



## definition

What is ergonomics? Most people have heard of ergonomics and think it is something to do with seating or with the design of car controls and instruments. It is...but it is much more! Ergonomics is the application of scientific information concerning humans to the design of objects, systems and environment for human use. Ergonomics comes into everything which involves people. Work systems, sports and leisure, health and safety should all embody ergonomics principles if well designed.

## using ergonomics

How do you use ergonomics? Ergonomics incorporates elements from many subjects including anatomy, physiology, psychology and design. Ergonomists apply their diverse knowledge to ensure that products and environments are comfortable, safe and efficient for people to use.

## ergonomic design

What is 'ergonomic design'? Ergonomic design is a way of considering design options to ensure that people's capabilities and limitations are taken into account. This helps to ensure that the product is fit for use by the target users.

## Ergonomics

Why is the video recorder one of the most frustrating domestic items to operate? Why do some car seats leave you aching after a long journey? Why do some computer workstations confer eyestrain and muscle fatigue? Such human irritations and inconveniences are not inevitable – ergonomics is an approach which puts human needs and capabilities at the focus of designing technological systems. The aim is to ensure that humans and technology work in complete harmony, with the equipment and tasks aligned to human characteristics.

Ergonomics has a wide application to everyday domestic situations, but there are even more significant implications for efficiency, productivity, safety and health in work settings. For example:

- Designing equipment and systems including computers, so that they are easier to use and less likely to lead to errors in operation – particularly important in high stress and safety-critical operations such as control rooms.
- Designing tasks and jobs so that they are effective and take account of human needs such as rest breaks and sensible shift patterns, as well as other factors such as intrinsic rewards of work itself.
- Designing equipment and work arrangements to improve working posture and ease the load on the body, thus reducing instances of Repetitive Strain Injury/Work Related Upper Limb Disorder.
- Information design, to make the interpretation and use of handbooks, signs, and displays easier and less error-prone.
- Design of training arrangements to cover all significant aspects of

the job concerned and to take account of human learning requirements.

- The design of military and space equipment and systems – an extreme case of demands on the human being.
- Designing working environments, including lighting and heating, to suit the needs of the users and the tasks performed. Where necessary, design of personal protective equipment for work and hostile environments.
- In developing countries, the acceptability and effectiveness of even fairly basic technology can be significantly enhanced.

The multi-disciplinary nature of ergonomics (sometimes called 'Human Factors') is immediately obvious. The ergonomist works in teams which may involve a variety of other professions: design engineers, production engineers, industrial designers, computer specialists, industrial physicians, health and safety practitioners, and specialists in human resources. The overall aim is to ensure that our knowledge of human characteristics is brought to bear on practical problems of people at work and in leisure. We know that, in many cases, humans *can* adapt to unsuitable conditions, but such adaptation leads often to inefficiency, errors, unacceptable stress, and physical or mental cost.

### The components of ergonomics

Ergonomics deals with the interaction of technological and work situations with the human being. The basic human sciences involved are *anatomy*, *physiology* and *psychology*, these sciences are applied by the ergonomist towards two main objectives: the most productive use of human capabilities, and the maintenance of human health and well-being. In a phrase, the job must 'fit the person' in all respects, and the work situation should not compromise human capabilities and limitations.

The contribution of basic *anatomy* lies in improving physical 'fit' between people and the things they use, ranging from hand tools to aircraft cockpit design. Achieving good physical fit is no mean feat when one considers the range in human body sizes across the population. The science of anthropometrics provides data on dimensions of the human body, in various postures. Biomechanics considers the operation of the muscles and limbs, and ensures that working postures are beneficial, and that excessive forces are avoided.

Our knowledge of human *physiology* supports two main technical areas. Work physiology addresses the energy requirements of the body and sets standards for acceptable physical workrate and workload, and for nutrition requirements. Environmental physiology analyses the impact of physical working conditions – thermal, noise and vibration, and lighting – and sets the optimum requirements for these.

Psychology is concerned with human information processing and decision-making capabilities. In simple terms, this can be seen as aiding the cognitive 'fit' between people and the things they use. Relevant topics are sensory processes, perception, long- and short-term memory,

decision making and action. There is also a strong thread of organizational psychology.

The importance of psychological dimensions of ergonomics should not be underestimated in today's 'high-tech' world – remember the video recorder example at the beginning. The ergonomist advises on the design of interfaces between people and computers (Human Computer Interaction or HCI), information displays for industrial processes, the planning of training materials, and the design of human tasks and jobs. The concept of 'information overload' is familiar in many current jobs. Paradoxically, increasing automation, while dispensing with human involvement in routine operations, frequently increases the mental demands in terms of monitoring, supervision and maintenance.

### **The ergonomics approach – understanding tasks ... and the users**

Underlying all ergonomics work is careful analysis of human activity. The ergonomist must understand all of the demands being made on the person, and the likely effects of any changes to these – the techniques which enable him to do this come under the portmanteau label of 'job and task analysis'.

The second key ingredient is to understand the users. For example, 'consumer ergonomics' covers applications to the wider contexts of the home and leisure. In these non-work situations the need to allow for human variability is at its greatest – the people involved have a very wide range of capabilities and limitations (including the disabled and elderly), and seldom have any selection or training for the tasks which face them.

This commitment to 'human-centred design' is an essential 'humanizing' influence on contemporary rapid developments in technology, in contexts ranging from the domestic to all types of industry.

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### **The origins of ergonomics**

Ergonomics is a relatively new branch of science which celebrated its 50th anniversary in 1999, but relies on research carried out in many other older, established scientific areas, such as engineering, physiology and psychology.

It originated in World War 2, when scientists designed advanced new and potentially improved systems without fully considering the people who would be using them. It gradually became clear that systems and products would have to be designed to take account of many human and environmental factors if they are to be used safely and effectively. This awareness of people's requirements resulted in the discipline of ergonomics.

Some years ago, researchers compared the relative positions of the controls on a lathe with the size of an average male worker. It was found that the lathe operator would have to stoop and move from side to side to operate the lathe controls. An 'ideal' sized person to fit the lathe would be just 4.5 feet tall, 2 feet across the shoulders and have an arm span of 8 feet.

This example epitomises the shortcoming in design when no account has been taken of the user. People come in all shapes and sizes, and the ergonomist takes this variability into account when influencing the design process.

The branch of ergonomics that deals with human variability in size, shape and strength is called anthropometry. Tables of anthropometric data are used by ergonomists to ensure that places and items that they are designing fit the users.

### **Vision**

Vision is usually the primary channel for information, yet systems are often so poorly designed that the user is unable to see the work area clearly. Many workers using computers cannot see their screens because of glare or reflections. Others, doing precise assembly tasks, have insufficient lighting and suffer eyestrain and reduced output as a result.

### **Sound**

Sound can be a useful way to provide information, especially for warning signals. However, care must be taken not to overload this sensory channel. A recent airliner had 16 different audio warnings, far too many for a pilot to deal with in an emergency situation. A more sensible approach was to have just a few audio signals to alert the pilot to get information guidance from a visual display.



### **Job design**

One goal of ergonomics is to design jobs to fit people. This means taking account of differences such as size, strength and ability to handle information for a wide range of users.

Then the tasks, the workplace and tools are designed around these differences. The benefits are improved efficiency, quality and job satisfaction. The costs of failure include increased error rates and physical fatigue - or worse.

### **Human error**



In some industries the impact of human errors can be catastrophic. These include the nuclear and chemical industries, rail and sea transport and aviation, including air traffic control.

When disasters occur, the blame is often laid with the operators, pilots or drivers concerned - and labelled 'human error'. Often though, the errors are caused by poor equipment and system design.

Ergonomists working in these areas pay particular attention to the mental demands on the operators, designing tasks and equipment to minimise the chances of misreading information or operating the wrong controls, for example.

considered include stairs and ramps, hygrothermal conditions (cold, damp, heat), security and accessibility. Sensory aspects include acoustics, lighting, comfort, communication systems, signage and navigation.

In 1995, the Government's Office of Science and Technology initiated 'EQUAL' (**E**xtending **QUAL**ity Life). This initiative draws research activities together that focus on achieving a better lifestyle, participating more fully and actively, and avoiding or alleviating the effects of disability. In 1997, the built environment was highlighted as an area in which EPSRC (Engineering and Physical Sciences Research Council) funded research could make significant contribution to the aims of EQUAL. 11 projects were funded at that time (for details see [www.epsrc.ac.uk/](http://www.epsrc.ac.uk/)). Further relevant information can also be found at the AgeNet web site [www.agenet.ac.uk](http://www.agenet.ac.uk).



### Design of information

Much of today's human factors research and expertise is channelled towards improving the ways we use information. Virtually everyone has experienced the frustration of using computer software that doesn't work the way they expect it to. For the majority of

end users of computer programmes, if the system is not working they have no recourse but to call for technical help, or find creative ways around system limitations, using those parts that are usable, and circumventing the rest or increasing stress levels by using a substandard system. Often the problems in systems could have been avoided, if a more complete understanding of the users' tasks and requirements had been present from the start. The development of easily usable human-computer interfaces is a major issue for ergonomists today.

Information design is a related area, concerned with the design of signs, symbols and instructions so that their meaning can be quickly and safely understood.