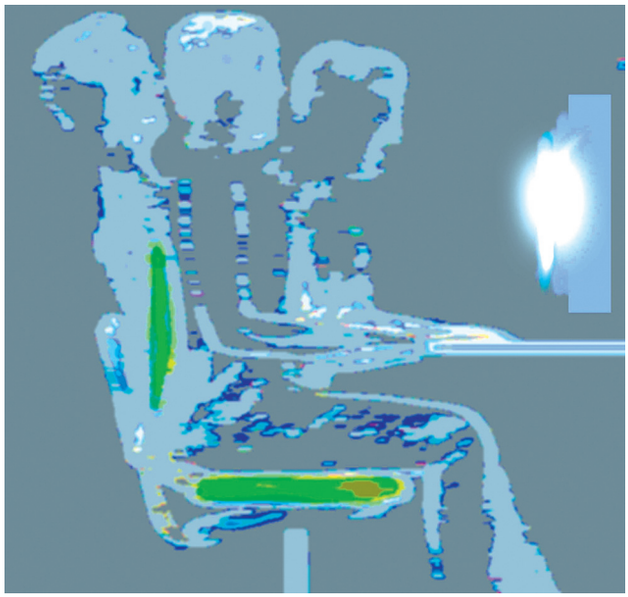
# Simply ergonomic

First steps in understanding ergonomic guidelines and standards by ergonomist *Duncan Abbott*



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IS IT A QUESTION of the emperor's new clothes, a fad or is there real substance to ergonomic guidelines? In the first of this series of 5 short articles, I ask how ergonomics is defined and by whom. If the word is used merely as an adjective, attached to a scrambled list of guidelines, then there is no substance in its meaning. This may well result in poor working practices that could expose the worker to risk and possible injury. However, if the ergonomic guidelines have been evaluated and tested and are appropriate to the industry to which they are being applied then they have the potential for being a useful tool. (For some good guidelines, see the article on nursing homes in the February 2004 edition of **HSW** magazine, pp 11–12).

Some organisations develop in-house guidelines, while others rely on third-party guidelines. In either case, following guidelines can backfire if the users do not understand their underlying assumptions.

There are over 2000 ergonomic standards available throughout the world. Each possesses certain characteristics, with its own status and legal characteristics, the domain that it is relevant to, its own scope that is the coverage of risks, and the type — what are its criteria for action. Some ergonomic standards are voluntary, others are mandatory. Some are generic for all industries (display screen equipment and manual handling ergonomic guidelines), while others are sector specific (such as OSHA's poultry and nursing guidelines). All guidelines will have some form of scope — global, exposure specific, or industry specific.

When evaluating whether guidelines will be beneficial to your organisation, you must assess your requirements and decide whether the guidelines address all (most) of the known ergonomic risks using a uniform approach, which can be applied to all industries. But the drawback of this approach is that it lacks specific scope so that you may well miss the issue of concern in your particular organisation. It is essential therefore that you examine your requirements and determine if a global guideline is sufficient.

The next aspect of the guideline's scope is to question whether it is exposure specific. Does it address a specific ergonomic risk or does it apply to wherever a risk is found? When evaluating if the ergonomic guideline is industry specific you must ask if it addresses all (most) of the ergonomic risks peculiar to an industry using a tailored approach such as OSHA's guidelines for supermarkets.

Having determined the scope of the ergonomic guideline, it is necessary for you to find out how the guideline works. For example, is it based on quantitative action or process type? A quantitative guideline will use precise and numerical criteria for determining whether (and what) action must be taken; whereas a process oriented guideline is based on a qualitative approach that emphasises an ergonomic program of "best" practices for reducing ergonomic hazards.

Next, it is prudent for you to consider the methodological issues, such as the sufficiency of the ergonomic hazards that are included, the scientific support for the guideline and the choice of ergonomic program components.

Most guidelines will examine risks such as repetition (the number of times the action is undertaken), force, posture, manual handling, vibration, contact stress and vibration. It will look at the ergonomic program by evaluating jobs, the reduction of risk, workers' training, management of musculoskeletal disorders (MSDs) and overall program evaluation.

You should try and find out what the scientific support is for any ergonomic guidelines adopted, such as whether the guidelines are coherent with scientific information, and what evidence exists to support the proposed ergonomic intervention.

It is useful to discern between process and qualitative guidelines. Process-type standards do not make any quantitative judgments about risk, so they are fully supported by the overwhelming epidemiological literature (studies that seek to find associations between exposure and disease, or cause and effect) that should demonstrate a qualitative relationship between ergonomic exposure and work related musculoskeletal disorders (WRMSDs).

Qualitative standards, however, are limited by the lack of consensus on how to measure exposure, the lack of a dose–response relationship between exposure and health outcomes, poor foundation for any threshold limit value, and the very nature of ergonomic exposures.

A further point to consider concerns the worker's exposure to risk, that is whether it can occur at work and/or away from work.

In trying to evaluate the effectiveness of an ergonomic guideline, it is necessary to determine how well it identifies the risk factors present, how effective it is in reducing exposure and how beneficial it is to the health of the workers.

Summing up, the health and safety manager must avoid common myths and misconceptions that can result in uncomfortable and costly mistakes. When using guidelines, make sure you know their origin — do not use guidelines that are written by suppliers who are often unaware of the underlying assumptions.

## About the author

Duncan Abbott works with a wide range of organisations in redesigning workplaces and job tasks to improve comfort and safety and increase productivity. He provides training in office and industrial ergonomics and this article is part of the ergonomics course run by enricoSmog Consultancy. How To Critically Evaluate Ergonomic Guidelines To Avoid Costly And Potentially Harmful Work-area Design is designed to help those in need of clarification on how to use ergonomic guidelines and runs in parallel with How To Design An Ergonomic Program. Readers may contact Duncan Abbott by telephone 01747 871868 or email da@enricosmog.com or visit the consultancy's website at www.enricosmog.com.

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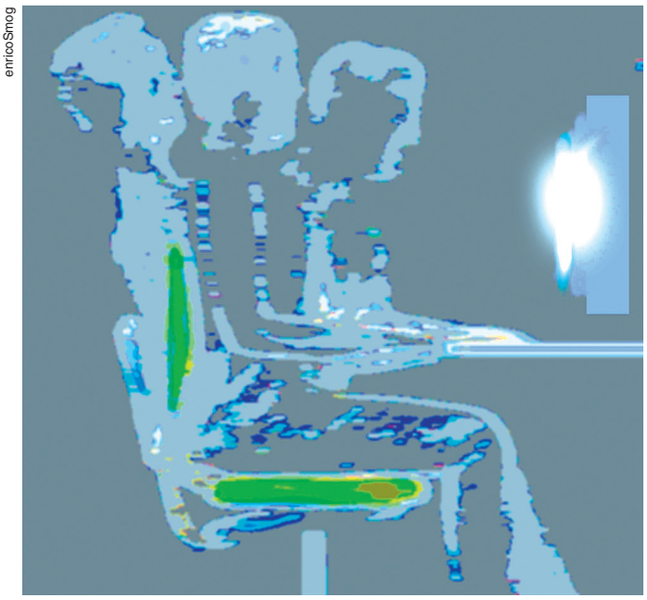
*In the second of this series of 5 short articles, Duncan Abbott introduces anthropometrics and biomechanics and explains the ergonomist's role*




WORK involves the use of tools and ergonomics is concerned with the design of these and, by extension, with the design of artefacts and environments for human use. If an object is to be used by human beings then it is presumably to be used in the performance of some purposeful task of activity. Such a task may be regarded as "work" in the broader sense. Thus, ergonomics can be defined as the science concerned with work or as a science concerned with design.

When undertaking a risk assessment the ergonomist will apply a multi disciplinary knowledge from various fields of the human sciences, including anthropometrics, mechanics, computer science, engineering, physiology, psychology, and sociology. This knowledge, when coupled with specific ergonomic methods and techniques, such as task analysis, video analysis, RULA (rapid upper limb assessment), will yield relevant information about hazards to allow the ergonomist to put forward improvements to increase the usability of a work system or product.

The ergonomic approach relates to many different human facets — not only physical injuries and their prevention. It can be considered holistic, as the ergonomist's intention is to design a workplace or environment to fit people, rather than the other way round. Thus the term "fitting the task to the worker" is commonly associated with the term ergonomics and, more recently, "inclusive design".

The measurement and analysis of body dimensions and the proportions of the human body in relation to workstation design, equipment, furniture, and consumer products is known as anthropometrics. Measurements of different body parts, and the effect that these have on the way things are designed, are why anthropometrics is a very important aspect of ergonomics. Using anthropometric data will help organisations to set up work areas that will allow the greatest number of workers to work safely and make work systems usable.

Biometrics is the science that deals with the forces that act upon the body; of particular importance to the ergonomist is posture and movement. Neutral posture is when the muscles and ligaments that span the joints are stretched to the least possible extent and so are assumed to be under less strain. The muscles meanwhile can provide their greatest force when joints are in this neutral posture. Bent wrists or asymmetry of the lower back are examples of joints out of a neutral posture.

The worker is the focus of ergonomics, where the intention is to prevent unsafe, unhealthy, uncomfortable or inefficient work practices by taking into account the physical and psychological capabilities and limitations of the human user.

The science of applied ergonomics can help a company achieve a safe work system where integrating technology and the worker's well being are essential requirements. Many organisations have found that having an ergonomist on the team has enabled them to achieve lower design and implementation costs by correcting ergonomic design for equipment and facilities at the initial part of a design project. Getting it right first time has been calculated at around 10% of the cost of a retrofit.

## Hazards and risks

Ergonomic hazards refer to workplace conditions that pose the risk of injury to the musculoskeletal system of the worker. Examples of musculoskeletal injuries are carpal tunnel syndrome (affecting the hand and wrist) and tennis elbow (inflammation of a tendon in the elbow). Ergonomic hazards include repetitive and forceful movements, vibration, temperature extremes, and awkward postures that arise from improper work methods and poorly designed workstations, tools, and equipment.

When an ergonomist undertakes a risk assessment they will consider: body posture and movement (sitting, standing, lifting, pulling and pushing), environmental factors (lighting, noise, temperature, and vibration), communication (information gained visually or through other senses, physical controls). By getting these factors right, the ergonomist can help an organisation keep its workforce safe and productive.

The ergonomist can assist an occupational health professional ensure that equipment, technical systems and tasks are designed in such a way that they are suited to each user. Humans vary so that most designs are suited to 90% of the population. Thus any risk assessment must ensure that workers that are short, tall, overweight, with disability, old, young, or pregnant are given consideration by making a reasonable adjustment to ensure their comfort and safety.

## Consulting an ergonomist

Ergonomics can improve performance; for example, operator error in complex technical systems has been substantially reduced. This has helped to reduce the risk of terrible accidents such as Chernobyl recurring. Some ergonomic knowledge has been compiled into official standards whose objective is to stimulate the application of ergonomics.

If costly mistakes are to be avoided, an ergonomist should be consulted when any workplace intervention or the task or environment is being considered. In the majority of cases the cost benefits of an ergonomic intervention will far outweigh its cost.

## Further reading

1. Pheasant, S, Bodyspace – Anthropometry, Ergonomics And The Design Of Work, (P4), ISBN 0 7484 0326 4
2. Ergonomics For Beginners, Dul, J and Weerdmeester, B, 2nd Edition, Taylor and Francis, ISBN 0 7484 0825 8
3. Alexander, DC, (1998, March), Strategies For Cost Justifying Ergonomic Improvements, IIE Solutions, 30–35

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# Simply ergonomic

*In the third of this series of five reports* Duncan Abbott *looks at work organisation, job design and task analysis*

WHEN ergonomists approach work organisation or job or task design, they will utilise a multidisciplinary knowledge to look at both the physical and cognitive aspects. They will study the physical layout to ensure items are placed so that they pose the least risk of injury or error. They examine the cognitive layout to ensure that items such as dials and controls are laid out to match the mental model of the operator/user so that they do not result in error or confusion when used.

To assist the ergonomists in their investigations, ergonomic methodology and tools, research, guidelines and standards might be consulted. Two methods that may bring success to any change are the task analysis and the user trial. Task analysis will be discussed in this article and user trials will be discussed in part 4 of the series.

## Why do a task analysis

A task analysis breaks down any task into its components of subroutines, which communicates to a task analyst all aspects of the task that an operator performs. The task breakdown will enable a designer to clearly understand the demands of the task, which is essential when redesigning an operator's task, providing new equipment or updating/modifying existing equipment. A task analysis when undertaken will ensure that a vital, but unseen, aspect is not ignored or missed.

The goal of the analysis is to break down the job into small tasks so that risk factors associated with each task can be identified. Each risk factor can then be evaluated to determine the likely impact on the operator, when changes to equipment, materials or environment takes place. Having gathered this knowledge the designer can then design out any hazards that may arise and, if this is not possible, put in controls to maximise safety.

The objective of the task analysis is to gather information and to get an overall detailed picture of the operator performing a task in his or her environment. If the task analysis is accurate, and the data collected is interpreted correctly, then a successful design will be achieved. Data can be collected in the following ways.

- By recording the operation of the operator using a video camera — there is a minimum of interruption, as the task analyser can study the operator repeatedly at their workplace.
- Documentation is studied, which gives an accurate picture of how work should be performed, whereas the video footage will reveal if this is what happens in practice.
- The task analyst observes the operator and, using a checklist, the priority and duration of tasks are determined.

Having completed the task analysis it is essential to ensure that infrequent or unscheduled activities, such as maintenance and cleaning are factored into the design. For example, many cleaners suffer from injuries that result from poorly laid out workstations, as the designer had made no allowance for cleaners to access all parts of the workstation. This has led to them adopting poor work practice to perform their tasks (see **HSW** July 2004, pp 12–14, Caring For Cleaners, for example).

## Work organisation

Forward thinking health and safety managers have realised that by getting the relationship between their greatest assets – people and technology – right, they can create work environments which are both flexible and responsive to the demands of its occupiers and users. For most organisations, technology has emerged as a key factor when considering work environments. As one of the few disciplines that adopt a socio-technical view, ergonomists believe that an organisation's implementation strategy must facilitate organisational change and human learning as well as technical change for it to be successful.

When organising work and making job changes, there are several factors that are often overlooked — repetition, speed of throughput, changing from a manual to automated task and managing change.

Repetition should be designed out at the initial stage. If repetition cannot be avoided then operators must be able to rotate jobs, so that they can avoid risk of injury and boredom. When operators are called upon to work at a predetermined rate, it is essential that the rate is constant and that speed does not fluctuate.

Also, when manual tasks are replaced by automation, the effects on the operator need to be considered. The interaction between human–machine or human–human can be upset. Any change in workload or task demands must be phased in, to allow the operators to achieve a task fitness that will help avoid the risk of injury. Changes must be introduced with care, so that they are accepted by the operators, and a post-analysis should be undertaken, for example a satisfaction survey.

## Summary

Success in a working environment can be achieved by utilising 2 simple methods.

Firstly, a task analysis should be done whenever environments are considered to be changed, new technology is to be implemented or a change of working practices is being considered. It should examine all parameters of the task, so that any proposed automation or workplace adaptation can be evaluated to ensure alterations will not hinder the task or frustrate the worker.

Secondly, user trials should always be considered when making changes to the working environment. For example, a mock-up of a redesigned counter should be made and some of the staff should interact with the new design. This ensures that any problems are corrected and costly redesign after implementation is avoided.

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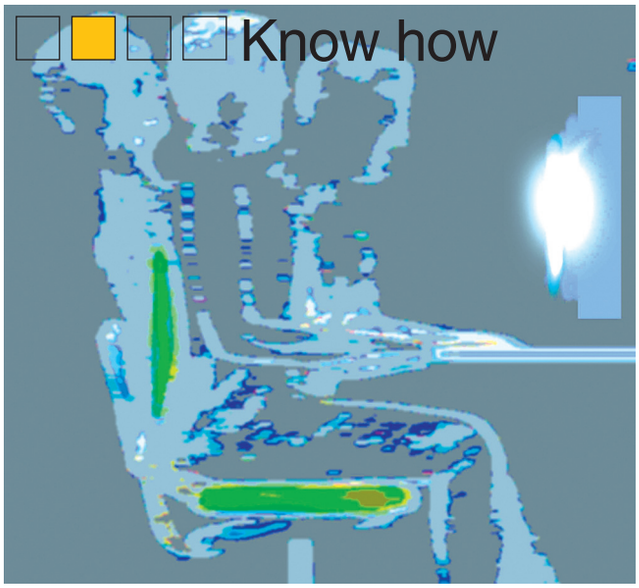


# Simply ergonomic

*In the fourth report of this 5-part series* Duncan Abbott *investigates usability asking why do work systems fail*

TODAY'S working environment is complex and demanding where a never-ending battery of new technologies is introduced to help streamline and facilitate the work that is conducted. For an organisation to meet changing operational requirements, the need to integrate space and technology effectively has become an essential requirement. Invariably, the root cause of any problems is a lack of usability resulting from the lack of recognition of the full needs of the worker in the design of the work system.

The International Standards Organisation defines usability as "the effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments" (ISO-DIS 9241-11).

## Think before you act

Going back to Part 3 of the series, the importance of task analysis was discussed, and its importance is reiterated here, because if a designer is to understand how their products or systems are to be used, then a task analysis should be carried out. For example, in the design of controls and displays it is essential that the allocation of function between human and machine is correct if human error is to be avoided.

If usability has not been considered then deficiencies in the design for displays and controls will occur. A task analysis should be undertaken that determines where problems are occurring. Then these can be addressed by changing the control or display. This exercise can be aided by recourse to ergonomic literature such as the Safety Of Machinery – Ergonomics Requirements For The Design Of Displays And Controls. The document is a European Standard that specifies general principles for human interaction with displays and control actuators, to minimise operator errors and to ensure an efficient interaction between the operator and the equipment.

It is also important to note that just as there are physical conditions that affect controls and displays, there are also environmental conditions too — including electromagnetic radiation, lighting, toxic waste, mist, heat, and noise. These factors should be considered as a usability need, because if the product is to be used in all types of environments then it must be fit for purpose if the user is going to be able to operate the product successfully. The combination of a task analysis, environmental audit and usability trial will alert the designer to all factors that may result in the failure of interaction between human user and product. (For more information about display and control design, see Communicating With Objects, **HSW**, Nov. 2003, pp9–10).

Usability can also be considered in relation to the use of instructions; if these are unclear then the wrong use of product, machinery or process will occur. Unfortunately, too many instructions and warning signs are signed off before they have been evaluated and tested. When examining instructions and warning signs, 2 aspects need to be tested: behavioural and comprehension.

Comprehension testing should be used for textual and pictorial information, which should determine whether users understand the information conveyed in the instructions or the warning.

Behavioural testing will determine the users' behavioural intentions as opposed to their behavioural compliance. This can be achieved by giving the user a questionnaire. It will ensure that the users are not just doing what the designer requires them to do. It is also quicker and cheaper than having to evaluate compliance over time.

## Iterative approach

The usability study should offer feedback as to how the instructions and warnings can be modified, which will allow an iterative design approach. Any changes in the design of instructions or of warning signs can be guided by the feedback received during the usability study. The process can be repeated until the instructions or warning sign achieves its goal.

When talking about usability we must consider work systems, and ask what is the main reason that can cause new work systems to fail? The answer to this question is invariably that the designer did not take full account of the human user in the specification of the system.

Technical change is a pervasive feature of organisational life. Companies devote a considerable proportion of their resources to the planning, purchasing and development of new technical systems to help them become more efficient and effective. Unfortunately, many companies look only at the technical implementation and not the usability of the system, thus leaving the human user out of the loop and feeling frustrated.

If resistance to change is to be avoided it is necessary to involve all potential users in the change process and not merely a selected few. Implementation procedures can make or break a technical innovation by the way potential users are introduced to the innovation and the extent to which they have an opportunity to shape the system to their requirements. It is important to remember that it is the people that use the technology who will make it work, and it is they who will ensure that the organisation derives the benefit. It, therefore, is worth getting the design right first time.

History is littered with companies that have failed to consider the most obvious drawbacks in their haste to install the latest technology and have paid dearly for it. It can be quite frightening not to mention embarrassing when suddenly hit by a "SGO" — a stunning glimpse of the obvious.

**The European Standard, BS EN 894–1: 1997, Safety Of Machinery – Ergonomics Requirements For The Design Of Displays And Control Actuators, Part 1 General Principles For Human Interactions With Displays And Control Actuators is available from BSI, visit www.bsi-global.com for more details.**

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