlines basic principles.

0.2 ERGONOMICS AND ITS PRACTICE

WHAT IS ERGONOMICS?

"Ergonomics is the scientific discipline concerned with the fundamental understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and overall system performance" (International Ergonomics Association (IEA), 2000).

Derived from the Greek ergon (work) and nomos (laws) to denote the science of work, ergonomics is a systems-oriented discipline that extends across all aspects of human activity, and therefore promotes a holistic approach to enhancing the well-being of people at work. To achieve this it considers the physical, cognitive, social, organisational and environmental aspects of work and the impact, both positive and negative, that these may have on the worker.

Practicing Ergonomists must have a broad understanding of the full scope of the discipline and be able to apply the principles in practice to improve working conditions.

DOMAINS OF SPECIALISATION IN ERGONOMICS

Due to the wide scope of ergonomics, in 2000 the IEA proposed the following three broad domains of specialisation within ergonomics in order to establish some clear identification of the recognised areas of the discipline.

Physical ergonomics is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. Relevant topics include working postures, materials handling, repetitive movements, heavy work, work-related musculoskeletal disorders, workplace layout, noise, thermal conditions and vibration, safety and health, as these relate to work.

Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning and motor response, as they affect interactions among humans and other elements of a system. Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human error, work stress and training as these may relate to the way humans work in systems.

Organisational ergonomics is concerned with the optimisation of socio-technical systems, including their organisational structures, policies and processes. Relevant topics include human system considerations in communication, human resource management, work design, design of work schedules, teamwork, participatory design, community ergonomics, cooperative work, new work models, virtual organisations, tele-work and quality management.

The emphasis of any ergonomics investigation may be more in one domain than another. However, no thorough evaluation of a workplace should ever be exclusively in one area.

The focus of ergonomics is the analyses of the interaction between the human operator and other components within the system. If there is incompatibility between any of the elements that make up the overall system the risk to the health and safety of workers increases. Any identification of a "mismatch" between the worker and the task needs to be addressed by adjusting the task to suit the capabilities of the worker.

INTEGRATION OF ERGONOMICS INTO OCCUPATIONAL HEALTH AND SAFETY (OHS)

The twofold objective of ergonomics is to enhance the safety and well-being of the workers and to improve productivity. This has obvious benefits for workers, the organisation and the nation.

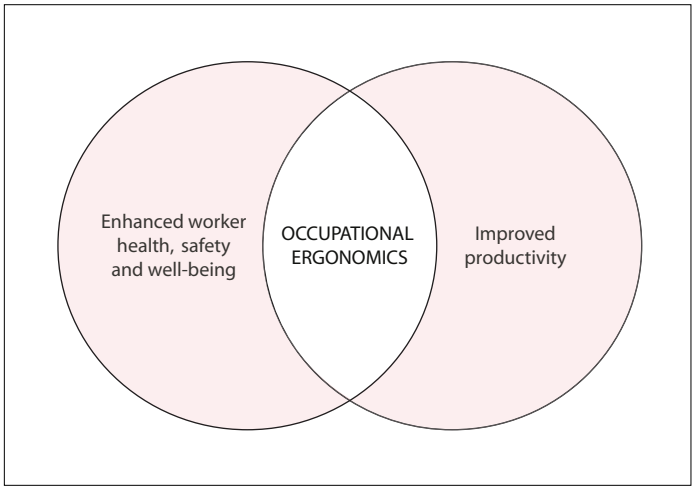


Figure 2 Two fold objective of occupational ergonomics.

Ergonomics is well established in many countries. However, in Industrially Developing Countries (IDCs) it is less well known and less practiced. Fortunately, there is a growing awareness of the crucial role that ergonomics can play in IDCs. It is therefore important that the few Ergonomists who are working in these regions strive to establish "functional partnerships" with other professionals involved in addressing the challenging problem of improving such sub-optimal working conditions.

FOCUS OF ERGONOMICS

Ergonomics focuses on the appropriate design of workplaces, systems, equipment, work processes and environments to accommodate the workers. The aim is to achieve compatibility between the needs of people with real limitations and the demands of their jobs. Consideration should be given to the immediate problem as well as the entire work setting and beyond.

Work demands need to be balanced with social demands. For example, mothers with young children; families with sick or elderly relatives; workers who are inadequately nourished may be more prone to occupational injury and disease.

Physically heavy work is often unskilled and the people employed to do it may have few options with respect to the work that they do. Problems of poor education can be compounded by low income and associated inadequate living conditions, poor nutrition and health issues.

MICROERGONOMICS

Much of ergonomics has focused on people working with tools, machines and other equipment. This is what we call the "human-machine" interface and is now often referred to as microergonomics.

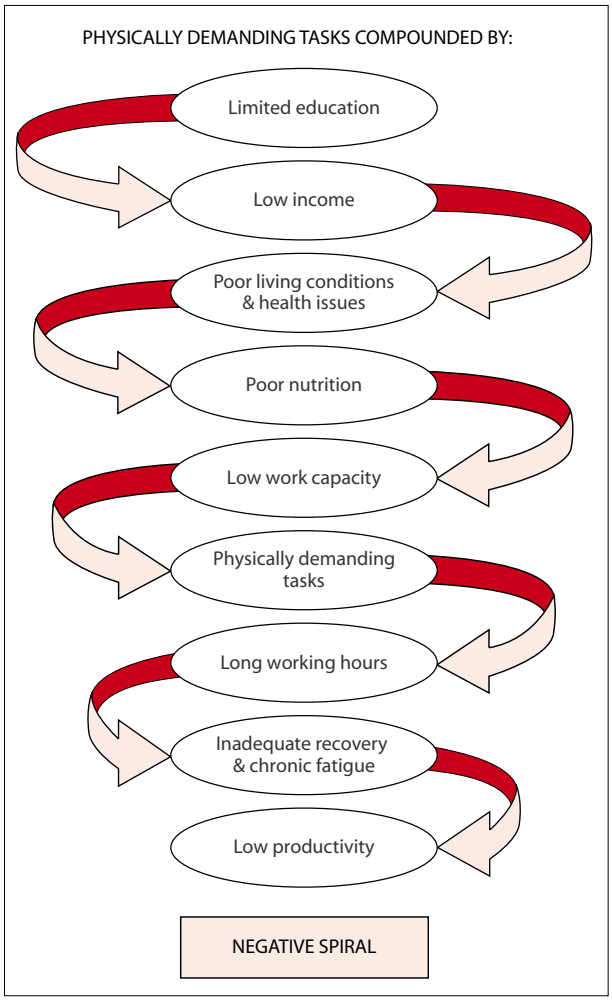


Figure 3 The consequences of poor education and low incomes for workers.
From Scott 2007

Any incompatibility between task requirements and the capabilities (mental and/or physical) of the worker can result in a sub-optimal situation. In turn, this may lead to errors, accidents and injuries. Working with employees Ergonomists can identify and prioritise problem areas and propose possible solutions. If necessary, they may recommend a redesign of the workplace, the tasks and/or the organisation of the work to accommodate individual workers as well as groups of workers.

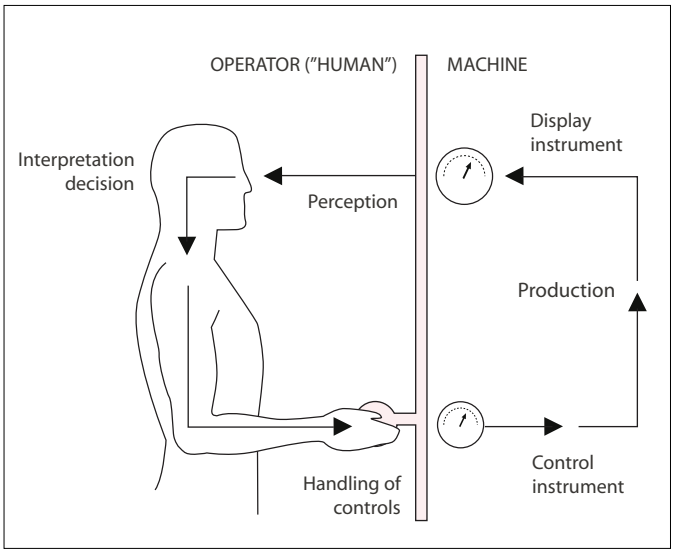


Figure 4 MICRO-ERGONOMICS
The human-machine interface.
From Grandjean 1988

MACROERGONOMICS

Since the 1980s Ergonomists have recognised the need to look beyond the obvious microergonomics issues and to make an assessment of the overall working environment. Hendrick (1986) argued that while it is possible to do an outstanding job designing a specific aspect within a working system i.e. at a micro-level, an Ergonomist might fail to achieve overall system effectiveness if there is a lack of attention to the larger picture or the design of the complete system.

To address this problem he proposed the concept of macroergonomics, which he defined as a "top-down socio-technical systems approach to organisational and work-system design". Work organisation has been defined as: the way in which all sub-systems of the workplace are co-ordinated, supervised and performed by each worker carrying out a specific job within the broader system.

Hence macroergonomics is concerned with the optimisation of organisational and work-system design through consideration of relevant personnel, technological and environmental variables. It examines the interactions and interdependence of all facets of the working environment and considers the way organisations are managed.

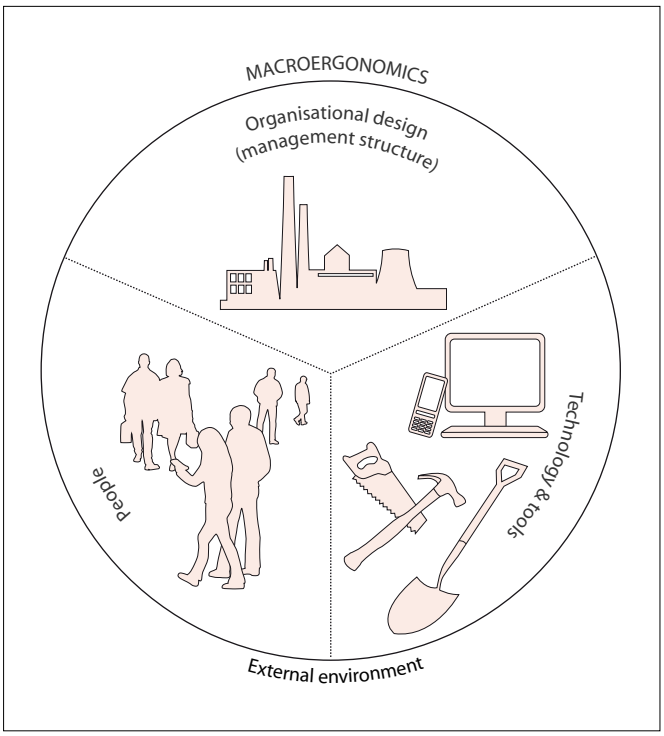


Figure 5 MACROERGONOMICS – Top down systems approach recognising the need for general, overall organisation and control. *Adapted from Hendrick 1998*

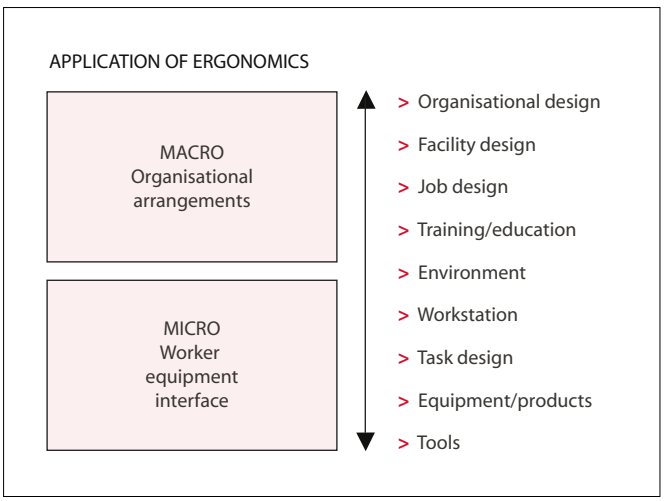


Figure 6 Application of ergonomics. *From McPhee 2008*

USING ERGONOMICS PRINCIPLES TO CREATE A SAFER AND MORE EFFICIENT WORK ENVIRONMENT

The control of risks associated with poor working conditions is like the controlling of many other hazards in OHS in that it requires a systematic approach and a commitment to continual improvement. Most of the 'people' issues relating to areas such as safety and the design of tasks, machinery, tools and work systems require the ongoing assessment and application of ergonomics investigation and intervention. Job requirements, and the way in which they are done, are constantly changing therefore any system needs to be flexible and continuously monitored.

The solutions to workplace problems need not be costly or complicated. However, they must involve a process that systematically identifies risks, determines how important each one is and then controls them by the best means possible. It also involves monitoring the situation to ensure that the process continues and is successful. The process of managing risks is relatively easy to initiate but must always focus on finding the right solution, implementing it and reviewing its effectiveness.

Much ergonomics information relating to the workplace is straight forward requiring the thoughtful application of basic principles. Often it may only be necessary to create an awareness of these basic principles, acknowledge sound practices which many workers already use and encourage and reward worker initiative.

WORKER PARTICIPATION IN APPLYING ERGONOMICS PRINCIPLES

Employees should be encouraged to become actively involved in the process of identifying problems and to make suggestions for improvement. Workers' experience can and should be used to plan, implement and refine changes in order to achieve more workable solutions for identified problems and to prevent the likelihood of future problems.

This involvement of the workers is known as 'participatory ergonomics' and is widely used for disseminating ergonomics information and successfully achieving change. It is based on the premise that the people who do the work tend to know the best way to carry it out in practice.

Participatory involvement ideally should include managers, workers, trade unionists, OHS personnel and supervisors, i.e. participants from the full spectrum of employees and employers.

However, smaller groups can be just as effective in some workplaces as long as managers commit to change and support the group's activities.

Success has been achieved within some organisations by forming a small team of committed people called an 'Ergonomics Facilitation Team'.

A notice board of Ergonomics Hints and Best Practices can be used to great effect and input from all should be encouraged. A "co-operative co-responsibility" can be developed whereby employers and employees interact on a regular basis to discuss problems and to implement appropriate solutions.

By involving a cross section of personnel within the company, one can create an "Ergonomics ethos" at all levels, which can have a positive effect on the company as a whole.

If non-ergonomics personnel identify a major or complex problem that requires expert knowledge and skill they should seek further advice from a qualified professional Ergonomist. With the growth of electronic communication

such as emails and the Internet professional support is now more easily accessible for people in different countries and in remote locations.

If this is not possible, an experienced outsider with some knowledge of ergonomics may be able to observe the situation from a different perspective, with 'fresh eyes', making note of all the relevant features of the job and the worker. Often such people can provide a more objective evaluation of hazards and risks.

BENEFITS OF ERGONOMICS

The focus generally should be on simple, low-cost methods of identifying and solving common problems in workplaces within IDCs. While the health and safety professionals' emphasis is on maintaining and improving workers' health, safety and well-being, the application of ergonomics can provide other benefits. These include:

- Minimising wasted effort
- Reduced damage to equipment
- Less waste of product
- Improved productivity

In a well-designed workplace workers can achieve more output with less effort and fewer risks to their health and safety. Good design often costs no more than poor design but, to be effective, it does require good organisation and careful planning in consultation with the workers.

The benefits of ergonomics can be achieved through:

- Adaptations which accommodate local workers
- Analysis of individual task requirements
- Assessment of worker capacity and abilities
- Balancing task demands, both physical and mental, with worker capabilities
- Improved workplace design
- Enhanced overall organisational management

COST-BENEFIT OF ERGONOMICS

Ergonomics interventions in IDCs need to be at a minimal cost, even 'no-cost', but they also must be effective in alleviating the stress placed on so many workers involved in demanding work. (See Figures 7 to 10). This in turn can assist in improving worker efficiency and have a positive influence on cost benefits to the company.

Figure 7 Excessive and unnecessary reaching.

Figure 8
Heavy, awkward loads can be much more effectively picked up, carried and lowered using team lifts or mechanical aids.

Figure 9
Fixed work postures and lack of task variety can be alleviated by regular breaks away from the task.

Figure 10 Unbalanced work posture and use of excessive force such as in this task can be the result of local conditions. Local solutions may be relatively easy once the problem is acknowledged.

Justifying expenditure to improve OHS has been difficult in the past. Often direct compensation and medical expenses were the only indicator that poor OHS practices were costly. These may not be good indicators in IDCs. However, reduced productivity and increased re-work rate are costly compared with the costs of many simple ergonomics changes.

In those companies where there is adequate data it is possible to calculate the real costs of injuries and illness to companies using methods and programs that are available commercially. These range in complexity from full company accounting systems to methods that apply to individual jobs or groups of workers.

Consider the feasibility, availability and cost of changes needed to improve working conditions in relation to the size and cost of the problem. Sometimes it may be necessary to justify the cost of change, or of different changes, or the costs of doing nothing at all. This is where conducting a cost-benefit or cost-effectiveness analysis can be useful.

Such analyses are best conducted prior to and after changes have been made. Where they are conducted beforehand payback periods can be estimated for budgets. If the payback period is short (3-12 months) this can be used to justify expenditures.

Cost-benefit and cost effectiveness programs require some basic information in the following five areas:

1. Actual number of productive hours worked per employee per year.
2. Salary or wage costs per hour worked.

3. Employee turnover and training costs.
4. Productivity and product/ service quality losses due to absent employees.
5. Cost of implementation of intervention(s).

You can then calculate the costs per hour of under-productive or absent workers. To this, costs of solutions can be added and a payback period can be estimated. Not all the information is essential but the more that you can supply and the more accurate it is the better you can predict the true costs and benefits of ergonomics.

The costs of wasted product, increased time to undertake the tasks, inadequate or poor quality workmanship and damage to equipment and product identified in the process can also be added to the costs of injuries and illness in workers.

While the cost of ergonomics interventions is generally straightforward to calculate determining the monetary value of the benefits is not as simple. However, Figure 11 illustrates both direct and indirect positive outcomes to both human and financial resources, associated with the implementation of ergonomics. Some benefits will be immediate and obvious, while others may take time before they are tangible.

	COSTS OF ERGONOMIC INTERVENTIONS	BENEFITS OF ERGONOMIC INTERVENTIONS
PERSONNEL	• Adviser fees • Internal staff time • Employee "down time" • Employee training	• Reduced accidents and injuries • Reduced absenteeism • Reduced costs of training • Improved skills
EQUIPMENT AND MATERIALS	• Equipment costs • Material costs	• Reduced maintenance time • Savings from equipment that needs modification • Savings from equipment that is underused • Net savings in material and supply costs
PRODUCTIVITY		• Reduced scrap rate • Reduced production parts and materials • Reduced overhead rate • Improved quality and quantity of product
PRODUCT DESIGN	• Increased design time • Increased design costs	• Reduced accidents • Reduced cost of litigation • Increased sales • Increased stock value

Figure 11 Costs and benefits associated with ergonomic interventions. *From Scott, Todd and Christie, 2006*

In a well-designed workplace workers can achieve more output with less effort and fewer risks to their health and safety. Good design often costs no more than poor design but, to be effective, it does require good organisation and careful planning in consultation with the workers.

0.3 IDENTIFYING WORKPLACE PROBLEMS

Problems may reveal themselves in the workplace in many ways. Workers may complain of aches and pains or other disorders; accidents and injuries may be more evident in some work areas; productivity may be lower than expected; or the incidence of errors or poor quality work may be unacceptably high.

Globally, work-related strain (both physical and mental) is being reported more frequently, and this tends to lead to such things as increased absenteeism, poor motivation or commitment to the job. This in turn can result in low worker and company output and increased costs of doing business.

Ergonomists need to be aware of the implications of individual differences and take into account a wide range of human factors such as how workers see, hear, understand, make decisions and take action. Consideration of these and other relevant factors are essential in any assessment as they will affect people's behaviour and responses as well as influence the way they react to problems and proposed interventions.

ELEMENTS IN OCCUPATIONAL ERGONOMICS IN IDCS

When analysing work and how it can be improved from an ergonomics point of view there are five basic elements that need to be addressed:

1. **Worker:**
   The human element of the workplace

   A range of characteristics need to be considered: age; health; residual disabilities; physical and mental capacities; experience and skills; education and training.

2. Job/task design:
What the employee is required to do, and what they actually do

This includes job content, work demands, time requirements such as deadlines, individual's control over workload including decision latitude, working relationships with other employees, and responsibilities of the job, tools and equipment.

3. Equipment design:
Work stations, tools and equipment

The design, positioning and use of workstations, electronic and mobile equipment, machinery and tools, and protective clothing.

4. Workplace design:
Overall work environment

The buildings, work areas and spaces; lighting, noise, thermal environment; and positioning of interactive work areas.

5. Work organisation:
The broader context of the organisation and the work and how this affects individuals

It includes patterns of work, peaks and troughs in workload, shift-work, consultation, inefficiencies or organisational difficulties, rest and work breaks, teamwork, how the work is organised and why, the workplace culture, as well as the broader economic and social influences.

Although each section can be evaluated on its own, it is the combination of all five elements which is the key issue. It is therefore necessary to asses the inter-dependence of all interacting sub-sections within the overall situation (Figure 12).

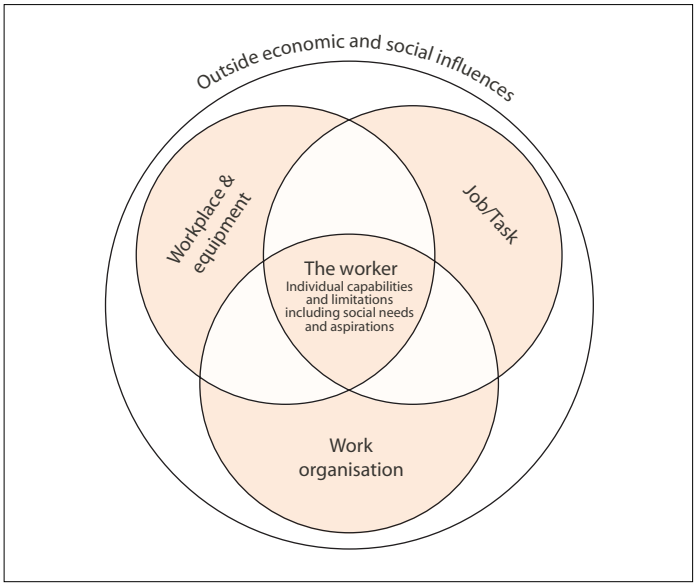


Figure 12 The relationship between different elements of ergonomics.

Individual and work factors that are likely to modify the risks to health and well-being include:

Worker capabilities and limitations

1. Training for the task
2. Skills and experience
3. Physical capabilities
4. Age
5. Special needs including recurring disability

Task design

1. Task demands including:
   - work intensity
   - duration of task
   - peak and cumulative loading especially repetitive work
   - length of working day
2. Work postures such as:
   - overhead stretching
   - stooping, forward reaching
   - kneeling or crouching
   - asymmetrical activities
3. Mental demands:
   - understanding of, and training in new technology
   - work responsibilities
   - work demands and job decision latitude

Workplace Design – Equipment design

1. Work postures and movements determined by equipment design and location, or by workplace layout
2. Information displays and controls such as dials, screens, levers, knobs and switches
3. Design, selection and maintenance of tools

Figures 13 and 14 Examples of unnecessarily awkward working postures. Easy access to loads is critical to reducing strain. See Figure 37, p67.

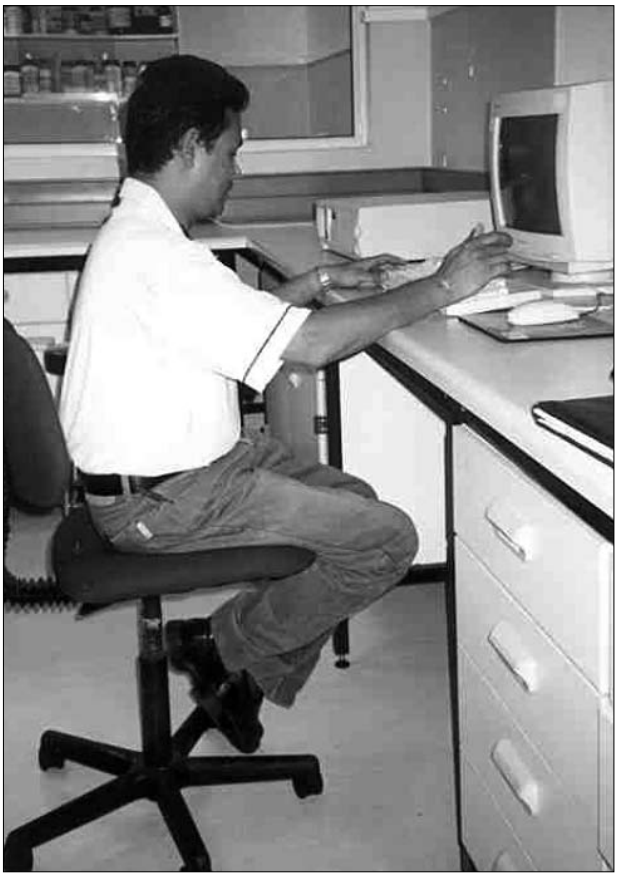


Figure 15 Example of a poor set-up for a computer user. See Figure 58 on p80 for recommended workplace arrangements for computer users.

4. Access to machinery and parts (for workers and maintenance personnel)
5. Working conditions such as slippery walking surfaces, unguarded machinery, working at height without barriers or a safety harness

Workplace design – Work environment

1. Space, access and workplace layout
2. Visibility in general and specifically for tasks
3. Noise
4. Environmental conditions (especially work in hot, humid, dusty or dirty environments)

Work organisation

1. Shiftwork organisation
2. Control over work processes
3. Job demands (physical or mental):
   - qualitative (difficulty)
   - quantitative (amount)
4. Task diversity and worker stimulation
5. Job training
6. Adequate work review
7. Communication, discussion and feedback
8. Recognition of effort

Ergonomics can play a major role in stopping or reversing any negative impact of potential problems. Addressing these factors should reduce the risk of human error and of excessive physical or mental work demands that can result in acute or chronic injury or illness.

CONTROL AND WORK LOAD

Job demands need to be balanced with the degree of control which the workers perceive they have over how the work will be done. Employees who have high demands placed on them and who have little job control (decision latitude) are the most likely to be at risk of developing psychological or physical disorders.

Conversely those who have high demands and a high degree of control over how they meet those demands contribute to high levels of motivation, learning and new behaviours. These examples are illustrated in the following diagram.

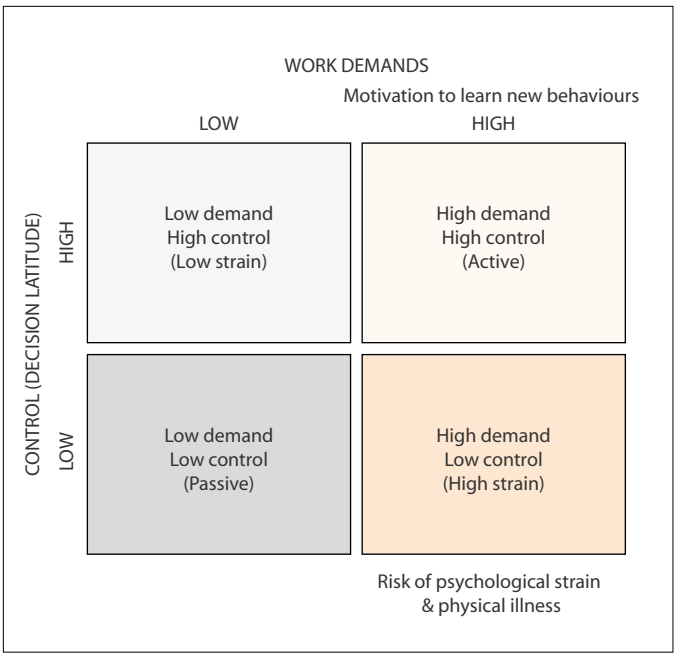


Figure 16 Demand vs control model.
Adapted from Karasek and Theorell 1990

SUPPORT FOR PEOPLE AT WORK

A modifying influence in the demands versus control theory can be support. Support, or the lack of it, can either reduce or magnify the effects of problems at work.

Supporting people at work by developing their skills, minimising their weaknesses and helping them to cope with life stresses is part of good management. Managers and supervisors need to understand the strengths and limitations of different types of technology and workplace design, and also how the limitations of some systems may lead to problems for users. This means full consultation with the people who will be doing the work from the start of the design phase through to the ongoing performance of the system.

People need consistent and adequate support throughout the design and implementation phases of new systems. Workers need to participate fully and provide feedback to designers and managers.

Assistance needs to be appropriate and effective. People, especially older workers, need to learn by doing. This helps them to gain confidence with new equipment, processes and systems. Managers need to keep a user focus and continually re-appraise and fine tune. Support must be kept going when the process or system is up and running especially for times of crisis - either at work or in individuals' personal lives.

Supporting people at work by developing their skills, minimising their weaknesses and helping them to cope with life stresses is part of good management.

0.4 RISK MANAGEMENT IN THE WORKPLACE

WORK HAZARDS AND RISKS

In occupational health and safety we talk about hazards and risks in terms of their identification, assessment and control to ensure that workers' health and safety are not compromised.

Figure 17 Awkward heavy lifting with a high risk of slips and injuries.

A **hazard** is a source of potential harm e.g. a heavy, awkward load such as a vehicle door.

Figure 18 Moveable stand to hold car door reduces strain and the risk of injury.

Risk is the likelihood or possibility of a problem occurring from an event or situation and the consequences if it did. The heavy, awkward load only becomes a risk when the person has to handle it.

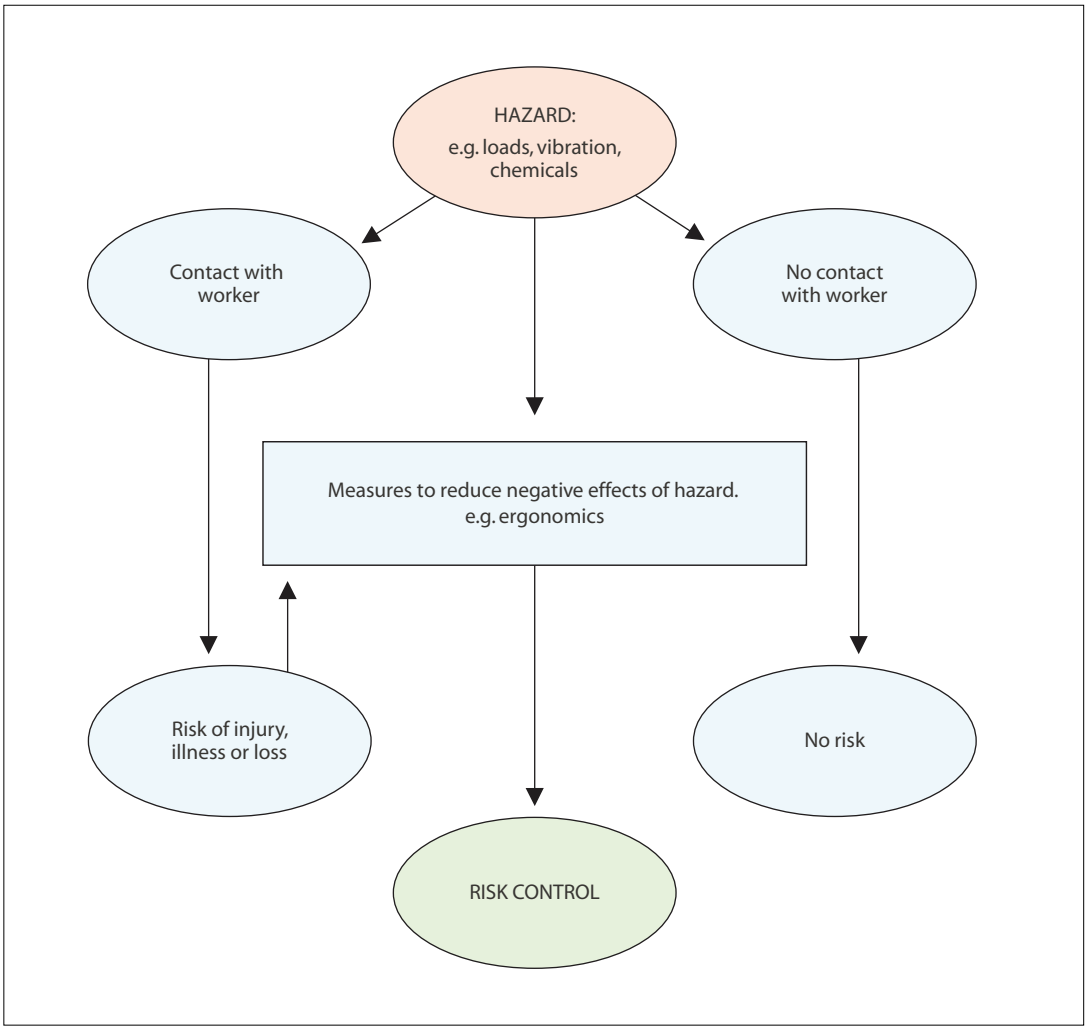


Figure 19 Workplace hazards and their control. *From McPhee 2005*

THE RISK CONTROL PROCESS

HAZARD AND RISK IDENTIFICATION, RISK ASSESSMENT AND CONTROL

A risk management strategy in occupational ergonomics involves identifying work hazards related to poor work design or work processes, assessing them to decide how important each one is and then controlling them by the best means available i.e. finding an 'optimum' solution. It also involves monitoring to ensure that the improvement continues and is successful.

There are many ways to identify potential hazards within the workplace. The common approach in ergonomics and occupational health is through risk identification, assessment and control, (the implementation of basic intervention strategies) followed by monitoring and evaluation of applied solutions.

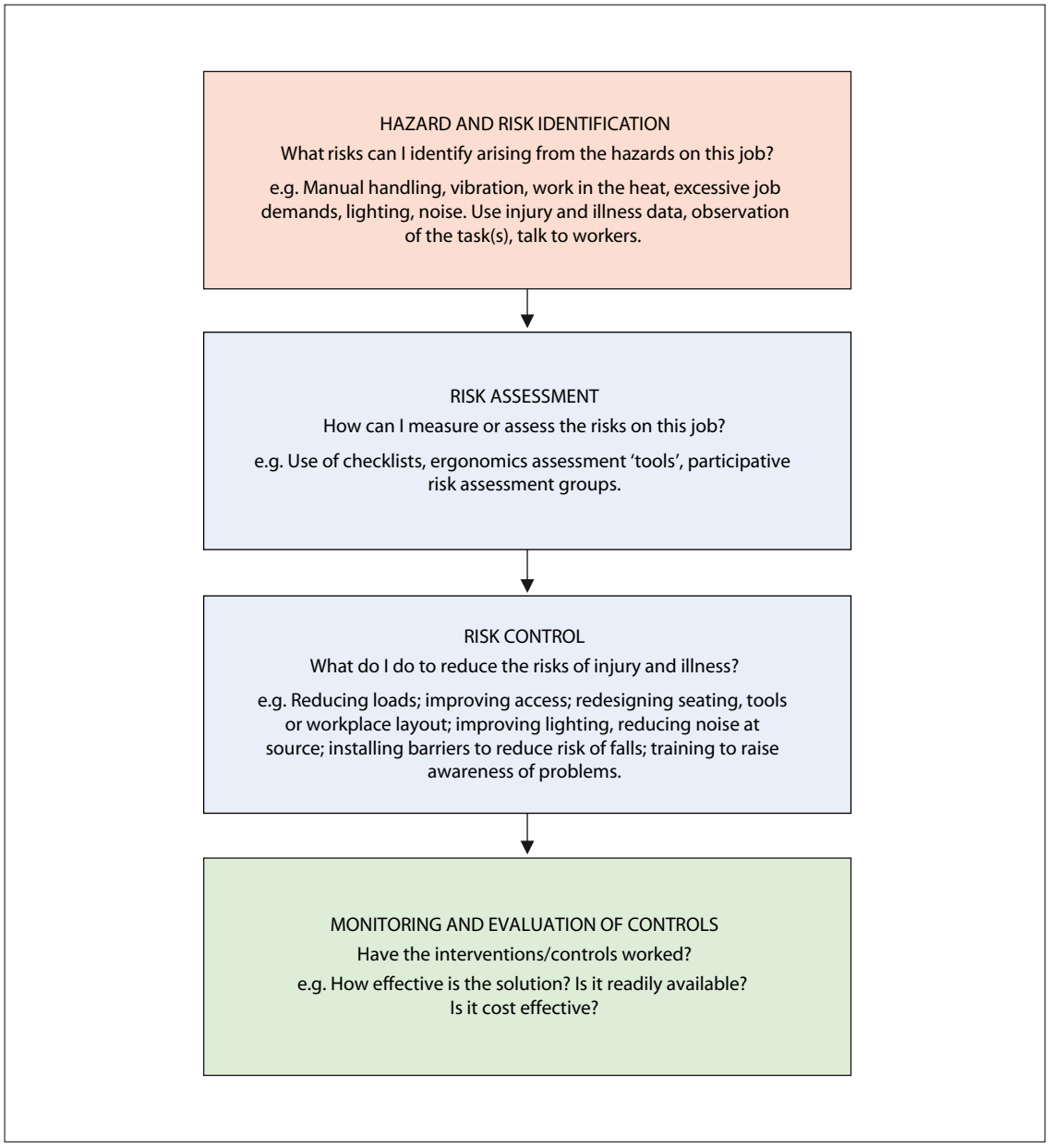


Figure 20 The risk management process.

HAZARD AND RISK IDENTIFICATION

The first step in controlling a hazard or a risk is to identify that it exists either in an industry as a whole or a specific workplace; and which jobs might be affected.

You may start by clarifying which jobs or tasks are associated with complaints, accidents or injuries. Where do workers do these jobs? How often do injuries or losses occur? How severe are the injuries or losses? Are there reports of machinery malfunctioning?

In determining which tasks/activities or situations may be hazardous, and which require assessment, the following sources of information can be used:

Injury records, statistics and other information such as first aid records, records of accidents or near-misses, workers' compensation documents and reports by supervisors and employees must be checked. However, at best this provides a list of past problems and it may not be a true indication of the hazards that currently exist.

Useable information is based on the systematic collection and analysis of information. Without this ergonomics may have little impact or the intervention may be inappropriate.

Consultation with employees such as formal or informal discussions with workers and supervisors on the job, and talking with employees in the health centre.

Direct observation of the workers, tasks and the workplace informally with 'walk-through' general observation and casual inspections. More formally you can make use of tools such as surveys, audits and checklists (such as those included in this manual).

This is called 'triangulation of data' and uses different techniques to validate and consolidate information.

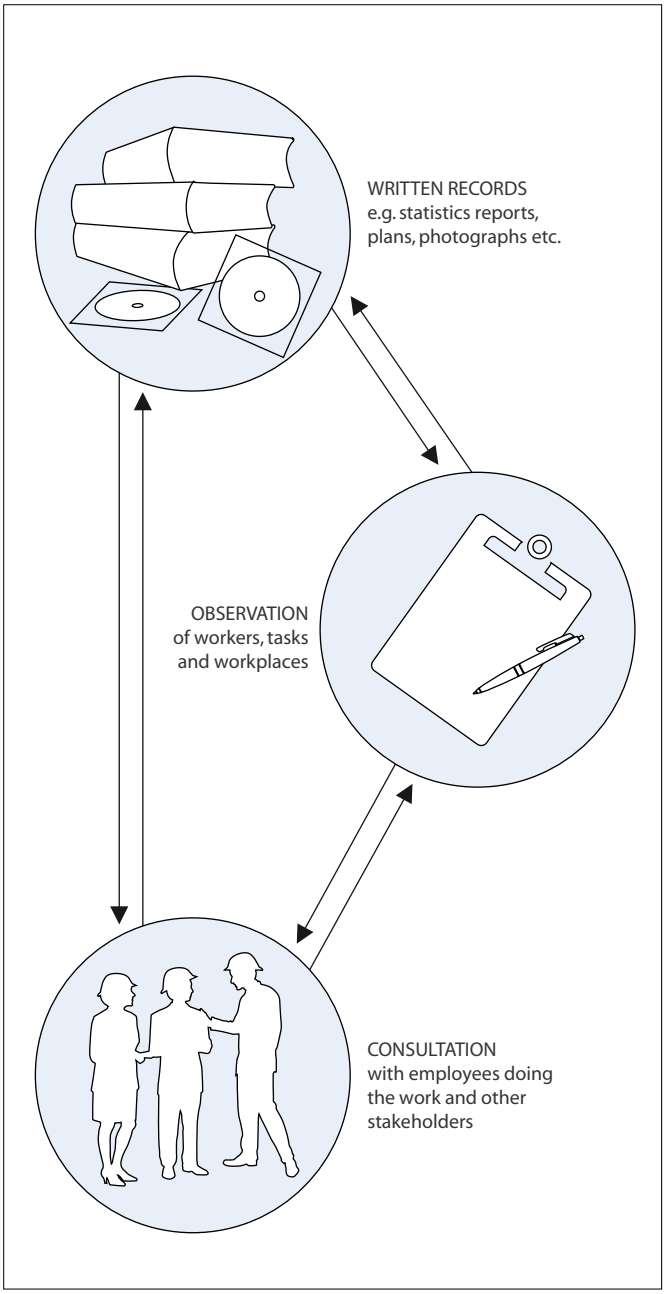


Figure 21 Triangulation of data.

RISK ASSESSMENT TECHNIQUES

Once a hazard has been identified, a risk assessment must be conducted. If there are numerous risks which cannot be dealt with at once, it is important to prioritise areas of greatest need which should be addressed first. To do this it is necessary to determine the possible severity of the hazard and the likelihood of a major problem occurring.

Teams of people do this best as a participatory process. They may be from the areas being assessed or from different areas. The workplace should be surveyed systematically to ensure that no hazard is missed. Hazard and risk identification can be carried out on jobs/tasks, locations/areas, roles/duties or processes.

Risk assessments should highlight:

- **Frequency of the risk** – is the risk common? how many people might be exposed to it? how many people might be effected if exposed?
- **Severity of the risk** – nature of the injuries and losses associated with the risk, cost of injuries/incidents or damage associated with the potential risk.
- **Work and individual factors which might contribute to the risk** – the nature of the task, the load, the work environment, work organisation, training, individual capability.

Risk Assessment is particularly important whenever:

- A work process and/or practice is to be introduced or modified (proactive approach).
- A work process and/or practice causes an injury, discomfort or even pain (reactive response).

The risk assessment will indicate the areas requiring risk control measures and it should be carried out in consultation with those who do the job. The following is an example of a commonly used risk ranking method Workplace Risk Assessment and Control (WRAC) that can be modified for use in ergonomics.

There are many more examples of risk ranking methods, particularly within large organisations, many of which develop their own.

Probability of an unwanted event occurring:

A	Common	**B**	Has happened	**C**	Could happen	**D**	Not likely	**E**	Practically impossible

Maximum reasonable consequence if the unwanted event occurred:

	DESCRIPTOR	PEOPLE	EQUIPMENT/COSTS	PRODUCTION DELAYS
i	CATASTROPHIC	Fatality	**Extensive** – could put the company out of business	More than 2 days
ii	MAJOR	Serious Injury / Illness	**Major** – may take up to a year to recover	1 – 2 days
iii	MODERATE	Lost Time Injury or Illness	**High** – may take several months to recover	6 – 12 hours
iv	MINOR	Injury / Illness requiring medical treatment	**Moderate** – may take up to a month to recover	1 – 6 hours
v	INSIGNIFICANT	First aid or less	**Minor** – may cause disruption for a short while	Less than 1 hour

The identified risks are then ranked according to their likelihood of occurrence and consequence according to the Risk Matrix:

PROBABILITY

CONSEQUENCE	A	B	C	D	E
i	1	2	4	7	11
ii	3	5	8	12	16
iii	6	9	13	17	20
iv	10	14	18	21	23
v	15	19	22	24	25

Probability x consequence

A RISK RANKING OF:

1 to 6 indicates **High Risk**

7 to 15 indicates **Moderate Risk**

16 to 25 indicates **Low Risk**

Figure 22 An example of a risk ranking method.
From CCH/Alara 1994

RISK CONTROL

The best time to do something about hazards is before they cause problems i.e. become risks. It is therefore essential to discuss with the workers involved how they see the situation and what they think could be done to prevent a problem.

It is also important that controls are matched to the level of risk. This is referred to in safety as the 'hierarchy of control'. The first three approaches in the hierarchy are known as 'hard barriers'; the last three are 'soft barriers'.

Hard barriers

1. **Elimination**
   i.e. removal of the hazard/s
2. **Substitution**
   e.g. changing methods, products or components
3. **Engineering controls**
   e.g. reduction through design

Good design of equipment is one way of reducing strain and injuries.

Hard barriers are usually much more effective in reducing real risk and are required where the risks are high and there is the likelihood of a serious injury or fatality.

Soft barriers

4. **Administrative controls**
   e.g. provision of policies and procedures, appropriate training, work breaks, job rotation, warning signs
5. **Personal protective equipment (PPE)**
   e.g. safety glasses, hearing protection, safety instructions

Soft barriers are generally less effective, as they rely on people's adherence to procedures or rules and are subject to error or violation. Compliance with rules and procedures is a major problem in any workplace and each individual must be highly motivated if they are to work effectively.

It is likely that a combination of modifications/adjustments to the task could be effective and often these are very simple. Sometimes a particular solution can be devised to solve a specific problem but often a solution is a combination of small changes.

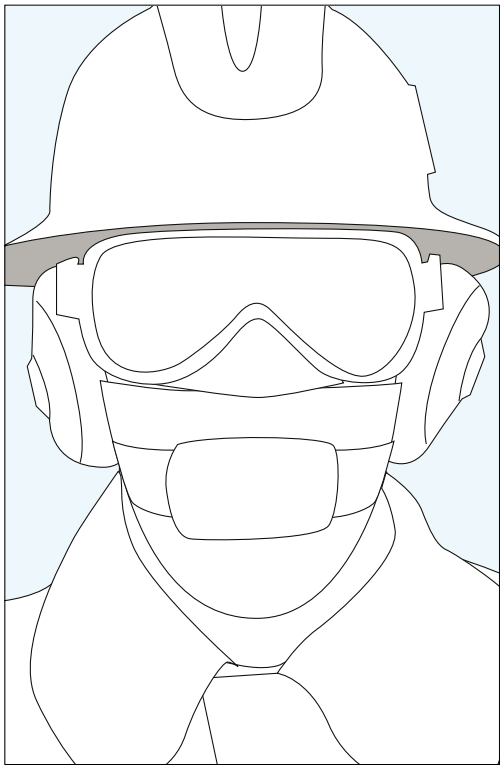


Figure 23 Personal Protective Equipment (PPE) is a soft barrier and necessary where more effective 'barriers' are not feasible. PPE can interfere with work performance and may be uncomfortable to wear.

EDUCATION AND TRAINING

To avoid workers following instructions without question it is important to educate them as to 'why' and not just 'how' they do the job. This is particularly necessary when the work needs to be done in a specified way. They also need to be aware of possible pitfalls and potential problem areas. This is likely to lead to a more "proactive" approach in identifying possible hazards before things go wrong.

6. **Training**
   i.e. awareness raising of health and safety issues, procedures and skills

Training is a soft barrier but necessary at every stage to complement a well designed workplace and efficient systems. It is particularly important for the successful implementation of change.

Sometimes training may be used as a substitute for hard controls, where there is the need for an immediate, temporary solution or where no other method of control is available. However, it needs to be done very well in such circumstances. This training must always include information on why ergonomics is important and the general principles of risk reduction.

Training can modify peoples' perception of risk and sometimes their behaviour but there is much less evidence of success in training people to use a safe method. Therefore, while training is essential for all workers, used on its own, it is likely to be unsuccessful in reducing risks of injury.

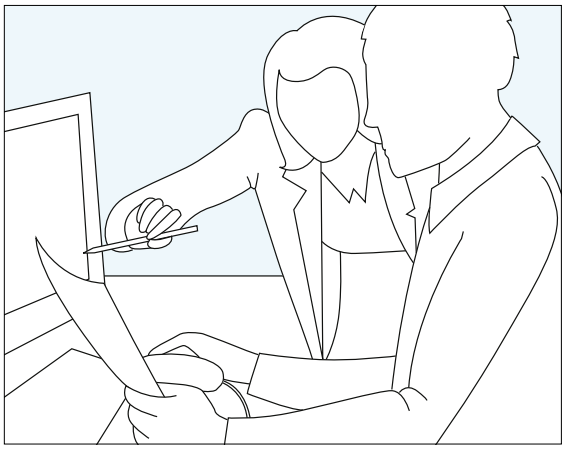


Figure 24 On-the-job training and support are very important especially when implementing change.

Sources of information on solutions:

- The workers who do the job including supervisors and managers
- Manufacturers and suppliers of equipment
- Specialists in particular areas of engineering, ergonomics, health and safety
- Other workplaces that perform the same or similar functions

Intervention strategies

Intervention strategies should be considered in relation to the actual, or potential, size and cost of the problem. It is also necessary to assess the proposed solution in terms of:

- Impact on the problem – does it wholly or partially solve the problem?
- Feasibility of application – is it within the organisation's capacity to implement?
- Availability of a solution – including long-term maintenance implications
- Cost

EVALUATION OF CHANGES

Once changes have been implemented it is essential to have follow-up evaluations in order to assess whether or not interventions have been successful, and if there are any residual problems. Evaluation is important if the benefits, or the lack of them, are to be determined.

All records of the cost/benefit (human and financial costs) of any ergonomics interventions must be kept, and can be used to demonstrate the worth of ergonomics practices to management.

How do you know if a change is working?

Various forms of evaluation can be used, and they need not be complicated.

- Reassess the situation using the same criteria used to identify the problem(s) initially.
- Evaluate the solution at regular intervals as immediate success does not necessarily guarantee that it will remain so, as in most working environments circumstances and/ or workers are constantly changing.
- 'Before-and-after' photographs or videos.
- Checklists or questionnaires can be useful in checking how well the solution is working. Look for reductions in injuries and/or absenteeism and complaints, and check on quality and quantity of the output.
- It may be as simple as asking users what they think, and watching what they do. Information on the effectiveness of the solution may be gathered through informal feedback or discussions with those applying the solutions.
- Informal or structured interviews. Are the workers happy with the arrangements? Could they be further improved? Do they understand why the intervention is an improvement? Are employees adequately trained and could they improve the situation if they had input?

Adoption of solutions from other workplaces can be useful but it is highly probable that the proposed solution(s) will have to be modified to each specific situation. If a solution is applied from elsewhere without assessment of local requirements it may create a problem of its own.

- Assumptions about the benefits of new equipment, tools, furniture or systems of work need to be challenged and tested before they are 'approved for use'. It is important that the people who do the work are involved in any decision-making (consultation).

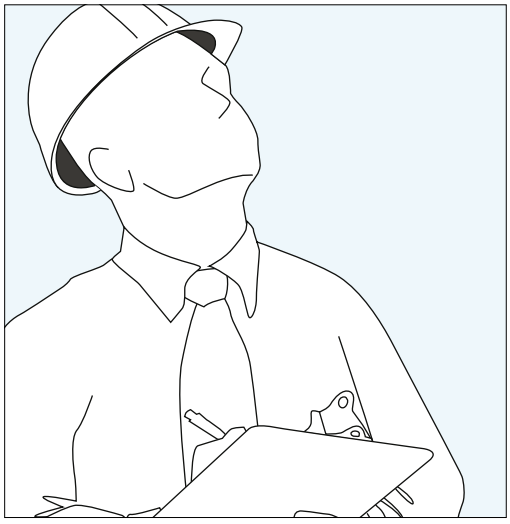


Figure 25 Evaluation of changes should be made regularly. Be honest and supportive to achieve the best outcome.

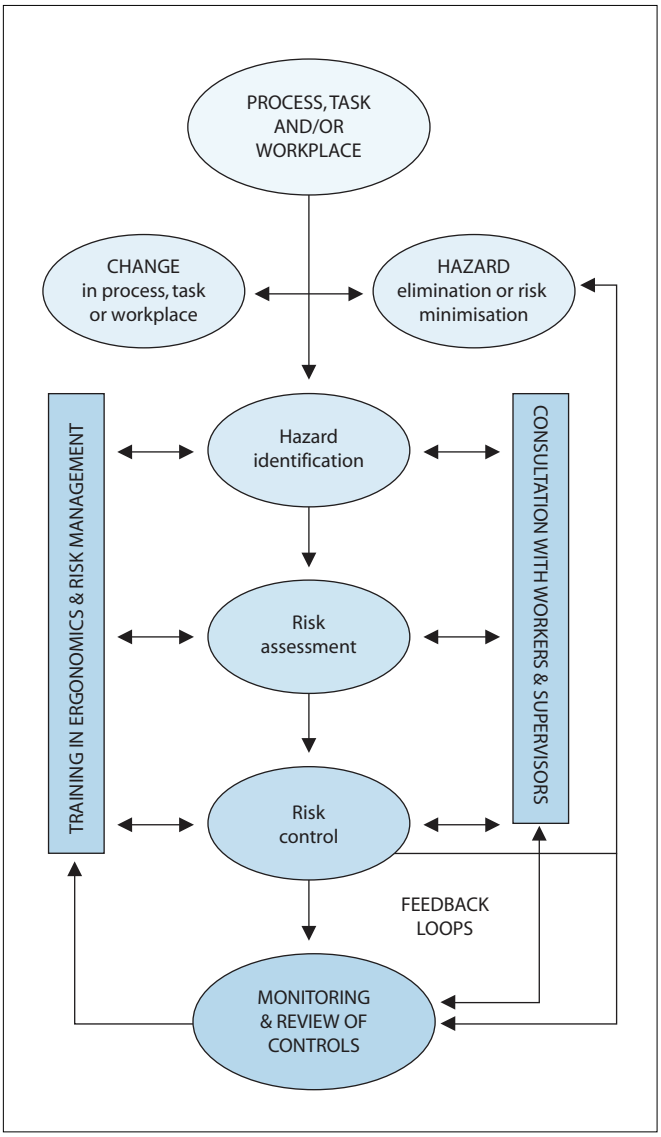


Figure 26 Ergonomics risk management process includes training and consultation. *From McPhee 2005*

To avoid workers following instructions without question it is important to educate them as to 'why' and not just 'how' they do the job.

0.5 PLANNING AND IMPLEMENTING WORKPLACE IMPROVEMENTS

In applying ergonomics improvements in the workplace, it is important to have a general overview of the situation. This is done by collecting basic information in broad terms about the working conditions. Since a number of work problems and risk factors are usually identified in any workplace, it is useful to know how these are related to the general characteristics of the workplace.

SETTING YOUR PRIORITIES

When you have identified your problems, prioritise them and deal with the worst and easiest to correct first. Use practical ergonomics tools such as the Workplace Action Checklist for Ergonomics Improvements in Section 6 to get started.

Guidance is also given in Section 7 (200 Principles in Occupational Ergonomics).

Solutions to problems need not be costly or complicated. There are various low-cost improvements, that are relatively simple and can effectively reduce existing risks.

WORKER PARTICIPATION

The process of managing problems and risk factors is relatively easy to initiate but must always focus on finding appropriate solutions that are acceptable to all involved in the work conducted at the specific work site. At each workplace workers should be encouraged to be actively involved in the process of identifying problems and making suggestions for improvements. Participatory ergonomics is the key to long term improvement. Workers are exposed every day to the situation and have accumulated extensive knowledge and skills about how to reduce the risks. The suggestions from workers can be used to work out feasible solutions and, more importantly, to prevent the likelihood of future problems.

Useful suggestions for feasible improvements can be gained from local good practices found in similar workplaces under similar local conditions and many of these examples are achieved at low-cost. Workers can learn from these and they demonstrate the successful application of basic ergonomics principles.

USEFUL SUPPORT ACTIVITIES

This process of change can be facilitated by actively involving managers, supervisors and workers from the planning stage. Information on good practices and training in participatory steps are particularly helpful in encouraging the process. Occupational health personnel are in a good position to provide support for these activities which incorporate:

- Educational seminars on the principles of ergonomics
- Regular meetings to discuss workplace problems and solutions
- Planning of improvement steps in safety committees and management-worker consultations, working in conjunction with the Ergonomics Facilitation Team
- Reporting good practices achieved in the same and similar workplaces
- Editing and dissemination of brochures showing local improvements
- Training workshops on the use of action checklists and group work for workplace improvement
- Dissemination of improvements achieved locally including photographs of good examples
- Award presentation meetings for commending workplace improvements contributing to safety, health and productivity

GATHERING DATA AND INFORMATION

The results of recent workplace monitoring and questionnaire surveys can be utilised if they are available. Types of information useful for undertaking an overview of problems in the workplace may include the following:

- Frequency and types of work-related accidents
- Frequency and types of work-related health problems

- Observations and complaints of worker fatigue
- Results of work stress surveys
- Results of monitoring the work environment
- Complaints of workers about working conditions and work environment
- Workplace problems identified by managers and workers

There are practical action-oriented manuals published for the purpose of learning low-cost types of ergonomics improvements applicable to many workplaces.

There are also a number of websites where we can look at similarly useful practical examples of ergonomics improvements. Some of these are listed in Section 9. The ILO publication "Ergonomic Checkpoints: Practical and Easy-to-implement Solutions for Improving Safety, Health and Working Conditions" ILO (1996, 2009) is very useful.

In this manual, there are 128 checkpoints describing **why** they are important and **how** to implement low-cost improvements followed by suggestions and useful hints. Illustrations in the manual are very helpful.

DEALING WITH PRACTICAL ISSUES

The process of managing change is very important in implementing the proposed improvements in any workplace. It is necessary to fully involve managers, supervisors and workers from the workplace. This is best done by providing practical advice about existing good practices and about how to plan and implement the necessary changes. In addition to the content of the changes to be made, advice should be provided about how to proceed with the change process. Typically, participatory processes need to be guided by this kind of practical, action-oriented advice.

In the planning and implementation of workplace improvements the steps taken aim at following the principles of managing change. These principles are listed in Section 7.

TEN TIPS FOR SUCCESS

1. **Start in a small way** and get some successful efforts underway – success breeds success.
2. **Start with problems that have simple solutions**, so that you are able to demonstrate immediate success and its benefits.
3. If you do not understand why the worker has a problem, or if you are not sure whether there is a problem, try to **watch the work carefully and interview the worker**. You may even do the work and try to experience it yourself as long as it is safe for you to do so.
4. **Focus on low-cost solutions** to secure support from both managers and workers.
5. **Select people to cooperate with you** who show initiative, work hard and are keen to achieve change (we sometimes call these people 'champions'). This group could form the basis of the Ergonomics Facilitation Team (EFT).

6. **Encourage joint effort** with people who are respected in the workplace by both managers and workers.

7. Make sure that managers and supervisors as well as workers are **actively involved in planning the change** and that there is something in it for everyone.

8. Make sure that **everyone involved gets credit** for the change. This always helps when you go back or try to solve similar problems.

9. Always obtain some **senior manager's support** for and commitment to your proposals. Very little will be achieved without this support.

10. **Encourage active and open evaluation of changes.** Try to confirm both benefits and remaining problems by inviting people to express their frank opinions. Motivate them to look at their work honestly and facilitate and encourage ongoing improvements.

EXAMPLES OF WORKPLACE PROBLEMS IDENTIFIED AND SOLVED WITH LOW-COST INTERVENTIONS

Examples of ergonomics improvements are listed below. These examples may serve as useful hints in the participatory steps toward planning and implementing sound ergonomics principles at work. As part of the participatory steps for planning, the Workplace Action Checklist in Section 6 can be used in organising walk-through assessments and subsequent group discussion.

REDUCE MATERIALS HANDLING BY USING A MODIFIED TROLLEY

Problem:
The manual handling of materials required placing and removing them on to and off a low trolley that increased muscular strain experienced by the workers due to frequent bending posture.

Solution:
The position of materials was raised and this made the handling work easier and safer.

Problem.

Solution.

USE OF A PALLET AND A LIFT

Problem:
Forward bending and stooping postures were frequent in handling materials from a pallet. The main problem was the low level of the pallet, which required a strenuous effort to lift boxes from the floor level pallet and place them on the stacking platform.

Solution:
A simple hydraulic lift system made "in-house" minimized the need for excessive stooping.

Problem.

Solution.

USE OF A CONVEYOR BELT

Problem:
Repeatedly carrying objects to higher levels.

Solution:
Conveyor belts made on site.

Simple 'made-in-house' conveyor belts to carry goods to a higher level.

A SIMPLE MATERIAL-FEEDING DEVICE

Problem:
Feeding of materials to a sewing machine caused concern about materials damage and posed a tripping hazard for people passing behind the machinist.

Solution:
A simple material feeding device placed over the head of

the operator not only eliminated these concerns but also increased productivity.

Problem.

Solution.

USE OF A LOWER SIDE STAND FOR ELBOW-HEIGHT WORK

Problem:
Meat cutting operations were unsafe due to a meat-cutting machine placed on a high work table.

Solution:
A lower side stand for the machine made it possible to cut meat at the appropriate work height at elbow level.

Problem.

Solution.

SKYLIGHTS FOR BETTER USE OF DAYLIGHT

Problem:
A storage area of a wood-working factory was dark and not suitable for materials handling work.

Solution:
Skylights installed on the roof made the area bright enough without an increase of electricity bills.

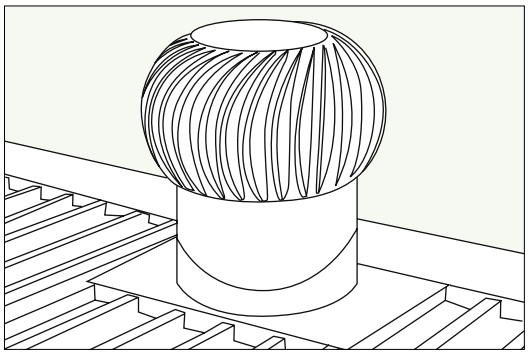
Problem.

Solution.

HOT WORKING AREA

Problem:
Unacceptably hot working conditions under an iron roof.

Solution:
"Whirly birds' inserted in the roof and fans reduced the temperature to an acceptable level.



Solution: 'Whirly Bird' roof ventilation.

NEWLY ARRANGED EATING PLACE

Problem:
Workers used to take their lunch within their work area. Meals could be contaminated by dust and the lunch break was not restful enough.

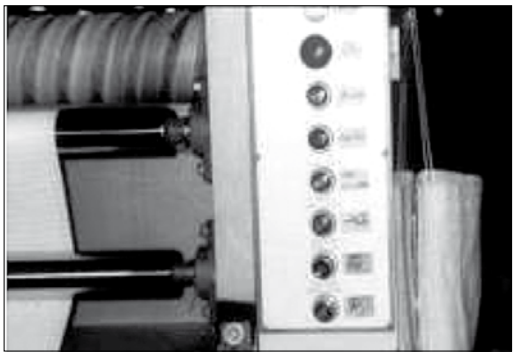
Solution:
A new eating place was created outside the work area by converting a storage area. Bringing in new tables and benches, workers could have a comfortable and restful lunch break.

Problem.

Solution.

Other examples of improved materials handling using a push-cart or multi-level adjustable shelves.

Improved access to materials using a tilt stand.



Use of local language labels for switches.

Machine guarding helps to protect workers from moving parts that could severely injure or kill them.

A resting corner for refreshment during a break.

Once changes have been implemented it is essential to have follow-up evaluations in order to assess whether or not interventions have been successful.

0.6 USEFUL TOOLS FOR IMPLEMENTING WORKPLACE IMPROVEMENTS

COLLECTING BASIC INFORMATION ABOUT THE WORKPLACE

Observation of the tasks and the work being done is essential to know the types of workplace problems that need to be solved in order of priority. This is done in conjunction with ergonomics risk management explained in Section 4. Consultation with managers and workers is always necessary in this process.

Where workers have special needs attributable to such factors as as age, reduced work capacity or disability, these should not be a barrier to doing the work. As far as possible, design the tasks to meet individual capabilities and limitations. Consider the following worker characteristics:

- Age
- Physical fitness
- Aptitude
- Work experience
- Education level and training for the job
- Problems reported about work life or away from work that may effect health or safety
- Restrictions concerning physical and mental capabilities
- Individual capability

Based on the results of an initial overview of workplace problems and the results of ergonomics risk assessment, workers and supervisors can progress to the planning and implementation of workplace improvements based on sound ergonomic principles.

Take the following basic aspects of the workplace into account:

- Work tasks including physical and mental load (what workers do)
- Workplace including tools and other equipment (what workers use to do their work)
- Work environment including heat/cold, noise, fumes (where workers work)
- Work organisation (the broader context of their work)

Complete this overview by using the first chart in this Section. By observing the work in consultation with the workers the aspects requiring further assessment and immediate improvements can be checked.

This questionnaire is an example of how you might start gathering information about mismatches between people and their work. It can be self-administered or can be used as the basis for an interview either on-the-job or at the Health Centre for each worker.

WORKER'S COMMENTS ON HER/HIS JOB

The health team (or the Ergonomics Facilitation Team once it has been established) would like to know which jobs are causing problems for employees.

Our first step is to ask you for some indications of problem tasks.

We would like you to fill out this questionnaire with regard to work tasks that you perform.

Name (Optional): _____

Work Group: _____

Work Area: _____

	Please Tick
1. Do you ever feel tired or fatigued when performing jobs or tasks (parts of jobs) at work? If yes, please outline the particular tasks: _____ _____ _____	Yes ☐ No ☐
2. When performing tasks at work do you ever feel pain or discomfort? If yes, please outline the particular tasks: _____ _____ _____	Yes ☐ No ☐
3. Do you find that you have to adopt any work postures/ positions that are awkward and/or make tasks more difficult? If yes, please outline the particular tasks: _____ _____ _____	Yes ☐ No ☐
4. Do you find that difficult access to any workplace makes a task awkward to perform? If yes, please outline the particular tasks: _____ _____ _____	Yes ☐ No ☐

5. What jobs or tasks would you change if you could? Please list jobs/tasks:

_____

_____

_____

6. Please list below the top 5 most strenuous/difficult/ dangerous tasks that you perform, how often you perform these and the time it takes to complete the job:

a. _____
_____

b. _____
_____

c. _____
_____

d. _____
_____

e. _____
_____

7. Any further comments...

_____

_____

_____

_____

_____

_____

_____

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_____

_____

THANK YOU

CHART FOR OBTAINING AN OVERVIEW OF THE TASK

Task: _____

Location: _____

Person doing assessment: _____

Date: _____

Element	Issues	No problem observed or noted by workers or observers	Needs further assessment
Work task	1. Actions and movements		
	2. Working posture and position		
	3. Location of loads and distances moved		
	4. Duration of the task		
	5. Repetition of the task		
	6. Sustained attention or monotony		
	7. Matching with worker experience		
Comments			
Work load	1. Suitability of equipment used		
	2. Physical and muscular load		
	3. Mental and psychological load		
	4. Potential over-working		
Comments			
Work environment	1. Space, access and workplace layout		
	2. Hazards particular to the work environment, e.g. uneven floors, poor visibility, temperature, air quality, noise		

Element	Issues	No problem observed or noted by workers or observers	Needs further assessment
	3. Need for personal protective equipment (PPE)		
	4. Need for special devices		
Comments			
Work organisation	1. Working time arrangements		
	2. Work flow and availability of materials		
	3. Adequate number of workers to complete the task on time		
	4. Availability of assistance for particularly heavy or stressful tasks		
	5. Effective procedures for reporting and fixing difficult or unsafe conditions		
Comments			
Individual capability	1. Physical and mental capabilities		
	2. Age and associated changes		
	3. Education and skills		
	4. Training for the task		
	5. Special needs including disability		
Comments			

Record any issues marked "Need for further assessment" and organise a risk assessment involving the group of ergonomics facilitators.

The purpose of the discussion is not to plan and implement ergonomics improvements directly but to discuss the types of workplace problems and risks that require immediate attention.

Follow this by the participatory planning and implementation of ergonomics principles.

WORKPLACE ACTION CHECKLIST

This action checklist for improving the workplace is useful in assessing the workplace and proposing immediate improvement actions. The attached checklist presents practical low-cost improvements that you can apply at the workplace. All the items in the checklist are presented in the 'action' form. These items have been selected based on recent experiences in applying the WISE (Work Improvement in Small Enterprises) methodology developed by the ILO.

The listed actions therefore represent the most commonly used low-cost improvements to working conditions in small and medium-sized enterprises. They correspond to basic ergonomics principles and cover common areas of materials handling, workstation design and teamwork environment.

Numerous improvements have been reported from many countries as a result of applying the WISE and similar methods. The attached checklist is a brief summary of the frequently reported improvements. Additional check items may be added by the users of the checklist by taking into account the local situation in each working environment. Occupational health staff can assist in doing this.

GROUP DISCUSSION BASED ON THE CHECKLIST RESULTS

Use this checklist for assessing the existing workplace conditions from an ergonomics point of view. The checklist is suited for joint inspection rounds of a workplace and for subsequent group discussion. Occupational health staff members should be encouraged to participate in the inspection team. For example, after conducting a joint inspection of the workplace the members of the inspection team can discuss both existing good practices and necessary improvement actions based on the checklist results. Managers, safety committees, worker representatives and people responsible for improving working conditions can then consider the results.

ERGONOMICS FACILITATION TEAM (EFT)

Once an EFT has been formed within a company/factory this Checklist is an ideal "tool" for the group to use.

The commonly used participatory steps using an Action Checklist is shown below.

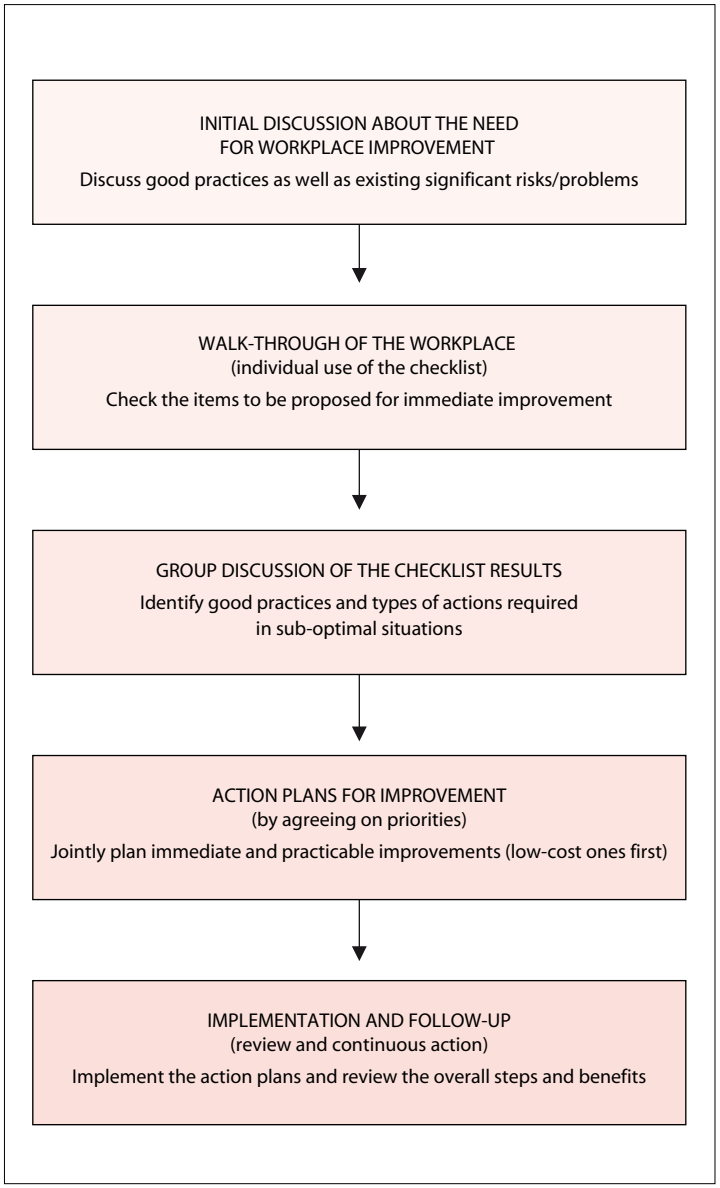


Figure 27 Participatory steps for using a workplace checklist for planning and implementing improvements.

WORKPLACE ACTION CHECKLIST FOR ERGONOMICS IMPROVEMENTS

This checklist is a list of practical ways for improving workplace conditions related to safety and health of workers. It is easy to implement. The checklist is useful for organising group discussions about identifying areas in need of improvements.

How to use the checklist

a. Define the work area to be checked. In the case of a small enterprise, the whole production area can be checked. In the case of a large enterprise, particular work areas can be defined for separate checking.

b. Spend a few minutes walking around the work area before starting to check.

c. For each item, look for a way to apply the improvement. If the measure has been applied or it is not needed, mark NO under "Do you propose action?" If you think the improvement would be worthwhile, mark YES. Use the space under REMARKS to put a description of its location and your suggestions.

d. After you have gone through all items, choose a few items where the benefits seem likely to be the most important. Tick PRIORITY for these items.

e. If you find other good points and points to be improved, write them in the margins

Workplace: _____

Checker: _____

Date: _____

A. Materials storage and handling	Do you propose action?
1. Clear and marked **transportways**	Yes ☐ No ☐ Priority ☐
2. Provide **multi-level racks** near the work area for materials, tools and products	Yes ☐ No ☐ Priority ☐
3. Use **carts, hand-trucks, mobile racks** and other wheeled devices when moving materials	Yes ☐ No ☐ Priority ☐
Remarks	
4. Provide a conveniently placed **"home" for each tool**	Yes ☐ No ☐ Priority ☐
5. Use **lifting devices** or lift-trucks for lifting heavy materials	Yes ☐ No ☐ Priority ☐
6. Provide **good grips** or holding points for all containers and packages	Yes ☐ No ☐ Priority ☐
Remarks	

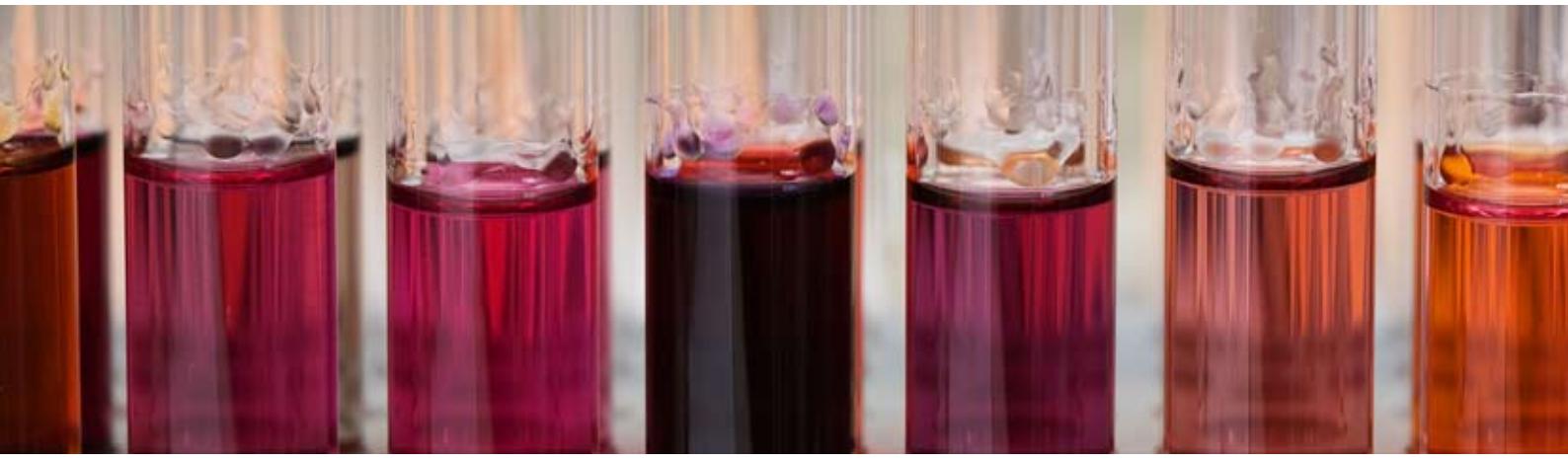
B. Workstations	Do you propose action?
7. Adjust **working height** at elbow level (if necessary, use foot platforms for small workers and work item holders for tall workers)	Yes ☐ No ☐ Priority ☐
8. Put frequently used materials, tools and controls within **easy reach** of workers	Yes ☐ No ☐ Priority ☐
9. Use **clamps, jigs and other fixtures** to hold items while work is done	Yes ☐ No ☐ Priority ☐
10. Use **hanging tools** or conveniently fixed tools for operations repeated at the same place	Yes ☐ No ☐ Priority ☐
Remarks	
11. Attach simple-worded **labels** (in the local language if required) and use **colours** so as to avoid mistakes	Yes ☐ No ☐ Priority ☐
12. Provide **good chairs** of correct height (with both the feet placed on the floor) and with a good backrest	Yes ☐ No ☐ Priority ☐
13. **Alternate sitting and standing** by assigning multiple tasks for each worker	Yes ☐ No ☐ Priority ☐
14. Set up a small stock of unfinished products **(buffer stock)** between different workstations in order to allow self-paced work	Yes ☐ No ☐ Priority ☐
Remarks	

C. Physical environment	Do you propose action?
15. Add **skylights** and high **windows** or re-position **lamps** for better lighting	Yes ☐ No ☐ Priority ☐
16. Relocate light sources or provide partitions to **eliminate direct or reflected glare**	Yes ☐ No ☐ Priority ☐
17. Provide **local task-lights** for precision and inspection work	Yes ☐ No ☐ Priority ☐
18. Increase the use of natural **ventilation** to improve the indoor climate	Yes ☐ No ☐ Priority ☐
19. **Isolate or insulate noisy equipment**. Provide workers with adequate hearing protection if noise cannot be controlled	Yes ☐ No ☐ Priority ☐
Remarks	

20. Attach proper **machine guards** to avoid contact with moving parts of machines	Yes ☐ No ☐ Priority ☐
21. Use **safety or interlocking devices** which prevent operation when the hands are in danger	Yes ☐ No ☐ Priority ☐
22. Make **emergency controls** clearly visible and easy to reach and operate	Yes ☐ No ☐ Priority ☐
Remarks	
23. Isolate or screen **hazard sources**, like heat, noise, dust or hazardous chemicals	Yes ☐ No ☐ Priority ☐
24. Ensure safe **wiring connections** for supplying electricity to equipment	Yes ☐ No ☐ Priority ☐
25. Provide at least two **unobstructed ways out** of every floor or every big room and make sure that workers know how to evacuate in an emergency	Yes ☐ No ☐ Priority ☐
Remarks	

D. Welfare facilities	Do you propose action?
26. Provide an adequate supply of cool, safe **drinking water** in all work areas	Yes ☐ No ☐ Priority ☐
27. Provide **hygienic and regularly cleaned toilets** and washing facilities close to the work area	Yes ☐ No ☐ Priority ☐
28. Provide quieter **resting corners**, away from work areas, with comfortable sitting arrangements and refreshing drinks	Yes ☐ No ☐ Priority ☐
Remarks	
29. Provide **first-aid equipment** and ensure qualified first-aiders are available wherever possible	Yes ☐ No ☐ Priority ☐
30. Provide enough **fire extinguishers** within easy reach at all work areas	Yes ☐ No ☐ Priority ☐
31. Provide opportunities to take **short breaks** when working on repetitive or arduous tasks	Yes ☐ No ☐ Priority ☐
Remarks	

E. Additional check items	Do you propose action?
Add a few check items corresponding to locally practicable actions important for improving ergonomics conditions of the workplace. These items may be added through group discussion by key persons or the members of the Ergonomics Facilitation Team. Make sure each item is described in the action form.	
32. Additional item:	Yes ☐ No ☐ Priority ☐
33. Additional item:	Yes ☐ No ☐ Priority ☐
Remarks	
34. Additional item:	Yes ☐ No ☐ Priority ☐
33. Additional item:	Yes ☐ No ☐ Priority ☐
Remarks	



SUGGESTIONS FOR WORKPLACE IMPROVEMENTS BASED ON GROUP DISCUSSION

The group of people participating in the workplace improvement process can discuss the results of applying the checklist. The group discussion should suggest the implementation of priority improvements at the workplace assessed. One to three improvements may be suggested. You may wish to use the following table for summarising the suggested improvements.

Priority order	Work tasks examined	Suggested improvement(s)	Person(s) responsible	Date of completion	Estimated cost

In general, practical steps can be taken for planning and implementing ergonomics improvements in any workplace.

0.7 TWO HUNDRED PRINCIPLES OF OCCUPATIONAL ERGONOMICS

ANTHROPOMETRY (BODY SIZE)

1. Consider differences in users' body size in the design of the workplace. Allow for different sized users where the fit between the equipment and user is critical.
2. Decide beforehand if you need to accommodate people in the extremes of body size range and make special provision for these people in the design of the workplace. When in doubt measure the standing height of your working population to determine roughly the range of sizes that you may need to consider. Use the appropriate anthropometric tables for specific populations.
3. Commercially available anthropometric tables are useful as a guide when designing work, workplaces and equipment but they should be interpreted with care bearing in mind the user population.

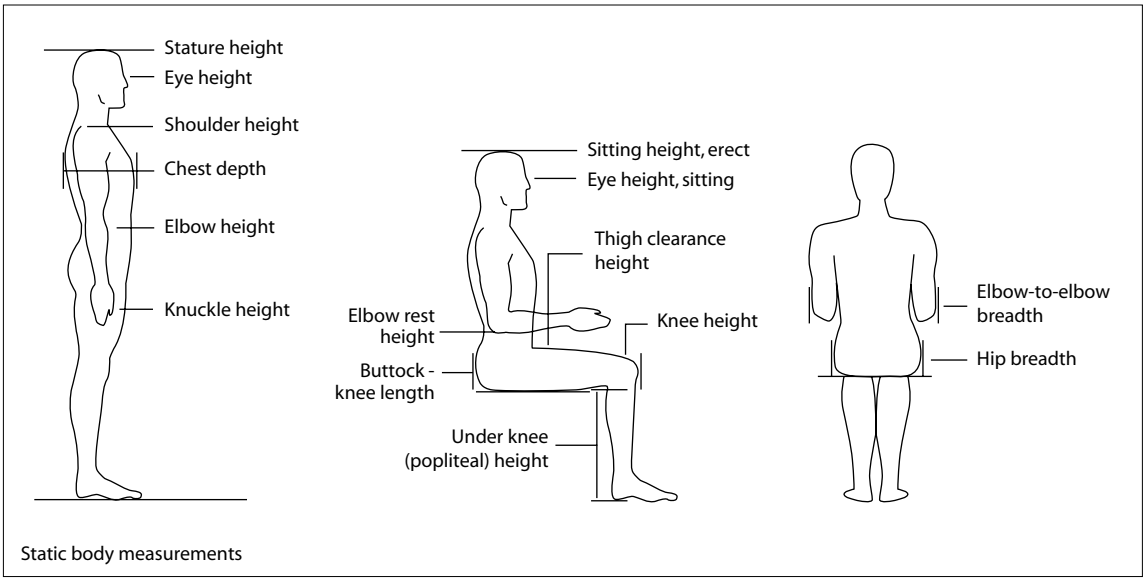


Figure 28 Consider differences in body size when designing workplaces and tasks. People who do the work should be your guide. These are some of the dimensions that are important in different types of work.

POSTURE AND MOVEMENT

4. Human physical performance is optimum when postures and movements are dynamic and varied.
5. In general the human body moves and works most efficiently when joints are in the neutral (mid) range and the muscles are around mid length. Strain can occur if joints are held in more extreme positions over extended periods.
6. Static muscle work tends to be more tiring than active muscle work even though the latter uses more energy. Most stabilising postures involve static muscle work and this restricts the natural blood flow.
7. The arms and shoulders are capable of highly skilled and precise movements but they are not strong and are subject to injuries when exerted excessively or for a sustained period. Shoulders are particularly flexible but can be unstable in certain positions. The lower limbs have more robust muscles for strength.
8. The spine can meet two competing physical requirements – rigidity and plasticity but this comes at a cost, which is to compromise strength. It is therefore prone to injury when stressed.

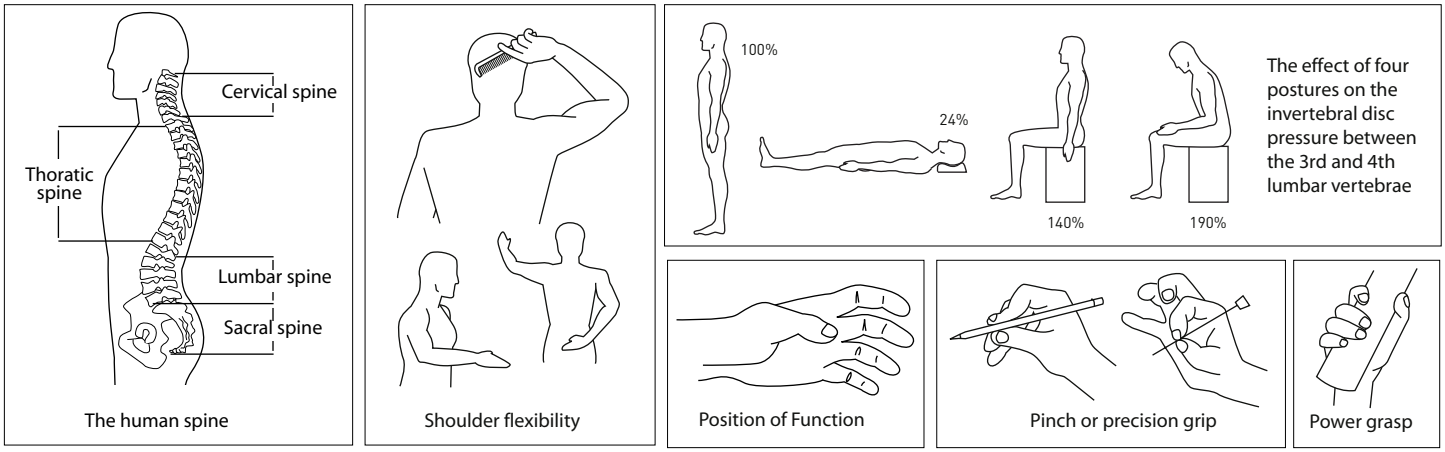


Figure 29 The functions of the hands, arms and spine give humans great dexterity and flexibility. However, this comes at a cost, which is strength. When severely overloaded joints and muscles suffer strain and may take weeks or months to heal. When there is slight overload for long periods injuries may develop slowly. Over the long term injuries that do not heal properly become chronic and impair a person's ability to work.
Adapted from Kapandji 1973 and Grandjean 1988

PHYSICAL WORK LOAD

9. Avoid sustained periods or frequent repetitions of physically strenuous tasks. Limit energy expenditure in a task to a reasonable level. A reasonable average maximum is about 1300KJ/hr for an 8 hour day.

10. Limit duration of continuous muscular effort. This is especially necessary in physically demanding tasks, repetitive work and work in the heat.

11. Avoid work in fixed or awkward postures. Also avoid prolonged repeated work using the same muscle groups.

12. Incorporate frequent short breaks in the work rather than a single long one.

13. Vary tasks, postures and movements as much as possible.

14. Avoid sudden peak forces and sudden or jerky movements.

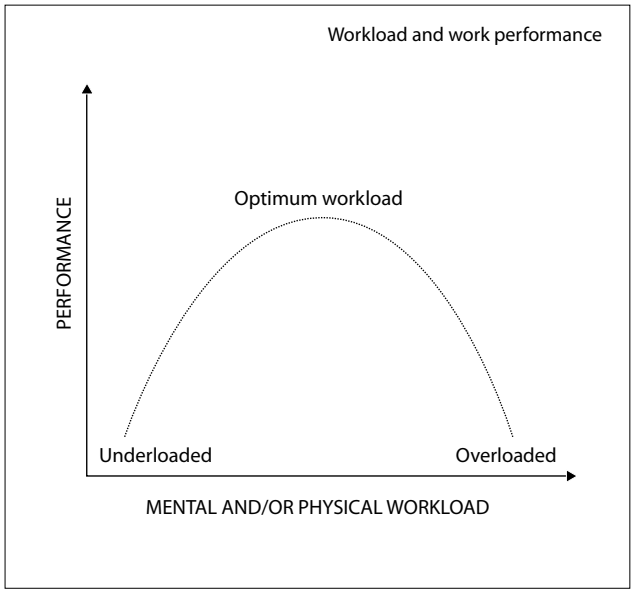


Figure 30 Human performance is best when people are working within the mid range of their capacity – neither overloaded nor underloaded. Individuals themselves usually can estimate this range quite accurately when there are no modifying external pressures.

MENTAL WORKLOAD (INFORMATION PROCESSING AND DECISION MAKING)

15. Ensure the workers' skills and abilities match the work demands.
16. Vary tasks to avoid prolonged work on monotonous tasks or highly concentrated tasks.
17. Incorporate appropriate rest breaks even for sedentary tasks especially when they are repetitive or demand sustained keen attention.
18. Ensure the work environment is optimal for the tasks to be completed. Avoid environmental hazards such as poor lighting, glare, excessive noise or temperature.
19. Avoid confusing or complex displays of information.

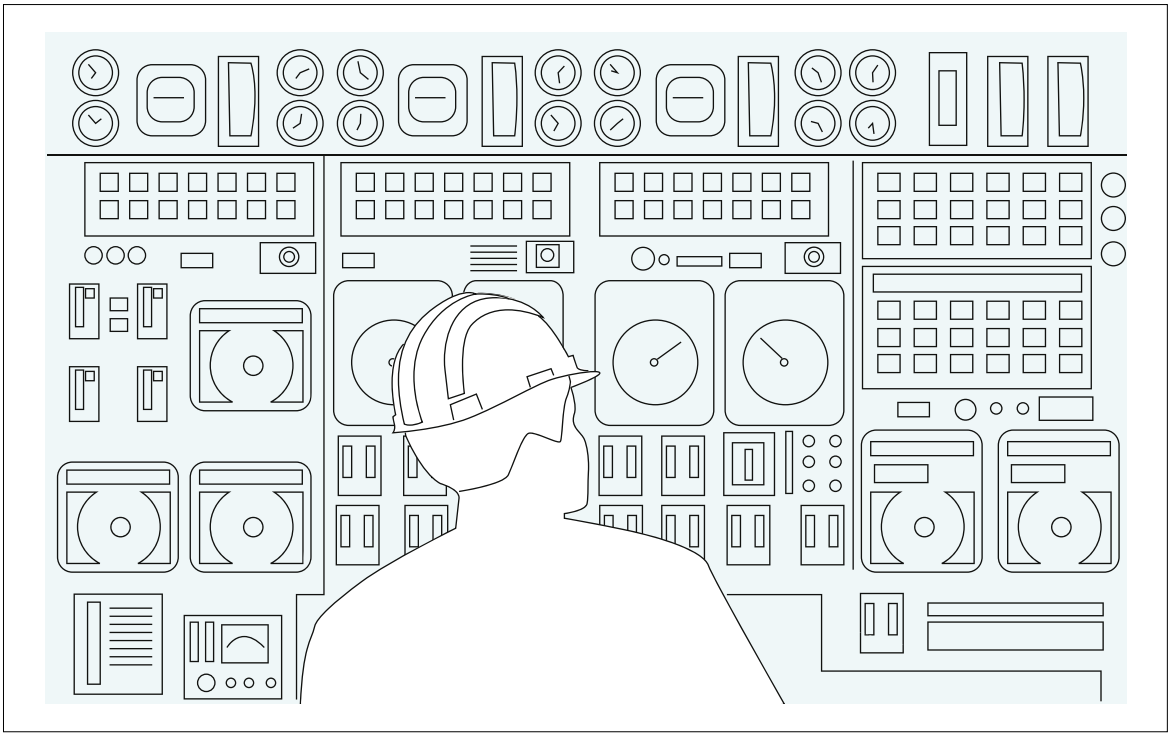


Figure 31 Errors can occur in simple or complex tasks. Design equipment and systems to reduce the likelihood of errors.

HUMAN ERROR

20. Acknowledge that all humans make errors.

21. Understanding the types of human error is important when designing work so that the frequency of errors is reduced and the consequences of making errors is minimised.

22. Education, training and proper design are key factors that help decrease the impact of human error at work. Proper design to avoid mistakes, such as appropriate colour coding and easy-to-read labels, is particularly important.

23. Employ early detection systems to ensure errors are identified promptly so remedial action can be taken before something goes wrong.

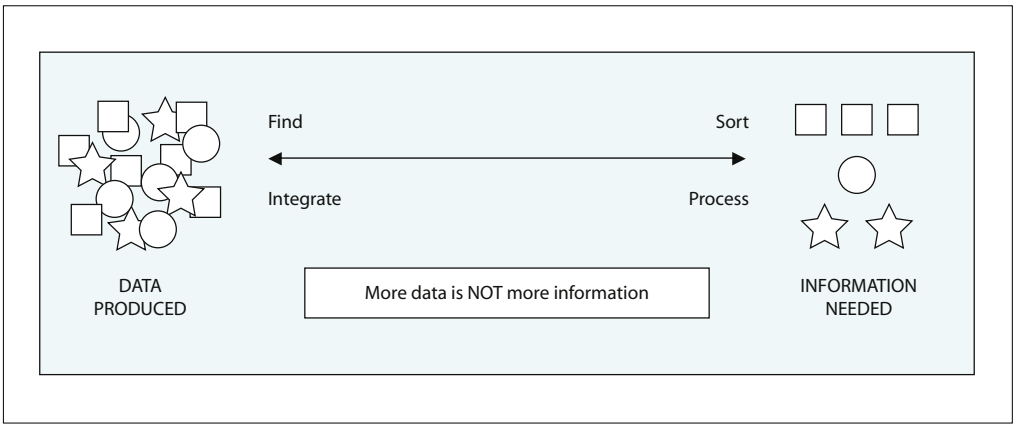


Figure 32 Human Error: errors can occur more often when information is confusing or obscure. *From Ellicott 2008*

MOTIVATION

24. Different people are motivated in different ways. It is important to match the work tasks with individual capabilities, education, training levels and preferences.

25. Workers should be consulted regarding any improvement strategies. These strategies should not compromise health and safety.

26. Vary tasks and responsibilities, increase autonomy and provide positive and constructive feedback to counter low morale.

STRESS

27. Stress due to work tasks that are too demanding or lacking control by workers can have a negative effect on work performance, health and well-being.

28. Symptoms of stress may be both psychological and physical.

29. Interventions to decrease stress may involve changing work organisation or the work environment and improving a worker's ability to manage stressors.

FATIGUE

30. Fatigue is a normal part of most work, but excessive fatigue needs to be avoided by appropriate job design. A tired person has to put in more effort to achieve the same amount of work as someone who is not tired. Tired people are more likely to be slower and make more errors.

31. Regular rest periods are necessary to help prevent the onset of fatigue. The length of the rest periods depends on many factors such as the intensity of the work, environmental conditions and the age and capabilities of the worker.

32. Sub-optimal personal, organisational, and environmental factors and ergonomically poor design of equipment can induce feelings of fatigue. It is necessary to identify key factors, such as poor sleeping arrangements, night work, working in the heat, and using equipment that is not 'fit-for-purpose'.

33. People need to recover from mental and physical effort. Work schedules and rest arrangements need to be appropriate.

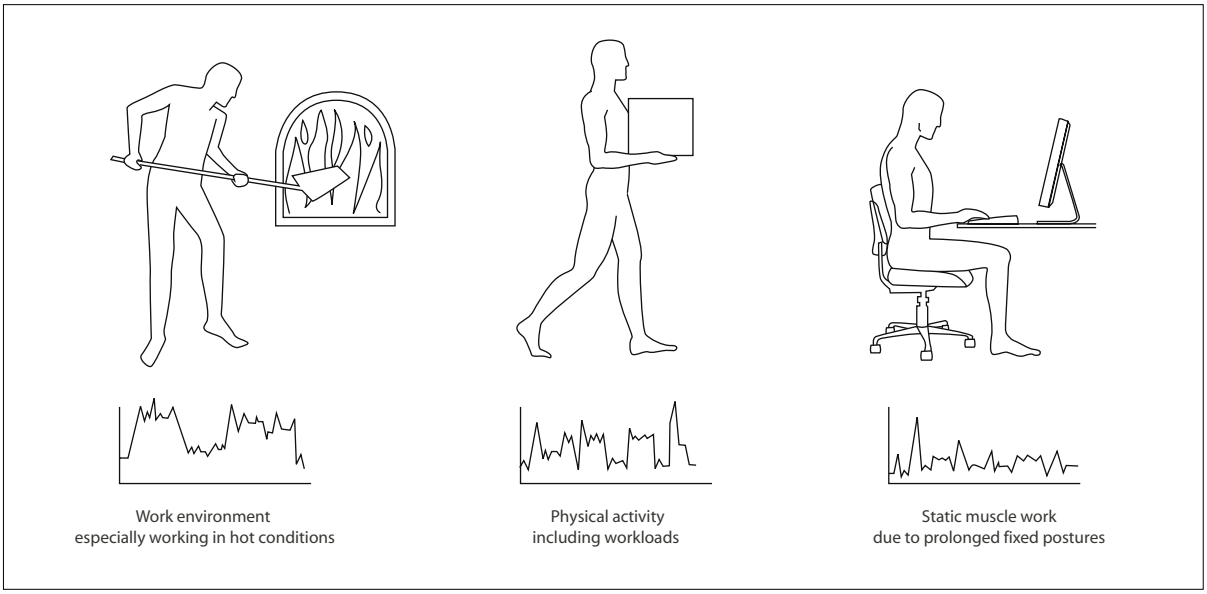


Figure 33 Physical and mental workload can be measured in many ways. Heart rate is one simple method.

OLDER WORKERS

34. A lifetime's acquisition of knowledge, experience in procedures and expert skills often compensate for physiological and physical limitations in older workers.

35. Older workers may not work as quickly as younger workers in stressful working conditions such as those induced by noise and sleep deprivation particularly if they are taking medication.

36. Design of tasks and organisation of work should be modified to accommodate any limitations older workers may have.

37. Older workers need and appreciate consultation and specific and careful training in new tasks especially those related to computer-based systems.

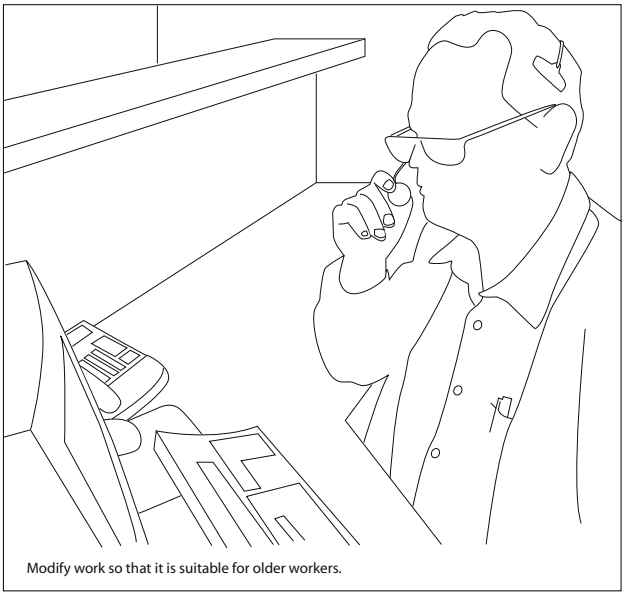


Figure 34 Older workers usually need to wear corrective spectacles and may have hearing difficulties. Physically their work capacity is reduced especially if they have arthritic changes due to heavy work in the past. Retraining requires careful consideration of their capabilities and supportive supervision.

PEOPLE IN SYSTEMS

MANAGING CHANGE

38. All work problems need to be addressed within the context of the wider work system.

39. Successful change requires vision, careful planning with firm and on-going commitment by senior and middle managers, workers and other stakeholders. Otherwise, the change process will be less successful or may fail totally.

40. Local problems need local solutions. It is useful to learn from good examples

achieved in similar local conditions. Keep in mind that imported solutions need evaluation with respect to their suitability for a particular workplace.

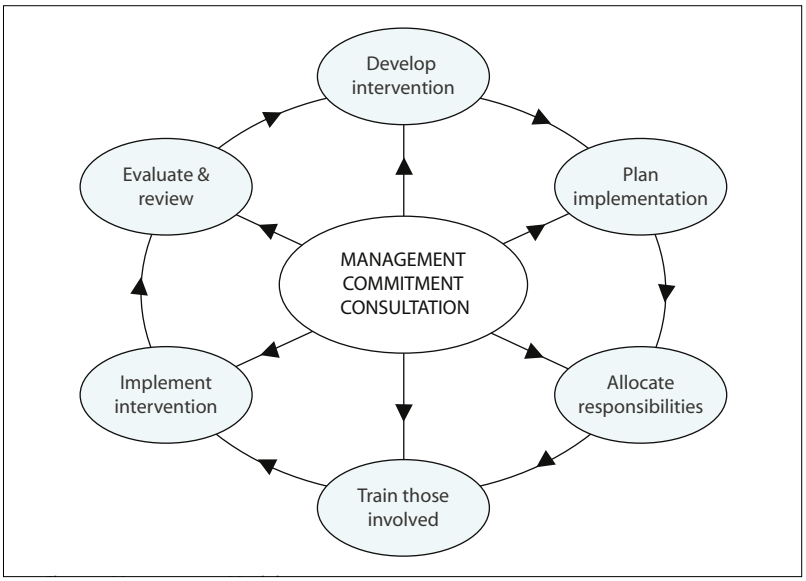


Figure 35 Change Management Model.

WORKPLACE RISK MANAGEMENT

41. Work problems relate to a broad range of workplace factors. It is useful to look at issues such as manual handling, work postures, physical and mental loads, workstation and tool design, physical environment, welfare facilities, protective equipment and work organisation in the overall work setting.

42. Major risk factors for injury and illness may be physical, psychological, psychosocial or combination of these. Immediate risk factors may be physical in nature but may arise from poor work organisation. Take into account the complaints and opinions of workers in knowing what can be done to reduce the risks.

43. Involve managers and workers together in seeking appropriate ergonomics improvements making sure that these are monitored and evaluated for their effectiveness.

44. As locally adjusted solutions are needed, a work and management climate that facilitates change and supports workers is important.

45. Solving workplace problems often requires a combination of small, incremental changes rather than a single solution to reduce the risks. These may not seem very impressive as individual changes but collectively they work to reduce the risks.

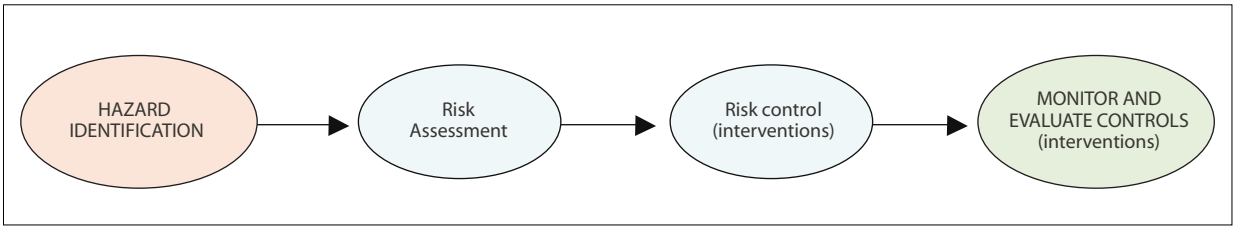


Figure 36 The Risk Management Process.

PARTICIPATORY ERGONOMICS

46. Participatory management can fundamentally change an organisation for the better if undertaken with care and commitment.

47. Participation by employees in problem solving at work can encourage ownership of changes and a better understanding of the process of change.

48. Participatory techniques are an excellent method for training workers in the theory and application of ergonomics.

49. Participatory workshops must include people with a suitable mix of skills and knowledge about different aspects of the work under review. This includes ergonomics and occupational health and safety expertise where necessary.

50. Effective workplace communication is essential in all areas of ergonomics.

TASK DESIGN

JOB SATISFACTION

51. The key characteristics of jobs are task significance, task variety, autonomy and feedback.

52. Repetitive jobs can be boring and lead to injuries due to cumulative overload, and/or poor concentration. Try as far as possible to vary task content and include regular breaks away from the workstation. Usually five minutes within each hour is considered satisfactory for light repetitive work.

53. Where there are high job demands, ensure that there is adequate control (job latitude) by the individual worker over how the work is completed.

54. Combine tasks and increase autonomy by using work groups. Where appropriate, also make use of job rotation within autonomous work groups.

55. Consider how changes in technology in the workplace may lead to the need for job re-design.

56. Workers need a basic education in ergonomics to enable them to participate fully in the development of ergonomics solutions to workplace problems.

57. Provide appropriate and on-going support for employees particularly during the implementation of new systems.

58. Understand the importance of effective worker consultation and work organisation.

59. Watch for workers who may have difficulties with work and try to support them in solving their problems.

MANUAL TASKS

60. Optimise manual handling tasks wherever feasible. Poorly designed manual work can be costly and inefficient and may cause injuries.

61. Provide well-designed manual handling aids where appropriate. Push-carts, mobile racks and trolleys are often useful for reducing handling tasks.

62. Correctly estimate individuals' capabilities in terms of handling weights, cumulative loads and work rates and design manual handling tasks appropriate for these. Always design handling jobs for the weakest, the smallest and for untrained workers.

63. Consider the cumulative effects of weights handled and the different planes of motion.

64. Consider the combined effect of task variables (such as height and horizontal distance of lift, size of the load, frequency of lift) and worker variables (such as age, sex, body weight, anthropometric dimensions).

65. Limit manual handling of supplies and equipment, most particularly double or multiple handling.

66. The time for one basic element of a task to be completed is affected by the preceding and succeeding elements.

67. Provide specific training in manual lifting techniques where necessary. However, as this type of training is often unsuccessful, try to minimise the lifting operations or mechanise them.

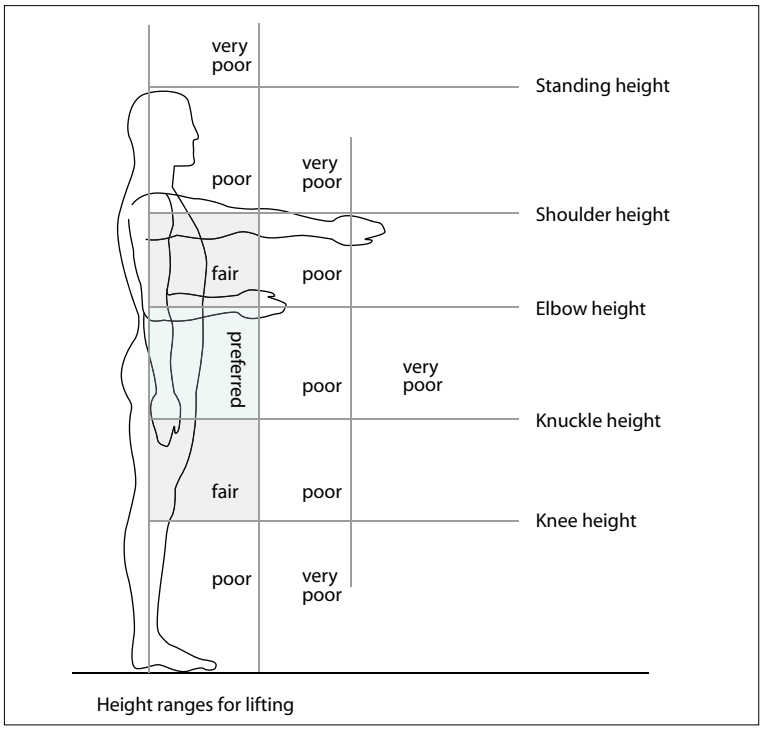


Figure 37 When designing workplaces and tasks try to ensure that handling (especially lifting, lowering, pushing and pulling) is in the preferred area i.e. close to the body; above the knees and below the shoulders (shaded area). Try to eliminate the need to bend and twist as this is a particularly damaging movement. *Adapted from the UK Manual Handling Regulations 1991*

DRIVING AND OPERATING MACHINERY

68. All tasks undertaken by the driver operator need to be assessed in terms of job demands and individual capabilities. Fatigue, overload and underload need to be managed to reduce the risk of errors.

69. The design of the cab must accommodate driver needs including vision, noise, dust control, seating and task demands.

70. Where vehicle or machine operation involves extended work hours and shiftwork there must be adequate provision for rest and work breaks in the work schedule.

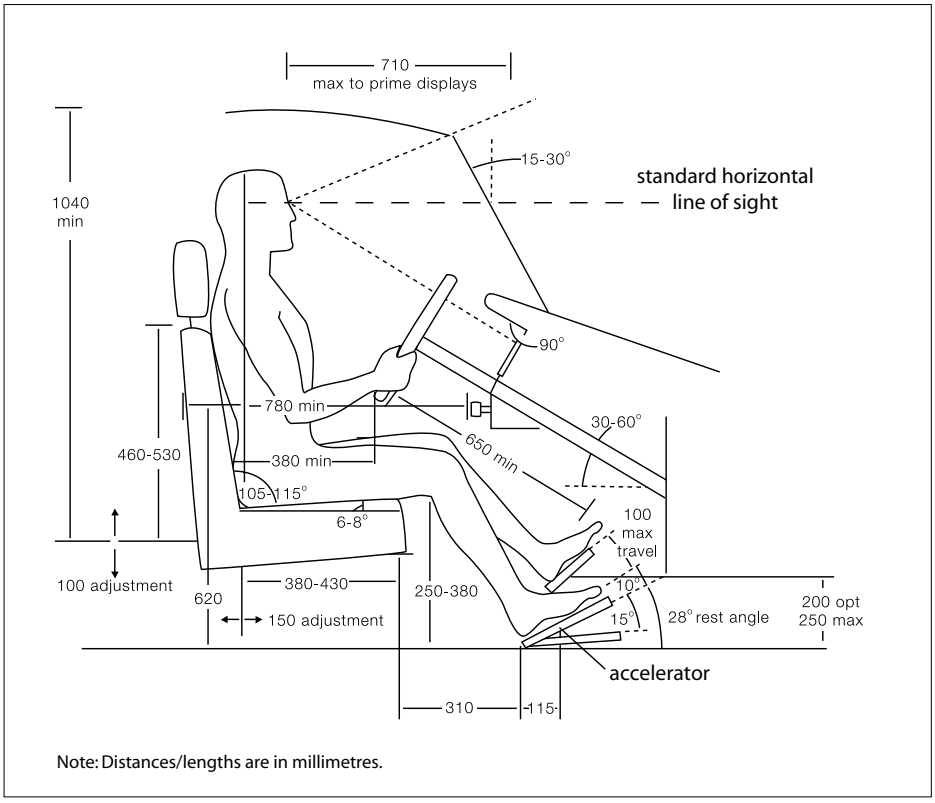


Figure 38 Optimum design of vehicle cabs is critical to driver safety, performance and comfort. In recent years manufacturers have paid more attention to accommodating taller and shorter drivers. While the above dimensions are useful as a guide, the most important element will be the range of adjustability offered to meet each user's needs, particularly in the seat. *Adapted from Saunders & McCormick 1993*

EDUCATION, TRAINING, EXPERIENCE AND SKILL DEVELOPMENT

71. The application of ergonomics requires worker involvement and training in order for workers to understand why changes are necessary and how best to use them.

72. Ensure that all workers are adequately trained in work techniques that reduce the risk of strain. Appropriate, timely and ongoing training is an important element in the effective performance of a job or task.

73. All necessary information on the operation and guidance of work equipment and tools needs to be available through education, manuals and training. Manuals need to be properly indexed and easy to use.

74. Different training methods are used for different types of work and workers, as well as for the skills and knowledge required to be learned. Training should be recurrent and up-to-date.

75. All workers require regular retraining to update their skills or to learn new ones.

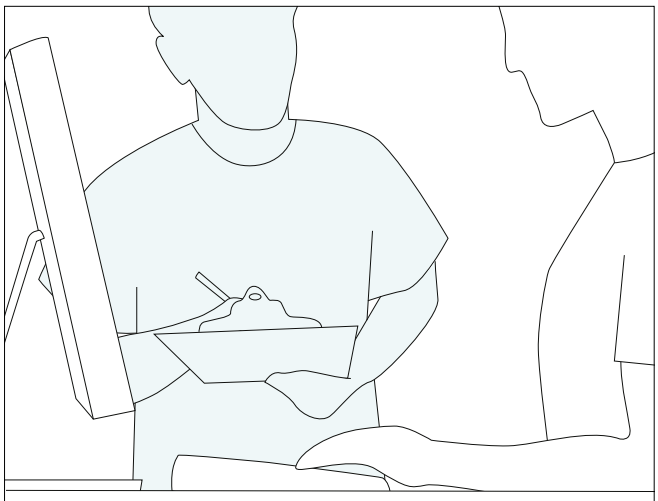


Figure 39 On-the-job supervision, coaching and support for workers particularly when they are learning new tasks or jobs is critical if they are to achieve their full potential.

EQUIPMENT DESIGN

WORK STATIONS, CONSOLES AND WORK BENCHES

76. There needs to be sufficient space for the use and storage of a range of equipment including tools and appliances, lifting aids, components and spare parts, computer-related equipment and supplies, manuals and reference materials, personal protective equipment (PPE) and fixed items.

77. When the work is stationary, try where possible to design the work space so that the work can be performed in either a sitting or standing position.

78. Wherever possible, modify the work space arrangements for each individual.

79. Size differences of all users should be considered in the design of the work areas. There needs to be sufficient head space for adequate clearance for the tallest person when standing upright.

80. Improve reach to frequently used materials, tools and controls. Place the most frequently used ones within easy reach of the workers. Reach distances should not exceed those of the smallest people.

81. Ensure that the size of the work area allows the largest workers to adopt comfortable work postures. Access needs to be adequate for the largest person wearing PPE and carrying equipment such as tools and testing devices.

82. Ensure that work tables, chairs and other furniture and equipment meet the individual worker's particular work requirements. Adjust work height at about the elbow height in both standing and sitting work. When forces are exerted on work items, the height of the items can be lower.

83. Allow for adjustment of postures and movements in tasks where workers are seated continuously. Encourage seated workers to undertake activities other than sitting and during breaks.

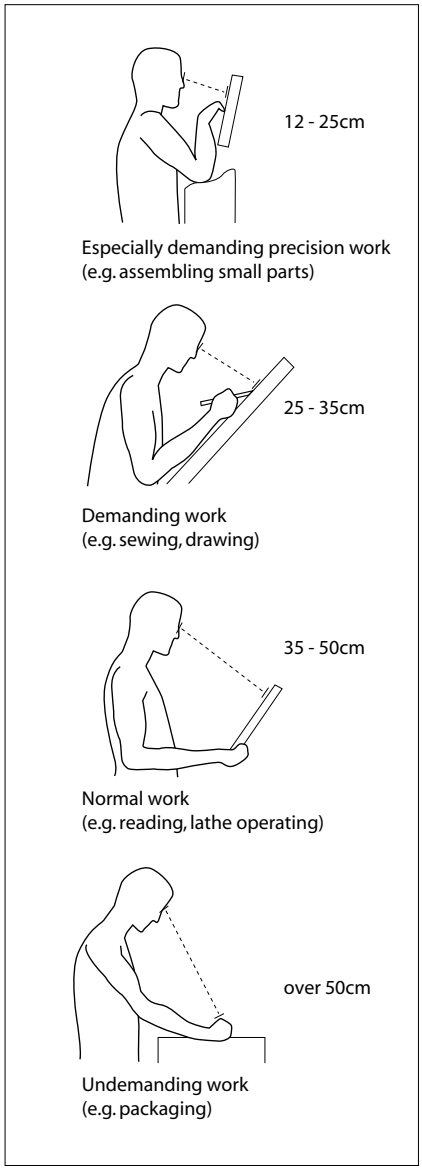


Figure 40 Viewing distances.

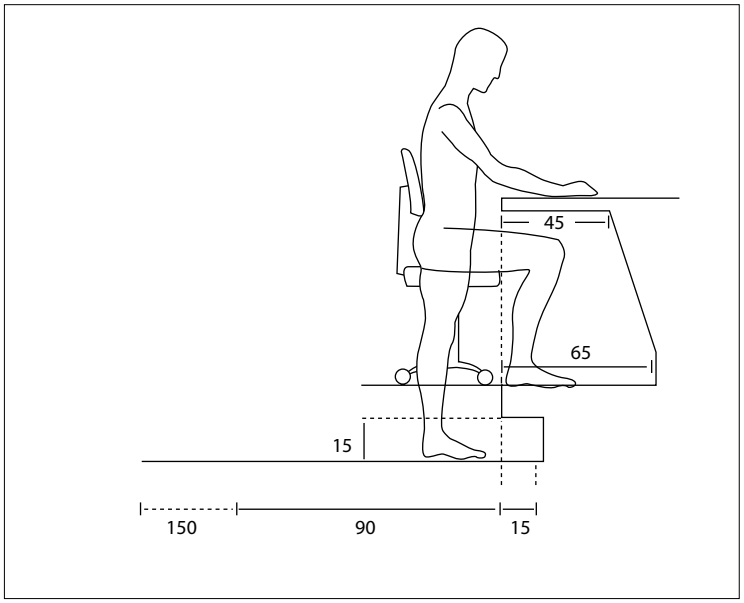


Figure 41 Leg space (cm).

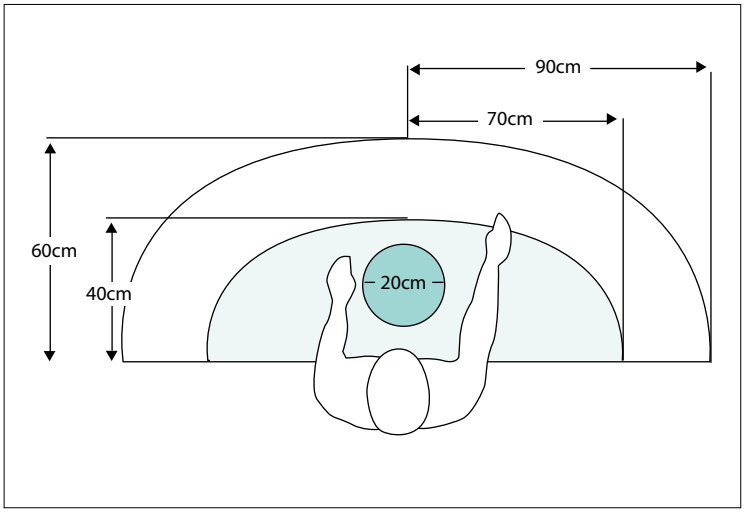


Figure 42 Horizontal work area.

Adapted from FIOH, 1989

DESIGN OF AND ACCESS TO MACHINERY

84. Work areas should accommodate the number of people required to do the job without posing risks to health and safety. Minimise height and space restrictions. Consider access and conditions for both routine work and maintenance tasks. This may involve specifying or modifying machinery design.

85. Provide open, even and uncluttered walkways on and around the machinery and equipment wide enough to be able to walk forward. Minimise changes in levels of walking surfaces. Cover or eliminate all holes or depressions where a foot could get stuck or which may pose a trip or a fall hazard.

86. Protect workers from accidental contact with moving parts of machines. Provide machine guards and safety devices so that they are in place at all times.

87. Provide appropriately designed steps, footholds and ladders for access to the machinery and equipment. Slip-resistant surfaces on all walkways and steps should be provided.

88. Sharp edges and protruding obstructions should be eliminated or at least minimised, and where possible padded.

89. Provide designated storage areas for supplies and equipment with adequate, safe access.

90. Eliminate pinch points and moving parts that could crush hands, feet, or the body.

91. Minimise or reduce reach distances especially for moving and handling loads. Minimise the need for bending especially when twisting at the same time. Minimal work should be carried out above the shoulders.

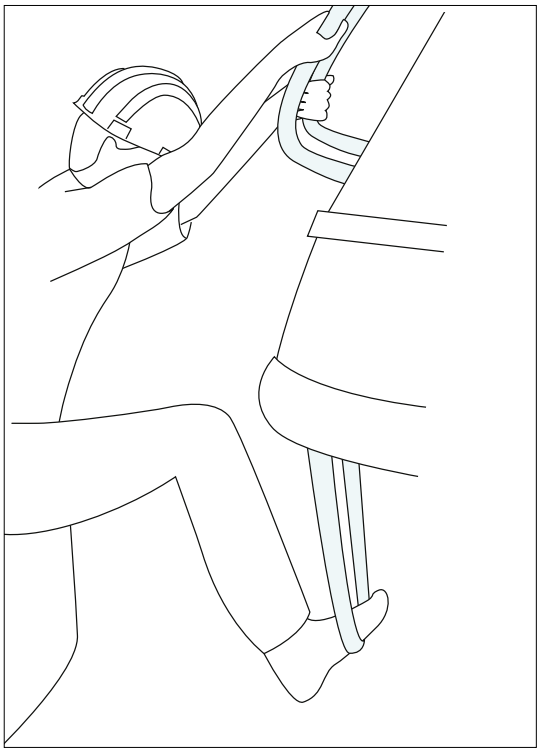


Figure 43 Non rigid ladders are not recommended for access.

TOOLS

92. In the use of tools, general work position as well as body and hand postures need to be comfortable and stable.

93. Stabilising work materials is essential and may need a jig or other mechanical device.

94. Handle characteristics such as shape, thickness, length and contact surfaces are important for a secure and comfortable grip. Controls should be suitable for the type of tool and its use and should be appropriately located.

95. The balance and weight of the tool should enhance its operation and make it as easy as possible for the user to operate correctly and precisely.

96. Appropriate tool storage may be required when not in use. This may also need to be made secure.

97. Special care should be taken about the electrical cord positioning.

98. Use guards to protect users and others from moving parts. Minimise debris and sparks.

99. Alignment of tools should be easy to use and give the user feedback on the correct positions.

100. Incorporate safety features such an emergency safety switch and prevention of electric shorts in electrically powered tools.

101. Maintenance and repair schedules should include day-to-day checks and services, the prevention of parts loosening, as well as planned services after longer periods of operating. These procedures need to be clearly specified and documented.

MECHANICAL AIDS

102. Job aids need to be well designed for the purpose and readily accessible to encourage their use.

103. When purchasing items, consider how and where to store them.

104. Height adjustable work tables and jigs need to be flexible enough to accommodate all users conducting different work tasks. Adjustments should be easy and quick to make from the working position.

105. Wheels on mobile equipment should be of sufficient diameter to enable them to roll easily over rough or uneven surfaces.

106. Maintenance programs must ensure that job aids meet safety requirements as advised by the manufacturers.

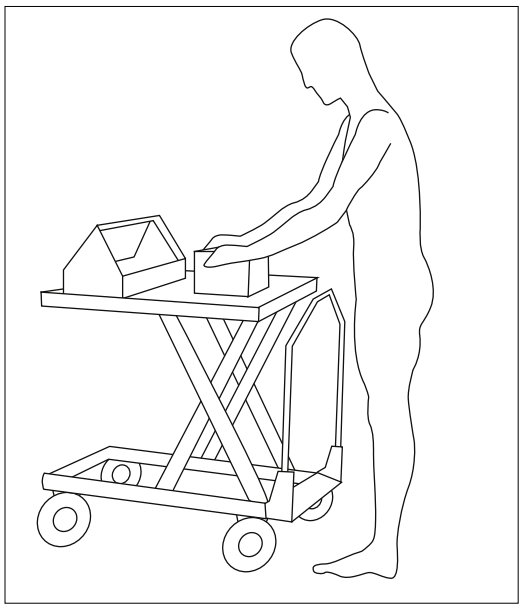


Figure 44
Height adjustable trolleys on large diameter wheels help transport tools.

DISPLAYED INFORMATION

107. Use the simplest ways of displaying information required to be transferred to the operator. The display format should be appropriate to the accuracy required.

108. Make sure that information is presented in the local language(s) of the workers.

109. The displayed information should have sufficient visibility in terms of viewing distance, size, angle, contrast, glare and illumination while taking into account other visual difficulties that operators might have.

110. The displayed information should be conspicuous enough to attract attention and to be distinguished from background interference and distraction.

111. The displayed information should have sufficient legibility, i.e. legible in terms of pattern discrimination, colour and brightness, contrast, size, shape, distortion and illusory aspects.

112. Pay attention to interpretability of the displayed information, i.e. how well viewers understand the meaning and are able to apply this understanding to their tasks.

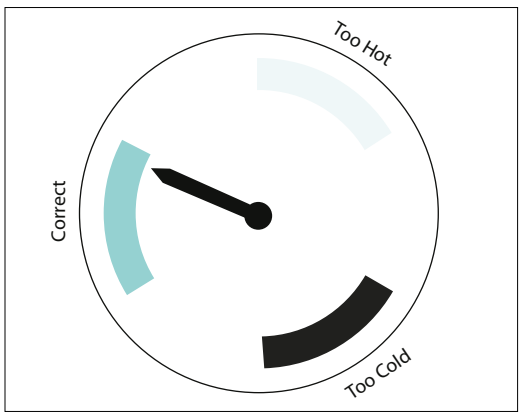


Figure 45
A display instrument should convey the required information as simply and unmistakably as possible.
Adapted from Grandjean, 1988

INSTRUMENTS AND OTHER VISUAL DISPLAYS

113. Location and layout of the displays need to comply with relevant standards and should be clear and readable from the operator's position.

114. Locate displays, grouping them if necessary, according to their function, the critical nature of the information and the frequency of usage. All key displays need to be in the direct line of sight of the operator.

115. Displays that are used infrequently may be out of the direct line of sight but the displayed information needs to be large and clear enough to be seen under sub-optimal conditions.

116. Provide all the necessary information for the operator so that well-considered decisions can be made.

117. Do not provide unnecessary information that may clutter the visual field and cause confusion.

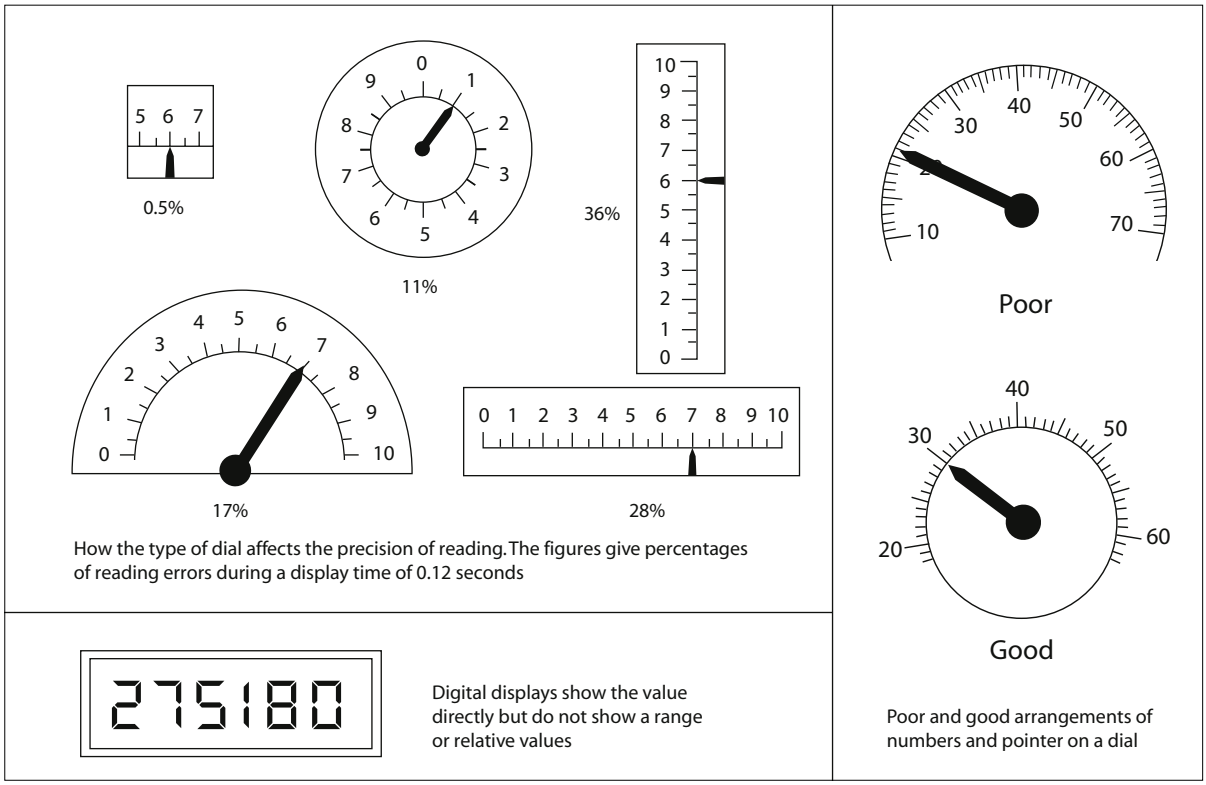


Figure 46 Displays of information need to be clear and unambiguous. The simplest display to communicate the necessary information is the best.

Adapted from Grandjean, 1988

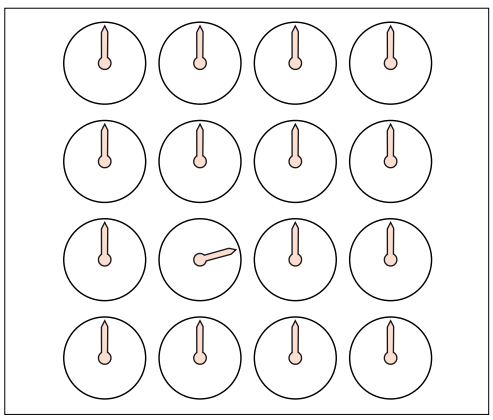


Figure 47
Arrangement of analogue displays for easy reading. Displays are designed so that "normal" is "up". Deviations from normal stand out.

From Grandjean 1988

WARNINGS

118. Warning lights alert the operator to a situation that makes the system inoperative or may cause damage. All warning lights should be clearly visible.

119. The colour of warning lights depends on their functions and on what other warning lights exist in the work environment. A red light usually indicates "stop". Yellow lights should alert the operator to a situation where caution, recheck or delay is necessary and if not attended to could lead to a dangerous situation.

120. Green should indicate that equipment is operating satisfactorily or that the operator can proceed. It can also indicate the successful completion of steps within a process.

121. White should indicate status, alternative functions, selection modes, a test in progress or similar items that imply neither success nor failure of system conditions.

122. The use of flashing lights should be minimised and used only to increase the conspicuousness of the signal and to alert the operator to a potentially dangerous situation. Flashing red lights should be used to indicate extreme danger.

123. Any additional indicators such as auditory signals should be provided where further information on the status of the system is required.

124. Be aware of the need to check the ability of individual workers in colour vision, especially with respect to the distinction between red and green displays. Location, size, shape of these displays and additional warning (e.g. auditory) signals can help.

125. Additional, auditory alarms may be included to bring the operator's attention to a problem immediately. They should not be too loud but should be able to be heard and identified either through distinctive pitch or frequency, or both.

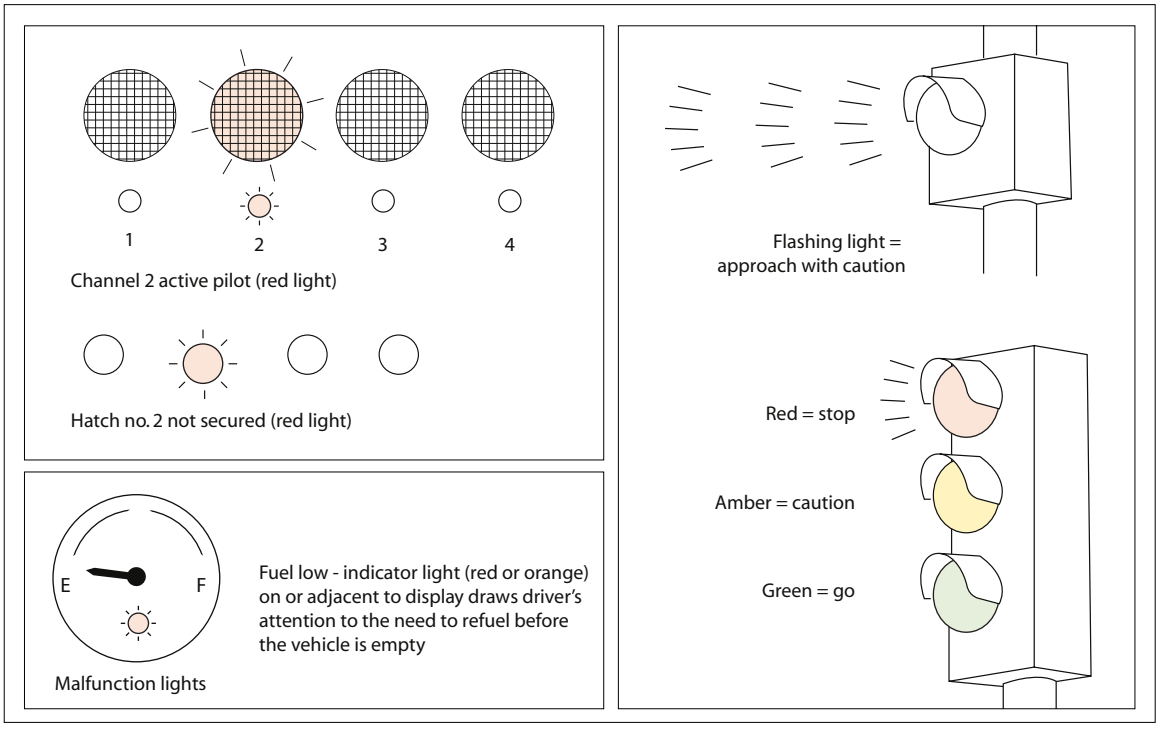


Figure 48 Warning lights and indicators should be simple, clear in purpose, consistent and draw peoples' attention to a problem without causing confusion or alarm. *Adapted from Grandjean 1988.*

SAFETY SIGNS

126. **Conspicuousness:** the sign should stand out and be located where most people would look.

127. **Emphasis:** words or symbols should imply danger. Words such as 'danger', 'hazard', 'caution' and 'warning' are suitable. Symbols should be standardised and immediately indicate the nature of the hazard.

128. **Legibility:** when words and messages are used, the size, style and contrast of letters and the background need to be sufficient to be read. A border or space separates the message from the background. The sign should be in the language of the workers concerned.

129. **Simplicity:** use as few words as possible; keep information short and simple; tell the observer what to do or what not to do; avoid acronyms or abbreviations.

130. **Intelligibility:** say exactly what the hazard is and what might happen if someone ignores the warning.

131. **Visibility:** make sure that the sign is visible under all expected viewing conditions.

132. **Permanence:** devices and sign materials need to be resistant to aging, wear, soil, vandalism and deterioration due to sunlight or cleaning.

133. **Standardisation:** use standard signs and symbols where they already exist. When signs and symbols that are not yet standardised but may be acceptable in view of their long-term usage are used, consider interpretation by visitors and newcomers.

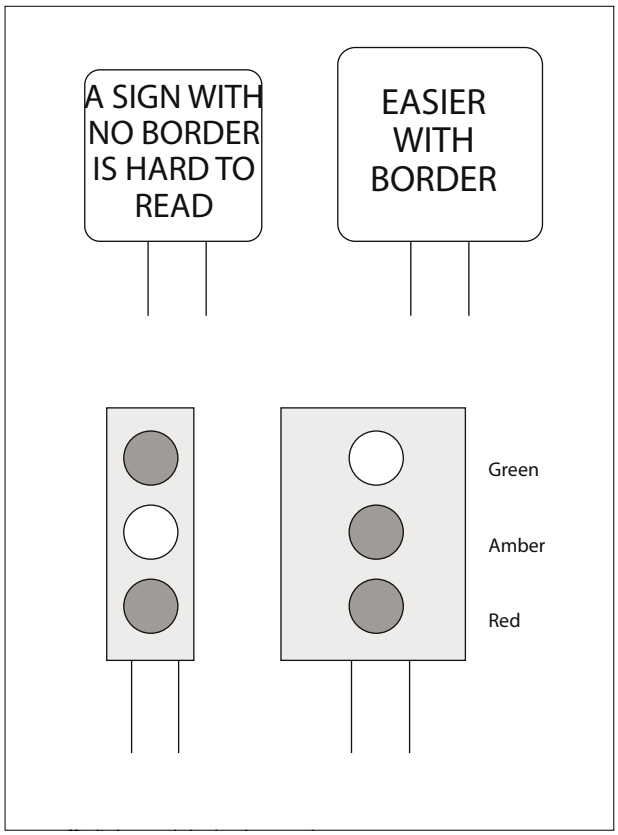


Figure 49 Black background shield provides contrast between the traffic lights and the background.
From Woodson, Tillman and Tillman, 1992

Figure 50 There are standards governing the use of safety signage in many countries.

CONTROLS

134. **Type of control:** the types of controls used should be consistent with the natural motions and postures of the operator's arm and hand or leg and foot.

135. **Feedback:** operators should know at all times what their input is accomplishing.

136. **Resistance:** resistance in operating the control should be sufficient to dampen inadvertent inputs but not so much as to cause fatigue.

137. **Position of the control:** the operator should not have to assume awkward postures or long reaches and should be able to manipulate the control through the entirety of its range. Postures adopted for continuous operation should be comfortable e.g. accelerator pedals.

138. **Size and shape:** the size and shape of the controls should be compatible with the size of the operator's hands, fingers or feet. Consider the wearing of protective clothing such as gloves as sufficient space is needed between controls to prevent inadvertent contact or activation of other controls. The shape of the control should be compatible with the grip or motion required.

139. **Two-handed operation:** two-handed controls may provide more precision but should not be used when an additional control is required to be operated simultaneously.

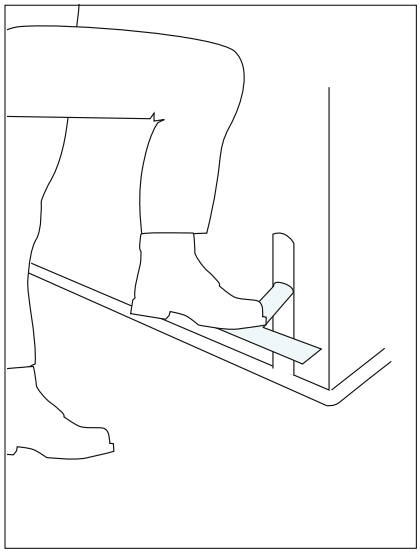


Figure 51 Pedals are undesirable for standing work, since they set up heavy static loads on the legs and back.

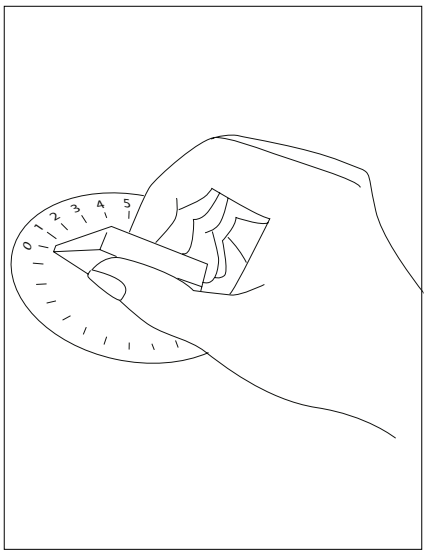


Figure 52 Pointed bar knob with click stops allows discrete values to be selected easily. *From Grandjean, 1988*

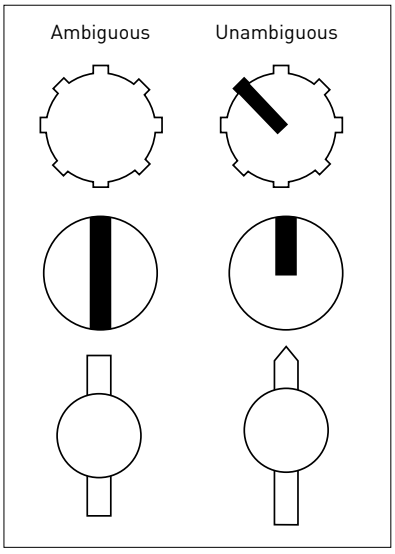


Figure 53 Where a knob moves in increments it should be designed so that its position is unambiguous. *From Grandjean, 1988*

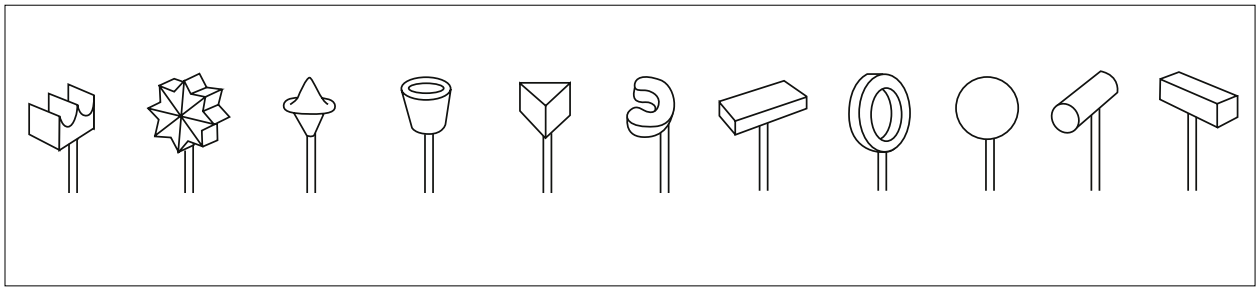


Figure 54 Types of hand grips (knobs) that are easy to distinguish. *From Woodson, Tillman and Tillman 1992*

WORK CHAIRS AND SEATING

140. No one posture is suitable all of the time or for all people. Regular changes in sitting postures are necessary to reduce the effects of straining the same muscle groups and fatigue. Tasks should be organised so that people can take breaks periodically.

141. If people are seated for most of the working day they need well-designed seating including adjustments and padding. No chair will seat people comfortably for more than about an hour at a time. Even the best designs become uncomfortable over time.

142. Work seating should be adjustable at least in seat height and backrest angle.

143. Adequate lumbar support at the base of the spine is important for comfort and back care.

144. Where computers are used some adjustability in keyboard height and in screen height, position and angle are important.

145. Desk and chair height should allow users to sit with their feet flat on the floor and their thighs horizontal with minimum pressure on the back of the thighs. Where a chair is too high due to a need to adjust the work height, a footrest should be used.

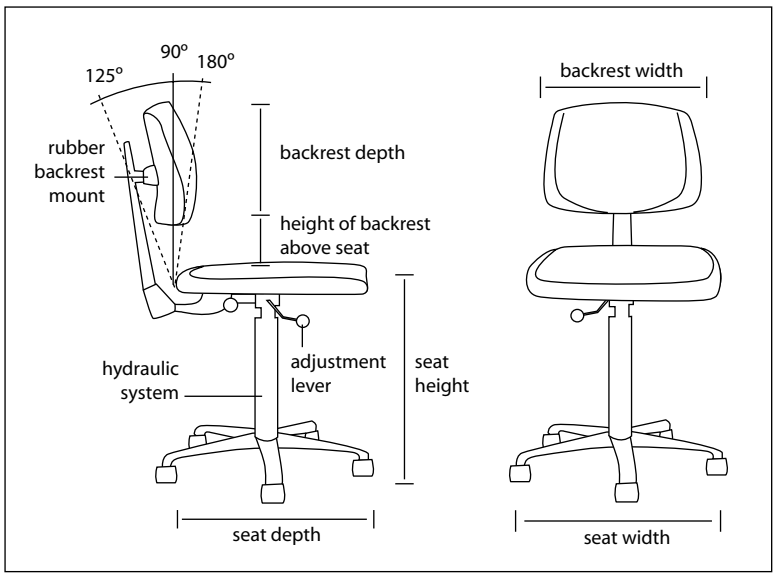


Figure 55 A well designed office chair for computer, office and control room work.
From McPhee, 2005

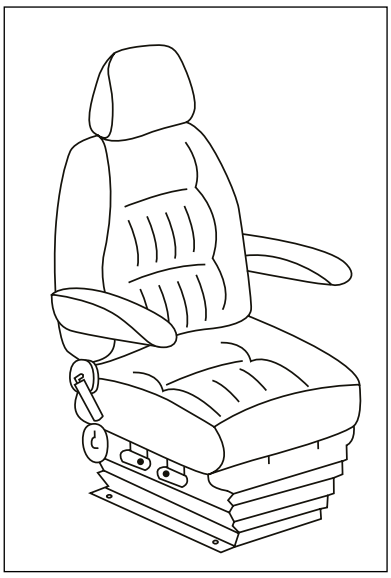


Figure 56 The design of truck seats is important for driver health, safety and performance. Adjustability to accommodate taller and shorter users is particularly important.
From McPhee, Foster & Long, 2009

VEHICLE CABS

146. Optimise the design of the cab especially the displays and controls and the driver seat. Optimise visibility within and outside the cab.

147. Allow operators and drivers regular breaks out of the seat and the vehicle wherever possible.

148. Improve shiftwork systems to avoid extended hours of work and insufficient resting periods between shifts. These lead to excessive fatigue, reduced vigilance and errors.

149. Minimise distractions for the operator while driving particularly in critical situations.

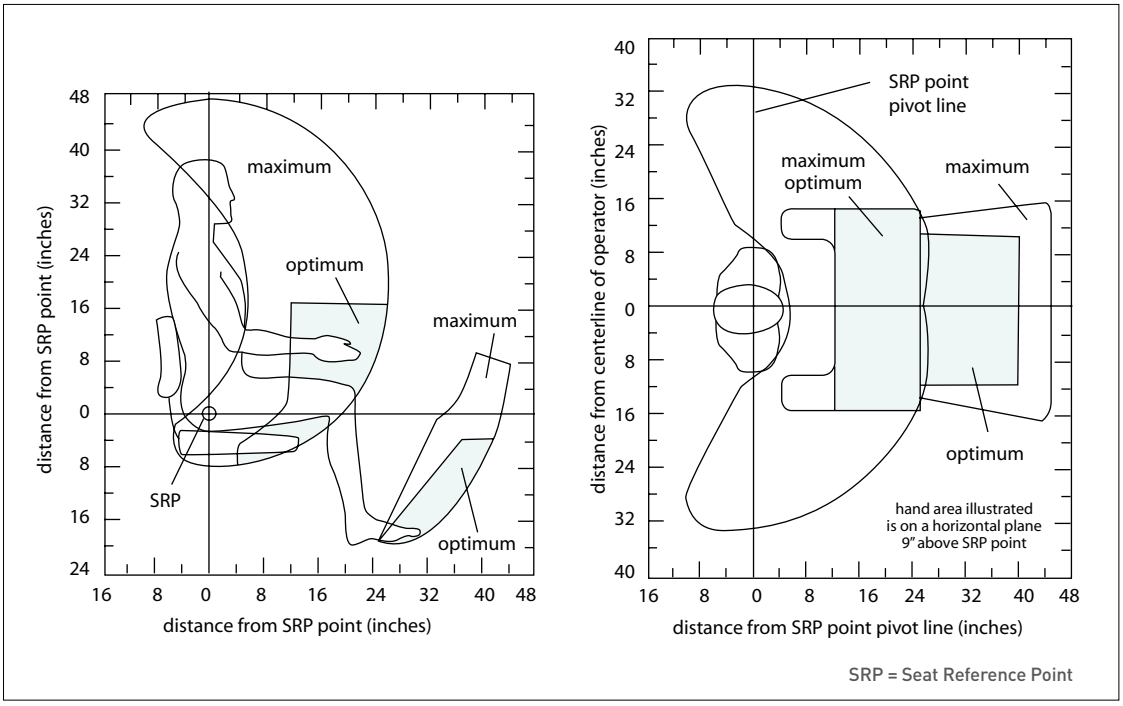


Figure 57 Space envelope for control locations in construction and industrial equipment.
Adapted from SAE J287

COMPUTER TASKS

150. Optimise the design of the screen, keyboard and the mouse for the task. The screen image must be clear and stable.

151. Carefully design the visual environment and minimise glare and reflections.

152. There should be suitable storage space close by for all reference material for users.

153. The computer workstation including chairs and desks must accommodate the full range of height and sizes of users. The size of the desk must be appropriate to the size of the screen especially where bigger displays are used. The desk must also be wide enough to accommodate all source material.

154. A suitable document holder should be used for source or reference materials.

155. Computer work should be mixed with other tasks to allow a variety of movements and postures.

156. Software used needs to be useable and flexible, and the type, amount and timing of training for its use must be appropriate.

157. The age of the users, their need for training in computer usage and the possibility of requiring reading glasses should be taken into account.

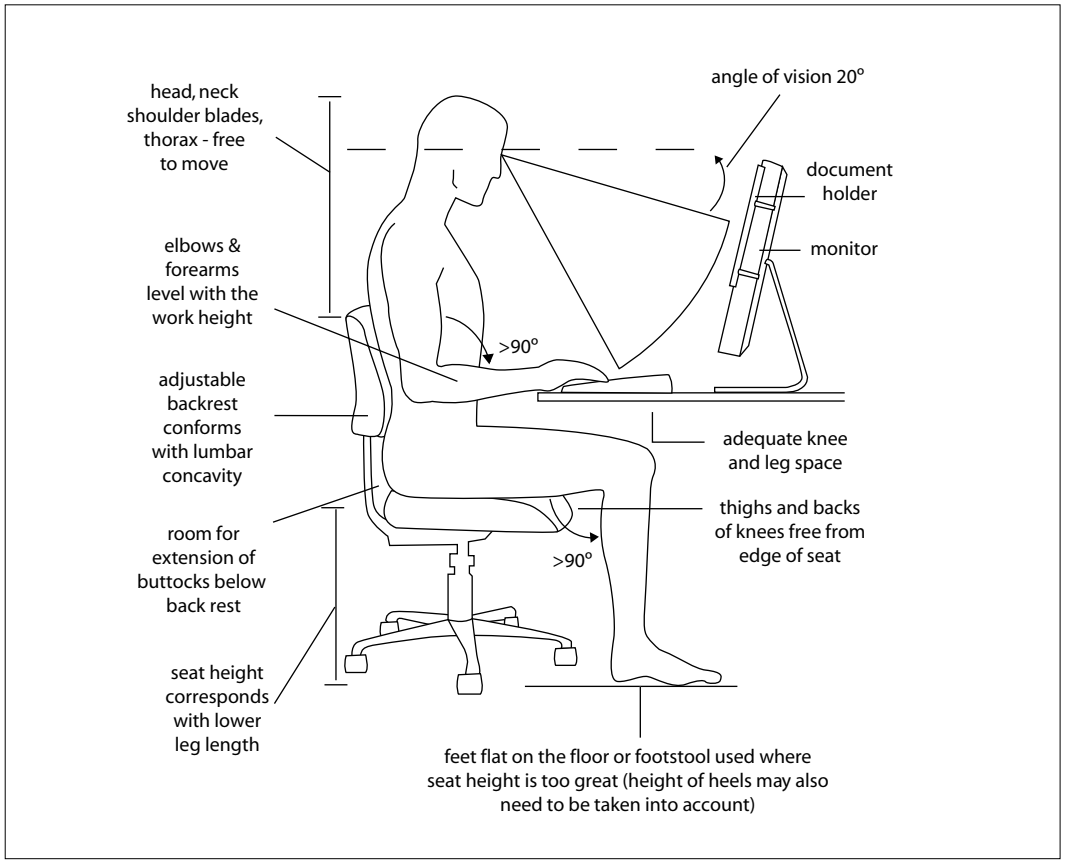


Figure 58 Optimum sitting position for computer work.
From McPhee, 2005

THE WORK ENVIRONMENT

WORK SPACES

158. Work spaces must accommodate all users, their equipment and the tasks to be carried out. Review workspaces regularly for their suitability for current tasks and users.

159. In industries such as mining, construction, transport and agriculture the worker's workspace may change constantly or may be mobile such as the cabin of a piece of plant or machinery. Care must be taken to ensure that ergonomics design principles are applied to these spaces.

160. Storage space must be adequately organised and all redundant material and equipment discarded.

161. Clean up slip, trip and fall hazards such oil on the floor, cluttered walkways and poor housekeeping. This includes maintaining temporary floors and uneven ground which may be a work area or walkway.

162. Ensure that the work environment, e.g. temperature, airflow, light, noise, is designed to optimise work performance.

163. Ensure adequate access by maintenance personnel to machinery in a breakdown situation.

ILLUMINATION AND LIGHTING

164. Quality of light including source, direction, hue and intensity is often just as important as the quantity of light. Avoid glare by rearranging sources of light.

165. Poor or inappropriate lighting can affect workers' health and safety as well as their efficiency.

166. Provide task lights in addition to general lighting for work with tools, computers, sewing machines and other precision tasks.

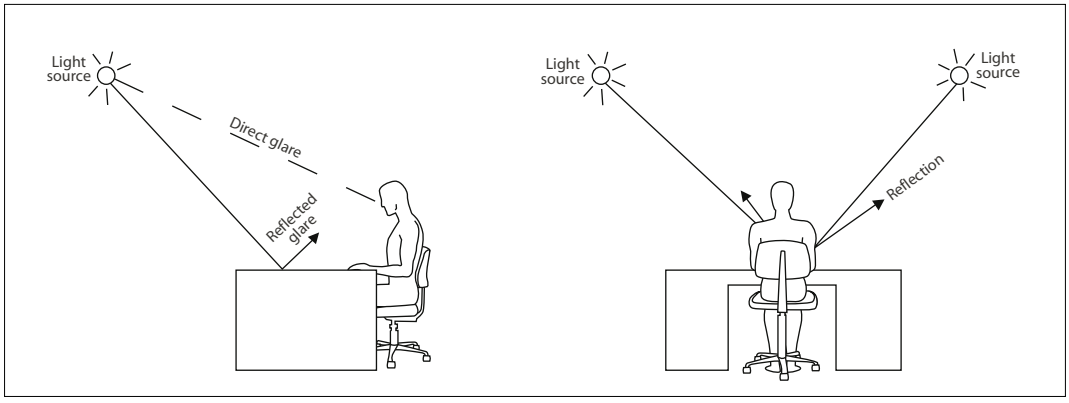


Figure 59 Light sources should be located in such a way that reflections, glare and shadows are avoided.
Adapted from Grandjean, 1988

NOISE

167. It is always more effective to control damaging, unwanted or nuisance noise at its source by improved design, isolation or enclosure of machinery.

168. Noise can distract and result in fatigue as well as damage hearing. Separate noisy and quiet work. Generally, background noise can damage hearing if it is so loud that you need to shout to be heard when talking to someone who is 500mm (half a metre) away.

169. Choose hearing protectors carefully to provide the right amount of hearing protection as well as comfort and ease of use.

VIBRATION

170. Vibration should not result in discomfort. Both whole body vibration (usually experienced when seated in mobile equipment) and hand-arm vibration (usually experience when using vibrating tools) should be taken into account.

171. Monitor the duration and intensity of daily exposures to vibration carefully and see if vibration-related symptoms, such as back pain, headaches, nausea, or numbness in the fingers are reported.

172. Minimise the effects of aggravating factors such as cold and humidity when using hand tools.

173. The design of equipment can significantly reduce vibration during operation. Reducing vibration at source through the careful selection of tools, seats and machinery saves time and money. Undertake regular and thorough maintenance of machinery, equipment and tools to minimise vibration.

174. Prevent the transmission of vibration by the use of damping materials and suspension.

175. Reduce the speed of vehicles and machines as an immediate control of harmful whole-body vibration. Drivers, operators and users of vehicles and equipment must be competent in specific operating and driving techniques and should be adequately supervised.

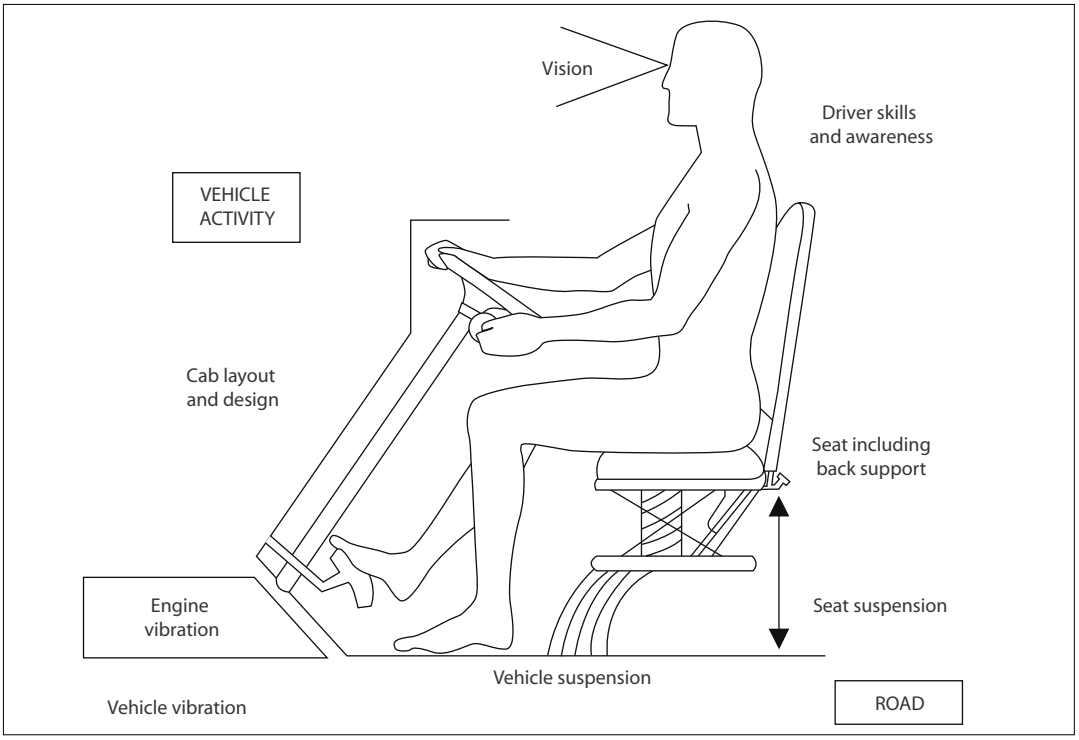


Figure 60 Sources of whole-body vibration (boxed) and modifiers. *Adapted from McPhee, 1993*

WORK IN HOT OR COLD ENVIRONMENTS

176. Regularly monitor thermal conditions and workers' responses to them.

177. Ensure that there is accessible clean, cool drinking water and encourage workers to drink adequate amounts of water regularly and frequently, especially in hot conditions.

178. Protect workers from the sun, heat and cold winds by providing adequate clothing and personal protective equipment (PPE) for the heat or cold.

179. Provide equipment that can be used appropriately, safely and easily when wearing PPE.

180. Ensure that work procedures are in place to reduce the risks of heat and cold stress. These include adequate work breaks, job rotation, extra personnel and job redesign.

181. Educate workers in the risks of working in hot and cold conditions and what they need to do to prevent problems including maintaining physical fitness, intake of adequate fluids and limiting alcohol intake.

182. Consider alternatives to placing workers unnecessarily in hot or cold conditions.

WORK ORGANISATION

HOURS OF WORK

183. Excessively long hours of work may reduce work performance, job satisfaction and harm health. Efforts are needed to reduce overtime hours and secure sufficient rest periods between shifts.

184. Individuals who perform heavy physical work or are exposed to a range of workplace hazards such as heat, noise, vibration or hazardous substances should not work extended shifts. Exposure standards for extended work days (greater than eight hours) have not been developed for many hazards. Therefore it is important to assess carefully workers' daily work demands or exposures to ensure that they are within acceptable limits.

185. Workers who are involved in intensive mental work where the consequences of error or non-reaction may be serious should not work consecutive long shifts (more than eight hours) or compressed work weeks.

186. It is essential that shift workers are consulted and take an active role in determining changes to current shift rosters and how these changes are to be implemented in the workplace.

187. Common problems with shiftwork include: an increase in general fatigue due to disrupted sleep; disrupted biological rhythms leading to restrictions to personal, social and family life; reduced access to leisure and sporting activities; and gastrointestinal, cardiovascular and nervous complaints.

188. The number of consecutive 12-hour day shifts should not exceed four, with no more than two consecutive 12-hour night shifts. Overtime is not recommended for individuals working 12-hour shifts.

189. Suitable arrangements need to be made to cover workers who are absent from work due to illness.

190. Shift patterns need regular review and adjusting to suit changing needs and circumstances.

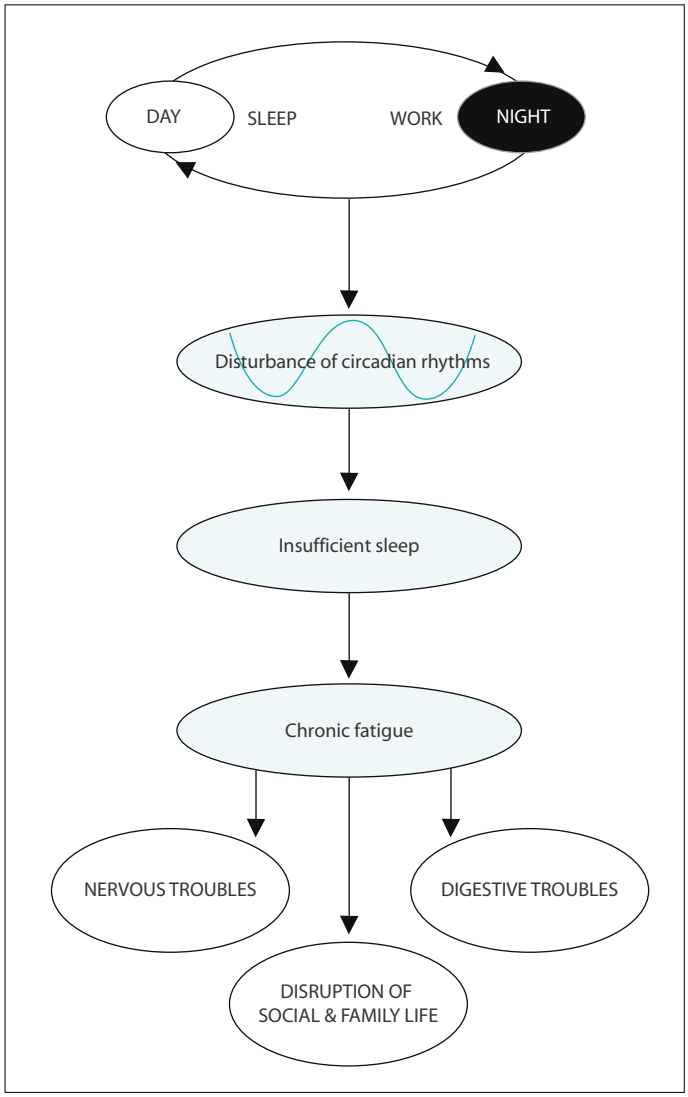


Figure 61 Causes and symptoms of occupational ailments among shiftworkers who periodically work at night. *Adapted from Grandjean, 1988*

WORK BREAKS

191. Work breaks are necessary for recovery and for reducing the effects of fatigue during work that is physically or mentally demanding.

192. The length and frequency of work breaks depends on a range of factors. These need to be determined on a task-by-task basis.

193. Physical exercises can be incorporated into work routines but they must be carefully planned and monitored.

WORKER CONSULTATION AND FEEDBACK

194. Worker consultation is necessary for any ergonomics program. Effective consultation includes information to and feedback from workers i.e. two-way communication between workers and managers. It requires respectful relationships and opportunities for all to discuss and investigate issues and participate in decision making.

195. Effective communication by everybody is an important element of participation and co-operation.

Figure 62 A focus group is an excellent method of worker consultation and problem solving.

WORK TEAMS

196. Teamwork provides a range of work options for individuals and if properly managed can be effective and efficient.

197. There are advantages and disadvantages to team work. The suitability of teamwork must be determined by taking into account individual and group factors as well as production needs and workplace issues.

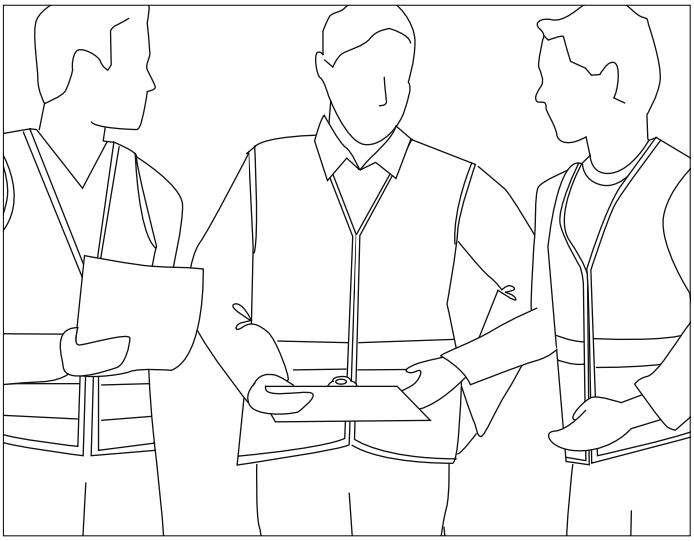


Figure 63
Effective team work can give people more control over the work process and encourages a broader view of the job. This can be rewarding both for the company and its employees but requires considerable training and investment in employees to develop team skills.

ECONOMIC AND SOCIAL INFLUENCES

198. Social support and assistance at work helps workers reduce adverse effects of day-to-day stressors in the working environment.

199. Social interaction is a necessary part of work and workers should not be isolated without opportunities to communicate with fellow workers.

200. Work should be an important and positive component of people's lives.

Different people are motivated in different ways. It is important to match the work tasks with individual capabilities, education, training levels and preferences.

0.8 GLOSSARY OF TERMS

Accident	An unplanned event that interrupts the completion of an activity, and which may or may not result in injury or property damage.
Anthropometry	The dimensions of the human body and how these are measured. It covers the size and proportions of people, the length and range of movement of their limbs, head and trunk.
Awkward working posture	A posture or action required to execute a task which creates some discomfort for, or is unable to be maintained by, the worker.
Biomechanics	The application of physics to the analysis of posture and human movement. It deals with the levers and arches of the skeletal system and the forces applied to them by the muscles and gravity.
Change management	An organised and systematic approach to anticipating and managing change in an organisation.

Constrained	Forced, cramped, restrained or unnatural, confined or restricted.
Consultation	The sharing of information and exchange of views between employers, employees and/or employee representatives, and/or an external expert on health and safety and ergonomics issues. It includes the opportunity for all stakeholders to contribute to decision-making in a timely fashion to minimise OHS risks.
Decision latitude	The degree to which individuals or group have control over their work processes and outcomes. It implies a certain degree of autonomy with respect to how and when a task/job is undertaken and completed.
Fatigue	A state of impairment that can include physical and/or mental elements, associated with lowered alertness and reduced performance.
Health	Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO Constitution).

Human error	An inappropriate or undesirable human decision or behaviour that reduces, or has the potential to reduce effectiveness, health and safety of the worker, or a breakdown in system performance.
Hierarchy of control	Matching appropriate solutions to the level of risk.
Injury	Damage to the body caused by exposure to a hazard.
Interventions	Making changes to control an identified risk. The aim is beneficial change.
Job	Specific set of ongoing tasks to be performed by an individual.
Job Analysis	Evaluation of all tasks and factors involved in, and completion of, various phases of a job in a particular sequence.
Job Design	The process of deciding on the tasks and responsibilities to be included in a particular job. The aim is to satisfy the social and personal requirements of the job holder as well as technological and organisational requirements.
Job Rotation	The planned interchange of jobs, or tasks, among a group of workers at appropriate intervals in order to increase the variety of work and reduce overuse of particular body parts. It allows sharing the most stressful tasks, adds interest and increases workers' skills.
Macroergonomics	An approach in ergonomics which examines problems and issues in respect to the overall system so that it achieves effective and lasting change.

Manual Handling	A wide range of human activities such as lifting, pushing, pulling, holding, throwing and carrying as well as repetitive tasks including packing, typing, assembling, cleaning and sorting.
Microergonomics	An ergonomics approach which examines localised problems associated with the "Human-machine" interaction, with the aim of finding and implementing solutions at that level.
Musculoskeletal system	The system of bones, muscles and connective tissues (tendons, ligaments, fascia, cartilage) which support and protect the human body and its organs, and are the basis of all motion.
Motivation	Individuals' intention or willingness to perform a task to achieve a goal or reward that will satisfy them. Each individual experiences differing amounts and types of motivation, and considers different rewards or incentives as being attractive.
Noise	Unwanted sound. High noise levels can be annoying, distracting, fatiguing and may also result in impaired hearing.
Occupational ergonomics	Ergonomics as is applied at work to the design of the workplace, equipment and tasks and to work organisation.
Occupational hazard	Anything that has potential to cause harm to a person at work.

OHS	Occupational Health and Safety (OHS) is the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention among workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health and safety; the placing of and the maintenance of the worker in an occupational environment adapted to physical and mental needs.
Optimum/Optimal	Best or most favourable balance between the needs of people and real-life limitations such as availability of solutions, their feasibility and costs.
PPE	Personal Protective Equipment (PPE) includes a wide range of devices that are designed to give individual protection from health and safety hazards. Common examples include safety shoes/boots, ear plugs, glasses, face masks or respirators, and gloves.
Psychosocial factors	Subjective aspects of work organisation and how workers and managers perceive them; e.g. career considerations, clarity of the workers' roles, work schedules, workload and work pace, and the social and technical work environment.
Risk Assessment	Process used to determine the likelihood of people being exposed to injury, illness or disease in any situation identified during the hazard identification process; and also the severity of the illness, injury or disease.
Risk Control	Process used after conducting a risk assessment identifying all practical measures for removing or reducing the likelihood of injury, illness or disease, implementing these measures and reviewing them to ensure their effectiveness.

Stakeholder

A person, a group or an organisation that has either an interest in, concern for, and/or involvement with, OHS and the outcomes of work in OHS. The stakeholder may be directly or indirectly affected by this interest, concern or involvement, which may be seen as a gain or a loss. Stakeholders may be clients (individuals to whom the service is directed), customers (those who pay for the service), fellow workers, employers, trade unions and/or other professionals. The wider community may also be a stakeholder in the sense that it benefits from good OHS practice and it may also pay for such services, or the lack of them, through insurance, taxes, prices for goods and services.

Standards

These are issued by the Standard setting body in each country and provide guidelines relating to the design, operation and maintenance of equipment and systems. All Standards have a specific number and date.

Stress/Strain

Stress is the demands placed on individuals, and strain is what people experience when they perceive an inability to cope with the demands.

A person is under stress when demands exceed his/her ability to cope physically and/or mentally with such demands. These demands can be personal or work-related or both. Strain can sometimes be referred to as distress.

System

Systems are the structures which underlie complex situations. A system is a set of interrelated and interdependent parts arranged so that it appears to be, and acts like, a unified whole.

Task	Set of human actions that contribute to a specific functional objective and ultimately to the output goal of a system.
Task Design	The study of the components of a particular task to improve efficiency and minimise deleterious effects on the people who will perform the task. It includes planning and reviewing of task elements with respect to human capabilities and limitations, and the design of equipment they use, the work environment and the work organisation.
Vibration	The oscillating or periodic motion of a particle, group of particles, or solid object about its equilibrium position. Whole-body vibration refers to vibration transmitted through the body in the sitting or standing position. Hand-arm vibration refers to vibration transmitted through the hands and arms when using vibrating hand tools. Both types of vibration can have deleterious effects on health.

Work Related Musculoskeletal Disorders (WMSD)

WMSD are a range of conditions arising from, or associated with, work. They are marked by discomfort or persistent pain and/or other dysfunction in joints, muscles, tendons or other soft tissues of the body.

Back pain is the commonest form of WMSD usually associated with manual handling of loads; awkward or static postures; or arising from rough rides (vibration). Disorders of the neck, shoulders, arms and hands may be referred to as repetition strain injury (RSI) or cumulative trauma disorder (CTD) in different parts of the world.

Workstation

A place designed for performing work tasks including machines, work tables, benches, desks, displays and controls.

Ergonomics can play an important role in occupational health and safety management where the primary aim is to reduce risks of injury or disease while enhancing the quality of working life.

0.9 SOURCES OF USEFUL INFORMATION

WEBSITES

OSH Answers of the Canadian Centre for Occupational Health and Safety (CCOHS)

http://www.ccohs.ca/oshanswers/

OSH Links: Ergonomics of the CCOHS

http://www.ccohs.ca/oshlinks/subject/ergonomics.html

Centre of Research Expertise for the Prevention of Musculoskeletal Diseases, University of Waterloo

http://cre-msd.uwaterloo.ca/

Ergoweb Buyers' Guide

http://www.ergoweb.com/ergobuyer/

International Ergonomics Association (IEA)

http://www.iea.cc/

International Ergonomics Association (IEA): Study programs

http://www.iea.cc/browse.php?contID=study_ergonomics

Human Factors and Ergonomics Society of Australia: Resources

http://www.ergonomics.org.au/resources/

Work Improvement Network in Asia (Training programs WISE, WIND, etc.)

http://www.win-asia.org/

Japan International Labour Foundation: POSITIVE Program (Training in ergonomics application by trade union initiative)

http:// www.jilaf.or.jp/English-jilaf/genpro/positive/index.html

Ergonomics Society of South Africa (ESSA)

http://www.ergonomicssa.com

Singapore: Ministry of Manpower: Managing workplace hazards - ergonomics

http://www.mom.gov.sg/.../building_capabilities/Managing_Workplace_Hazards_/Ergonomics.html

Hong Kong Ergonomics Society

http://www.ergonomics.org.hk/ra.html

Ergonomics Society, United Kingdom: About ergonomics

http://www.ergonomics.org.uk/section.php?s=1

Ergonomics Society, United Kingdom: Links

http://www.ergonomics.org.uk/page.php?s=17&p=87

Japan National Institute of Occupational Safety and Health: Checkpoints of computer work

http://www.jniosh.go.jp/results/2007/0621_2/checkpoint_en/index.html

Health and Safety Executive (HSE) Britain

www.hse.gov.uk

National Institute for Occupational Safety & Health (NIOSH) USA - Centers for Disease Control and Prevention (CDC)

www.cdc.gov/niosh/nioshtic

PUBLICATIONS AVAILABLE THROUGH WEBSITES

Ergonomics Society, United Kingdom (for journals)

http://www.ergonomics.org.uk/page.php?s=8&p=94

Ergonomics Society, United Kingdom (for books)

http://www.ergonomics.org.uk/page.php?s=8&p=95

Hong Kong University of Science and Technology Library (ergonomics)

http://library.ust.hk/guides/ergonomics.html

Finnish Institute of Occupational Health [for books and other publications in English]

http://www.ttl.fi/internet/english

Coal Services Health and Safety Trust (Australia)

Practical Ergonomics. Application of ergonomics principles at work. 2005, 106 pages. (Barbara McPhee)

Bad Vibrations: A Handbook on Whole-body Vibration in Mining. Second Edition, 2009, 60 pages. (Barbara McPhee, Gary Foster and Airdrie Long)

www.coalservices.hstrust.com.au

BOOKS AND OTHER USEFUL PUBLICATIONS ON OCCUPATIONAL ERGONOMICS

Note: Most of these can be found most easily by 'Googling' the title or the author.

Ahonen M, Launis M and Kuorinka T (Eds.).

Ergonomic workplace analysis.

Helsinki, Ergonomics Section, Finnish Institute of Occupational Health, 1997. ISBN:9518016747. [Available from bookshop at www.ttl.fi/internet/english)

Bridger RS.

Introduction to Ergonomics, (2nd edition), and accompanying instructor's manual.

Published by Taylor & Francis, 2003. ISBN 0-415-27378-1.

Dul J and Weerdmeester B.

Ergonomics for Beginners, (3rd edition).

London, Taylor & Francis, 2008. ISBN: 9781420077513.

Karasek R and Theorell T.

Healthy Work: Stress, Productivity, and the Reconstruction of Working Life.

New York, NY: Basic Books, 1990. ISBN: 9780465028979.

Kroemer K and Grandjean E.

Fitting the Task to the Human – A Textbook of Occupational Ergonomics Approach.

London, Taylor & Francis (CRC) 1997 (5th Ed). ISBN: 0-7484-0665-4.

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London, Taylor & Francis, 1995. ISBN: 0748401318.

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Focus Groups.

London, Taylor & Francis (CRC Press), 2003. ISBN: 0-415-26208-9.

Monk TH and Folkard S.

Making Shift Work Tolerable.

London, Taylor & Francis
(CRC Press), 1992.
ISBN: 9780850668223.

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and Oxenburgh A.

Increasing Productivity and Profit Through Health and Safety.

London, Taylor & Francis
(CRC Press), 2004.
ISBN: 9780415243315.

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Bodyspace Anthropometry, Ergonomics and the Design of Work.

London, Taylor & Francis, 2006.
ISBN 9780415285209.

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New York, Cambridge University
Press, 1991.
ISBN: 9780521314190.

Rodahl K.

The Physiology of Work.

New York. Taylor & Francis,
London, 1989.
ISBN: 9780850664836.

Sanders MS and McCormick EJ.

Human Factors in Engineering and Design.

New York, McGraw-Hill, 1992.
ISBN: 007054901X.

Scott PA. (Ed).

Ergonomics in Developing Regions: Needs and Applications.

Florida, CRC Press, Taylor and Francis
Group, 2009. ISBN:978-1-4200-7911-1.

Violante F, Armstrong T
and Kilbom A (Eds).

Occupational Ergonomics: Work Related Musculoskeletal Disorders of the Upper Limb and Back.

London, Taylor and Francis, 2000.
ISBN: 0748409335.

Wilson JR, Corlett EN.

Evaluation of Human Work.

London, Taylor and Francis, 1995.
ISBN 07484-0084-2.

Ergonomic Checkpoints: Practical and Easy-to-implement Solutions for Improving Safety, Health and Working Conditions.

International Labour Office, 2009.
ISBN 978-92-2-122666-6.

International Ergonomics Association

ICOH

Joint Project of the International Ergonomics Association
and the International Commission on Occupational Health
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