So you want to learn more about people ...

Step in for a journey to discover the potential, capabilities, strengths (and limitations) of this essential element in systems design!

Module 4

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(Sincere thanks to Prue Howard, Amanda Brain and Steve McKillup for their valuable contributions)

Organisational ergonomics

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Contents

Introduction to the module

Consideration of job design as being important and the notion of there being a relationship between job design and worker satisfaction had its foundation with the Scientific Management Movement. The work completed by Taylor (1898 to 1912) and the results of the Hawthorne studies (1924 to 1932) have had a significant and ongoing influence on the way we organise work. This area has gained increasing importance and as you work through this module you will recognise the many problems we are facing in the workplace today. This module is very brief and only provides a few examples of issues to be considered.

Issues in job design

The importance of "Job Design" is probably most easily illustrated through an example of its impact on a particular industry (see link for example of impact on mining industry).

Related to the above issues are many commonplace considerations in the way we organise work (eg. shift work):

- does the organisation of shifts fit with our workers' circadian rhythm?
- has there been adequate consideration about what meals might be available for the night worker?
- has there been consideration of the social situation of the shift worker and the ability of that worker to get some sleep?
- does the following shift allow enough time for a "wind down" and the opportunity to get some sleep (nurses regularly work 2.30 pm to 11.00 pm then 7.00 am to 3.30 pm)?

- is there sufficient variety of tasks over the shift to keep a tired worker awake?

Sound familiar?—You covered many of these aspects in the first half of this package. For further reading on the design of shift work and monotonous tasks a link has been provided.

Your next reading will provide insight into the relationship between stress and human error.

Ergonomic user interface

The user interface is known by a number of different terms, for example, Human Computer Interaction, Human Computer Interface (HCI), Computer Human Interaction (CHI), Man-Machine Interface (MMI) and User-System Interaction (USI).

An interactive system should not only be user "friendly" but appropriately functional to the meet the needs, particularly the mental characteristics, of the users. Designers need to know why it is important to consider ergonomics. People differ so it is important to know to whom the system is being targeted (see mental models link). It is imperative that ergonomic considerations are incorporated into the design from the inception of the product.

Features of ergonomic software

Ergonomic software should be (Pollock, 1990):

- **adaptable**, for example, change of screen colour to meet visual needs of users
- **transparent**, the user should know what the computer is thinking
- **comprehensible**, for example, the user should be able to understand commands without difficulty
- **natural**, that is, designed to take into account "natural" compatibility
- **predictive**, that is, a computer should respond the same way each time the same command is given
- **responsive**, every time the user responds the computer should respond
- **self-explanatory**, the user should not have to continually consult a manual
- **forgiving**, the software should include some checks, for example, asking the user if they want to save before closing down a document
- **efficient**, for example, limiting the amount of keystrokes or mouse actions required to perform a task
- **flexible**, the software should allow for multiple users and uses
- **available**, this refers to the package being reliable and available for use whenever required.

Designing for novices and experts

Novices and experts have different needs in software design. The table below outlines some of these differences.

Design considerations	Novice user	Expert user
Knowledge of use	Prompt with online help and tutorials	Less need for online help and tutorials
Knowledge of commands	Prompt with menus	Allow for quick operation and shorter commands
Information chunks	Thinks in small chunks—use small steps	Thinks in large chunks—allow for multiple steps with one command
Safety net	Have high rate of mistakes allow for backtracking	Novices can progress to experts—software should allow the transition

Activity 4–1

Revisit your sketch of your vehicle once again. Assess usability of the control design in your vehicle and include any notes on your sketch.

Environmental factors

Of the environmental factors which influence work, the most obvious are illumination and thermal comfort. This module will not detail monitoring of these aspects but instead will concentrate on the application of principles to the design of the workplace environment in ergonomic terms. The supplementary discussion and guidance to Standards is to add an Australian context.

Lighting

When performing visual tasks, our eyes see the light reflected off a given object. This light given off by objects is called “luminance” and is measured in c^d/m^2. There are preferred “lighting” levels to achieve the right amount of light falling on or reflected off objects to make visual tasks easier. These sources of light may be natural (windows) or artificial luminances (lights and lamps) “illuminance” is the light falling onto a surface and is measure in lux.

When we look at an object, our eyes (pupils) adjust to the reflected light or light given off an object. This controls the amount of light entering the eye.

When there is a significantly brighter source of light in our line of vision, our eyes have trouble in adjusting to allow in the right amount of light to see the object and block out excess light. “glare” is the name for sources of light in our line of vision which make it difficult for us to see objects, images etc. Glare does not damage the eye, but may cause difficulty performing tasks and eye strain or headaches. Generally, the source of light, in line of vision, has to be at least ten (10) times brighter than the light given off by the object before problems arise.

Different light sources give off a different mix of colours, (e.g. white light, yellow light, ultraviolet light). This is the colour-rendering characteristic of the light source. It will affect the colour that objects appear to be and the brightness of an object or room. These affect visual comfort and ability to see detail.

There are a number of considerations in lighting design:

- illuminance for task performance
- sources of glare or shadow
- colour rendering characteristics
- visual environment—colouring, textures, adequate variation illuminations to create pleasing visual environment, but not overwhelm.

The 1680 series of standards relates to lighting.

AS1765–1975:	*Artificial lighting for clinical observation*
1680.1–1990:	*General principles and recommendations*
1680.2.0–1990:	*Recommendations for specific tasks and interiors*
1680.2.1–1993:	*Circulation spaces and other general areas*
1680.2.2–1994:	*Office and screen-based tasks*
1680.2.3–1994:	*Education and training facilities*
1680.3–1991:	*Measurement, calculation and presentation of photometric data.*

Illuminance

The lighting level falling on surfaces in a particular area depends on the tasks performed. Generally tasks involving reading or writing require approximately 400 lux, conference or copy rooms around 240 lux and store or stockrooms around 160 lux. For high visually demanding activities, such as drafting, 600 lux is required.

Lighting levels preferred for a task are also “personal”. Typically, people with poor eyesight and increasing age, require higher lighting levels and are more sensitive to sources of glare. Task lights (desk lamps) may be used to address individual needs. If people are not experiencing visual strain and can perform the visual task with ease, the levels are adequate for the person.

Computer areas are difficult because of the following:

- Low lighting levels are suitable for computer screen use as the computer is self-lit. However, illuminance of approximately 200 lux is adequate.
- Around 400 lux is required for reading source documents. Bright sources of light in a person’s line of vision when looking at the computer, or which are reflected by the screen, may result in difficulty reading the screen and/or the person’s assuming an awkward posture (to avoid the light source). Positioning of light sources becomes critical, preferably to the side or directly above the work area.

Glare and shadow

Overhead lighting sources which direct light down (e.g. eggshell diffusers) decrease reflection from screen to eyes. Unfortunately, they increase the number of luminances (lights) required to avoid shadows and may reduce general lighting levels.

Positioning of light sources to the side or above computer operator will minimise light sources in line-of-sight, or reflected from screen.

Positioning computer perpendicular to windows (i.e. to side of computer operator), is preferable. If this is not possible, provide suitable curtains or blinds.

Shadows on work area should be avoided by use of multiple locations for lights and lamps, (i.e. either side of work area). Areas with inadequate lighting should have additional light sources installed, not increased wattage of existing lamps as very bright sources of light increase “glare or reflection” problems. Sometimes, simple cleaning a light or fitting and replacing tube/bulb may increase levels adequately. Tubes deteriorate significantly over time.

Positioning of lighting is also relevant to visual inspection tasks. Back lighting or angle lighting may assist in fault detection.

Visual environment

Choice of position and colour-rendering characteristics of luminances affect visual task performance and atmosphere of a room.

People prefer the brightness of the area they are looking at to be higher than the surrounding areas in line of vision and peripheral vision (e.g. bright desk tops with duller storage areas and floor). They also prefer consistent levels across areas in which they work (e.g. across a desk top).

The colour characteristics of light sources will affect perception of lighting levels. Consistent colour-rendering characteristics of bulbs and tubes should be utilised across an work area. Sometimes particular colour-rendering characteristics are required for visual inspection tasks to highlight what is being looked for.

The lighting levels across a section should be fairly consistent. High levels of natural light (windows) in a work area on an outside of a building make the centre work area appear dull. Increasing artificial light levels in central areas, or tinting external windows, may reduce this contrast.

Areas should not be lit with single fluorescent tubes, but with two or more phase shifted tubes to minimise visible flicker.

Vision and VDU

AS3590.1–1990:	Visual display units describes the visual characteristics required of a VDU.
AS1680.2.2:	Describes the lighting requirements (replaced 2613).

Choice of position and colour-rendering characteristics affects visual task performance.

Activity 4–2

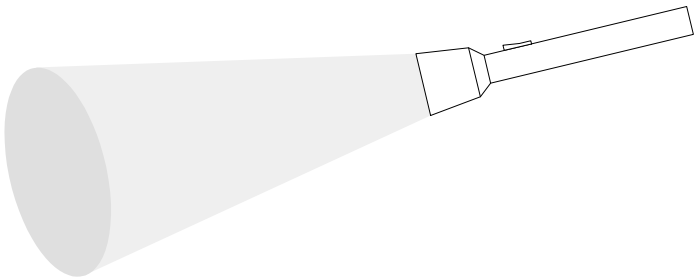
Reconsider the issues presented by the first link (ICOH Vision & Work Committee). Look at your current work environment – How many of the factors in the model may be influencing your ability to work efficiently?

Activity 4–3

Using a torch try the following:

Position the torch in front of your line of sight and try to write on the page. Position it to the side of the page and repeat from the other side.\

Figure 4–1



Note:glare

shadows

Where is the “best position” for writing ?

Using the same torch look at a piece of carpet. Try shining directly down, at an angle from the side and from the front.

Which is the best position for looking at texture?

These activities should have highlighted how critical the placement of lighting sources can be to the performance of tasks.

Thermal comfort

Again this area is covered in detail in your studies in occupational hygiene and will not be discussed in detail here. The implication from an ergonomics perspective is about design of job, environment, equipment and protective clothing:

1. Gloves and mittens may result in:
    - increased forces generated in hand to grip
    - decreased dexterity.
2. Protective clothing:
    - may restrict movement
    - may increase effort to work (weight and resistance).
3. Environment temperature affects:
    - manual dexterity
    - fatigue
    - strength
    - mental performance.

Course summary

That concludes this study package. In this learning activity we covered how information was received and processed, and how the human body is able to perform work. Subsequent modules have given you the opportunity to address some of the other ergonomic issues which equip you to assess the workplace in a holistic manner.

Human Factors (or ergonomics) as a discipline is integral to your practice as an engineer. We hope that you have found this package both interesting and challenging, and that you will find the knowledge gained useful in your practice.

Review questions

Review question 4–1

Is job design necessary? Choose one issue in job design (such as worker motivation) and outline all of the possible consequences of a failure to consider job design principles.

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Review question 4–2

What skills can the ergonomist bring to training and selection.

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Review question 4–3

Explain in your own words—What is meant by mental models?

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Review question 4–4

Draw a mind map to explain the principles of usable design in relation to human computer interaction.

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Review question 4–5

Imagine for a moment that you are employed to design a food processing plant. The workers are required to pack boxes onto a pallet in the cold room. Drawing on your learning from this module, explain the importance of each of the environment factors discussed in relation to this work (Don't forget to revisit Module 1-Task Analysis!).

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