National Occupational Health and Safety Commission

Ergonomic Principles and Checklists for the Selection of Office Furniture and Equipment

November 1991

ISBN 0 644 24516 6

ERGONOMIC PRINCIPLES FOR THE SELECTION OF OFFICE FURNITURE AND EQUIPMENT

1. Introduction

The Ergonomics Unit at Worksafe Australia receives frequent requests for advice on the purchase of furniture and equipment for offices. It also advises frequently on remedial action in offices where there are problems such as complaints of musculoskeletal discomfort or excessive glare. In May 1990, the Department of Administrative Services began to draw on the experience of the Unit by involving it in the process of selecting the contractors to supply office chairs to Commonwealth Government departments. This was followed by the Unit's involvement in the selection procedures for contracts for adjustable desks and other equipment such as footrests and document holders. These activities led to the Unit developing a series of checklists for the ergonomic evaluation of office furniture and equipment.

Checklists for the ergonomic evaluation of products are useful for the following reasons:

- They require decisions to be made on the essential and desirable criteria for selection;
- They ensure a consistent approach to the evaluation of a large number of products; and
- They provide a guide to manufacturers and suppliers on the ergonomic criteria being used in the selection process.

The aims of the criteria used in the checklists are to optimise the comfort and productivity of office workers and to minimise their risk of suffering musculoskeletal disorders. Since they are usually selected and purchased separately, there are separate checklists for each type of furniture or equipment. However, it is important that each item be considered in the context of the whole workstation. The aims of this introductory paper are to explain the principles which should be applied to the overall workstation design and how the checklist criteria were developed.

2. Office Ergonomics and Occupational Health

Ergonomists aim to provide working conditions which are well above the minimum required to ensure health and safety of the workforce. Thus, in achieving a comfortable, productive and satisfying office environment, any musculoskeletal complaints would also be minimised. To design such an environment, it is necessary to consider not only furniture and equipment, but also the job designs, lighting, noise, air quality, office landscaping and personal space. This paper concentrates on furniture and equipment which both have a strong influence on postures.

Constrained Postures

In office work, discomfort and pain are most likely to be caused by constrained postures, and hence static muscle loads which lead to early fatigue. (See, for example, Hunting et al., 1980, Hunting et al., 1981, Kilbom et al., 1986, and Westgaard et al., 1986.) Constrained postures which are often troublesome are:

- Forward flexion of the neck;
- Twisting of the neck;
- Elevation of the shoulders;
- Twisting of the trunk;
- Forward reaching of the upper arm;
- Abduction of the upper arm;

Ulnar deviation of the hand; and

Extension of the wrist.

The time for which such postures must be held is crucial in determining the need for correction. Thus, there are two general approaches to the problem:

Avoid prolonged maintenance of constrained postures by ensuring frequent rest breaks, designing the job to provide variety, and limiting the proportion of the working day which has to be spent on some activity which constrains posture, such as continuous keying; and

Minimise the need for poor posture in all activities by giving attention to furniture and equipment and its proper arrangement and adjustment.

Neither approach should be made in isolation. There is obviously an interaction between the two. The less ideal the ergonomics of a workstation, the greater will be the need for rest breaks. This is one way in which ergonomic improvements can have a beneficial effect on productivity.

Job Satisfaction

Apart from its influence on posture and hence comfort, poor ergonomics of a workstation can have a bad effect on job satisfaction. This is increasingly so as people become aware of the existence of good furniture. For this purpose, furniture is probably a "hygiene" factor, that is, it causes dissatisfaction if it is not good, but does not greatly contribute to satisfaction once good furniture has been obtained. However, avoidance of dissatisfaction is still a significant reason to get the furniture right. In doing so, the users must be thoroughly involved in the selection process.

3. Principles for Designing an Office Workstation

Each workstation must be considered as a whole, rather than by selecting individual items of furniture and equipment in isolation. The bases for the design include:

The tasks to be done at the workstation;

The materials and equipment required; and

The dimensions of the operator/s (anthropometry).

The reason for emphasising the study of the complete system is the strong interaction between most individual items. For example, it is no use selecting a chair of sufficiently low height adjustment to allow small people to rest their feet on the floor if the work surface is of a fixed height which is too high for the resulting seated height. In fact, for work at fixed surfaces, the benefits of seat height adjustment are largely lost, as shown in Figure 1.

For such cases, the purchase of footrests becomes essential, whereas footrests are not needed if both chair height and work surface height have sufficient adjustment ranges, as shown in Figure 2.

The Tasks

In considering the overall workstation design, we must start with an analysis of the tasks which need to be performed there. No amount of ergonomic furniture can solve a situation where there is simply insufficient space. For example, as computer technology has been introduced into some offices, the computers or their terminals often have simply been placed onto existing desks, thus using up a large proportion of the space which is still needed for clerical tasks. The "paperless" office is still a long way from being achieved, so it is usually necessary to design for both keyboard work and writing work. Consider the following example in which the selection of "ergonomic" desks failed to take this into account.

An organisation purchased a large number of "split" desks in which the right-hand half of the desk was intended for a keyboard and was adjustable in height. Consequently, all the computer terminals were installed on the right-hand side. Unfortunately,

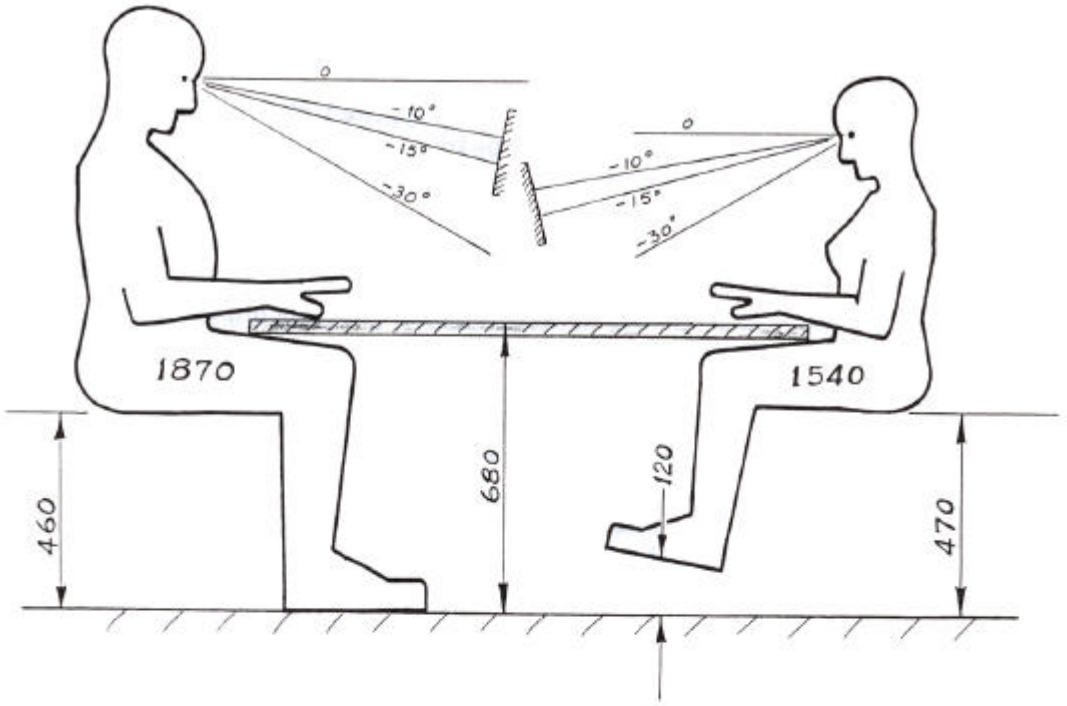

Figure 1. People of different heights sitting at a fixed height workstation. Dimensions are in mm. The people are drawn using IWA templates (Robert Bosch 1978).

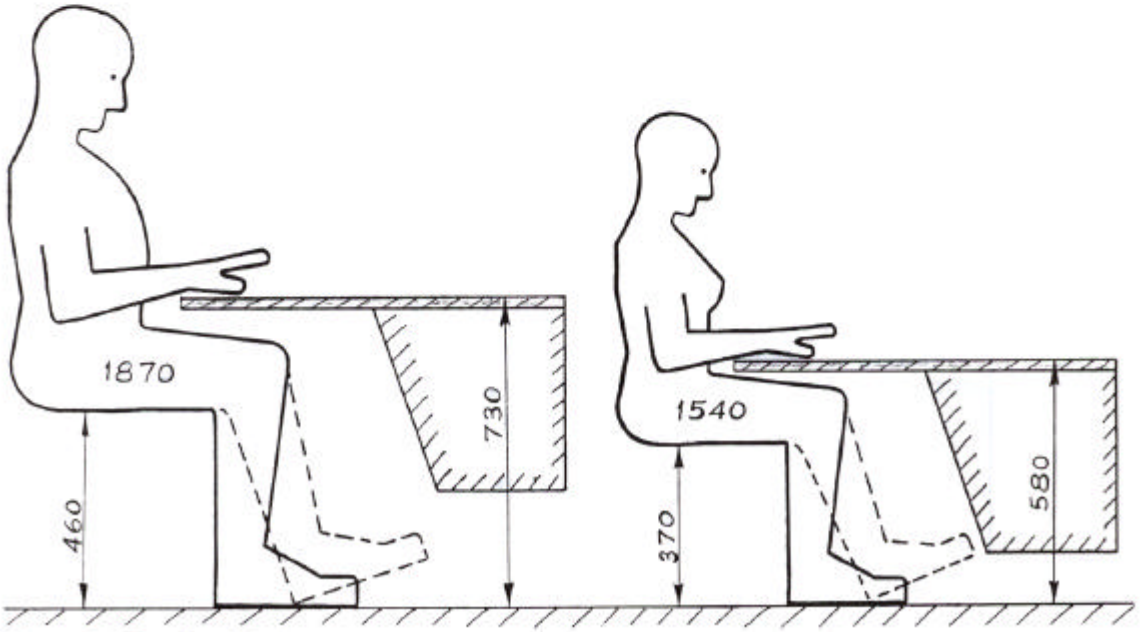

Figure 2. People of different heights sitting at adjustable height workstations. Dimensions are in mm.

most of the jobs involved a considerable amount of clerical work in addition to the use of the computer. Also, most of the employees were right-handed. In order to write, these employees had to twist around to their left to find a space for writing on the desk. Alternatively, they used a drawer unit which they pulled up on their right for writing on, but this gave no knee space, so again their bodies had to be twisted.

Since modern keyboards are all quite thin, the need for separate surfaces for keyboards is now not so pressing. Separate adjustable surfaces are also notorious for interfering with knee space. In fact, the split desks referred to above are usually found to be fitted with padding around the under-desk mechanism. This padding has been fitted by operators after they have banged their knees. Split surfaces also reduce the flexibility of use of a desk. Hence, it is preferable that the whole desk surface height be adjustable.

Equipment Required

An analysis of the tasks to be performed at a workstation will indicate the equipment required, which may include reference manuals, files, writing materials in addition to the computer, a telephone, a calculator and printer. The arrangement of these items may be planned on a scale drawing, or the actual items can be set up on a prototype workstation. It is likely that a single desk will not provide sufficient space, and a return will also be necessary. The depth of some desks may also prove insufficient. At this stage one might consider the possibilities of reducing the size of the equipment. Personal computer design is tending to reduce the "footprint" size. Also, the tower style of the central processing unit enables it to be placed on the floor rather than on the desk. VDU monitors are still very deep, particularly with plugs protruding from the back. The development of thin screen displays will be of great assistance.

Anthropometry

Reach distances, work surface and chair heights, VDU monitor heights and many other features of workstations should all be based on anthropometric data. Australian designers have the problem of deciding which data set or sets to use. European or American data sets are commonly used, but the Chinese and

South-east Asian components of our population are increasing rapidly. The ethnic mix in each organisation is likely to be quite different, so the best approach may be to develop anthropometric distributions for each organisation from different data sets, using the proportions of each ethnic group. Some applications of anthropometric data are discussed below.

The arrangement of equipment on a working surface should be based on placing the most frequently used items within the easiest reach. Reach distances on a horizontal work surface may be divided into a "Normal work area" and a "Maximum work area". The Normal area may be reached while the upper arms are still relaxed and close to the body. The Maximum area is reached by stretching the arm out fully. Figure 3 shows these reach limits for a 5th percentile European woman superimposed on the plan view of an office workstation. (See Pheasant (1986) for more information on reach distances.) Most of the equipment is apparently out of reach. The situation is improved to some extent by allowing the chair to swivel, but in this case, an under-desk drawer unit on the right limits the swivelling range. Leaning forward can bring more items into reach, and finally the person may need to get up from the chair and lean even further. This situation may be improved by use of vertical space, that is, shelving to hold some of the less frequently used materials.

Modern office chair design has solved many of the problems of fitting a wide range of different sized people by providing convenient adjustments. The ranges of adjustments should be checked to ensure that they cater as much as possible for the ethnic mix in the workforce involved. For example, to ensure that all people can obtain good back support, the backrest must be sufficiently adjustable in the fore and aft direction. This changes the effective depth of the seat which should be no greater than the buttock to popliteal length. The backrest height should also be adjustable so that all users can get optimum lumbar support. Fixed dimensions, such as the seat width, must be chosen to suit as large a proportion of the population as practicable. If the seat width is at least as great as the hip width of 95th percentile European women, then it will suit more than 95% of the workforce.

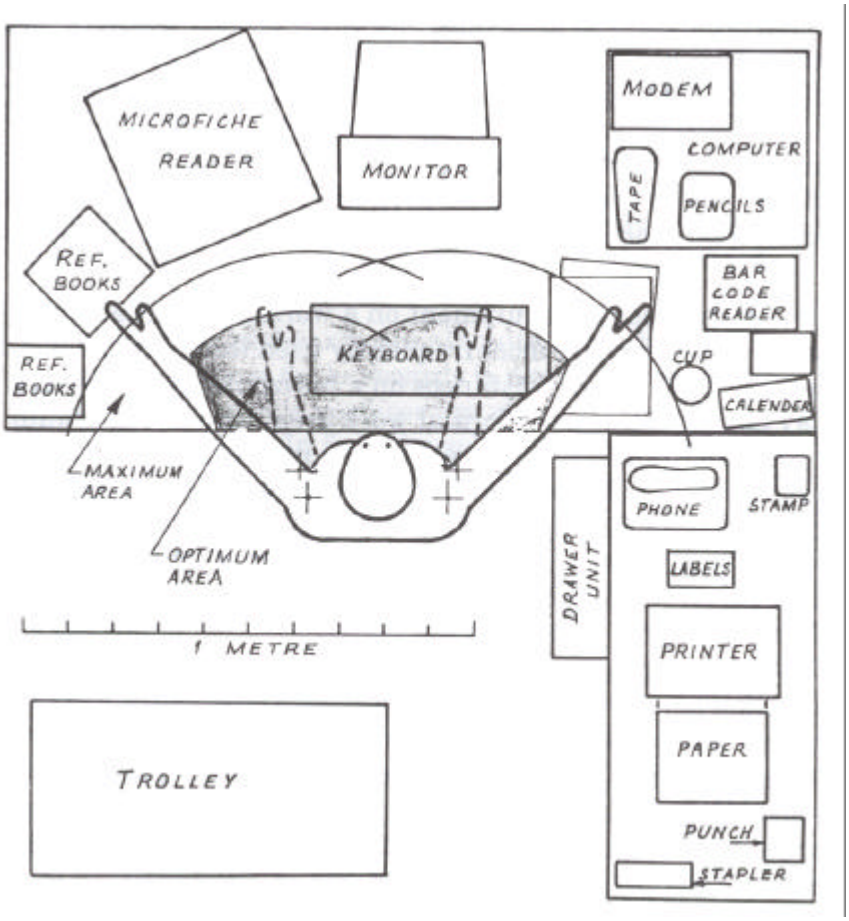

Figure 3. View of a typical office workstation showing horizontal reach areas for a 5th percentile female of European origin.

VDU monitor heights should be based on the eye heights of people, a comfortable viewing angle and a comfortable viewing distance. These measurements are illustrated in Figure 1, where the viewing distance is shown as 700mm. The viewing distance should depend on the size of letters on the screen, and the lower case letters should subtend 15 to 20 minutes of arc to the user's eye. This amounts to a maximum viewing distance of 700mm for typical letter heights of 3.1 to 4.2mm. While closer viewing distances are often recommended, users tend to prefer distances even greater than 700mm. For example, a survey by Grandjean et al.(1984) of the preferred settings of 59 operators showed a mean screen distance of 760mm (range 610 to 930mm). Some workstations prevent the screen from being placed at such distances.

4. Furniture and Equipment to be Selected

Items for which purchasing decisions commonly need to be made include:

Free-standing desks (fixed or adjustable);

Cluster workstations;

Chairs;

Footrests;

Document holders;

Desk lamps;

Monitor arms;

Drawer units;

Shelving;

Anti-glare screens;

Wrist rests; and

File trays.

Items such as footrests, document holders and monitor arms are often described as "ergonomic" equipment, possibly giving people the impression that they are necessary for the development of a workstation which would satisfy ergonomic criteria. This would be a mistake. In fact, excessive equipment often uses up valuable space and gets in the way. The needs of each workstation and the person or persons to be working at it must first be assessed.

For example, a footrest is normally not necessary if both desk and chair are adjustable through sufficient ranges, which is the preferred arrangement. Desk lamps are not needed when the ambient light levels are adequate.

Monitor arms are not needed with most personal computer arrangements, since placing the VDU monitor on the central processing unit usually results in an appropriate height, and modern monitors have a built-in capacity to tilt and swivel. Monitor arms can be valuable for getting the monitor well out of the way for other tasks, or when sharing a monitor display with other people. However, there are many cases where monitor arms have been purchased without good reason, and it is not uncommon to find that a monitor arm has created more problems than it has solved. Particularly undesirable are monitor arms which require tools for their adjustment, since these tools are soon lost.

Wrist rests should not be needed with modern thin keyboards and well-rounded desk edges. Anti-glare screens should be only a last resort where the workstation cannot be arranged to avoid veiling reflections on the VDU screen.

Just as some "ergonomic" equipment is not always necessary, the extent of adjustments available in some products may not be warranted. More adjustments does not necessarily mean better ergonomics. A bewildering array of adjustment stalks now protrudes from some "ergonomic" chairs. Even when only the basic adjustments are present it is a problem to get users to adjust their chairs correctly.

The now commonly available option of seat tilt should be approached with caution. It can be valuable for workers who spend a lot of time bent forward over their desks, but for most, the fixed horizontal seat surface provides adequate versatility. The seat tilt adjustment mechanisms available allow backward as well as forward tilt, so there is the danger that users will leave the adjustment in the backward tilt position at all times, thus putting undesirable pressure under their thighs. Also, some mechanisms free both seat tilt and backrest angle at the same time, making it quite difficult to adjust each of these independently.

Adjustable height desks are certainly a great advantage, allowing quick adjustment for users of different sizes, and for individuals when they change tasks. However, if the cost of these items is a problem, we should not overlook the possibility of modifying fixed desks to suit individuals. This can usually be done quite cheaply by a tradesperson.

Cluster workstations, in which work surfaces are attached to dividing partitions, are increasingly popular for furnishing office spaces, but most of these products pose problems with height adjustment. When the height is difficult to adjust, it is unlikely to be done. A small adjustable section for a keyboard is often provided with these workstations, but what about the other tasks? Workstations are often seen where there is a large height difference between the adjustable and fixed sections, and this suggests that the fixed sections are at an inappropriate height.

The adjustable keyboard surfaces in cluster workstations also fix the position of the computer, making the workstation less flexible for other tasks. The optimum positioning of the VDU monitor to minimise screen reflections and background glare is also inhibited. Convenient height adjustment for the whole of the work surface should be aimed for.

Cluster workstations have the advantages of dividing up individual workstations, providing supports for shelving and ducting for cables, but in choosing between different products of this type, the ease of height adjustment should be carefully examined. Another problem to consider is the work surface depth provided, and whether it is sufficient to allow a VDU monitor to be pushed back to an optimum viewing position. The partitions in a cluster workstation prevent the monitor from being pushed back as far as it might on a free-standing desk where part of the monitor, plus the cables and plugs, can extend over the edge of the desk.

Having decided which items are really necessary, ergonomic checklists, such as those developed by the Ergonomics Unit of Worksafe Australia, should be of value in comparing different products on the market, or designing some equipment to be made in-house.

5. Development and Use of Checklists

Furniture and equipment may be selected on the basis of user trials, but these procedures require the services of a representative group of users, the larger the size of the group the better. Trials can be very time-consuming when a wide range of products needs to be evaluated. A comprehensive checklist can be a useful screening tool enabling a short list of chairs to be identified for user trials. It also has the advantage of selection criteria being available "up front" to manufacturers so that they are more aware of ergonomic design features.

Checklists contain both objective and subjective requirements. Among the objective requirements are critical dimensions. Specifying dimensions too closely would be hard to justify and would excessively inhibit freedom of design. Usually, an acceptable range can be given for each dimension. The dimensions should be based on available anthropometric data for the user population. If standards do not compromise the requirements of anthropometry, reference must also be made to all available standards since conformity with them is desirable for maximising potential markets, The procedures for developing checklists for office chairs were typical of the development of other checklists. They are described below.

Development of Checklists for Office Chairs

In developing the checklists, it was found that no single source of information was sufficient. The primary basis for the dimensions should be the appropriate anthropometric data. Unfortunately, Australia lacks a set of anthropometric data for its present ethnic mix, but both British and Chinese data were consulted (Pheasant 1986).

National Standards are also useful sources of information, and the following were consulted:

Australian Standard AS 3590.2-1990, *Screen-based workstations; Part 2: Workstation furniture*;

British Standard BS 5940:Part 1:1980, *Office furniture, Part 1. Specification for design and dimensions of office workstations, desks, tables and chairs*;

Health and Safety Executive, 1991, *Seating at Work*, London: HMSO;

German Standard DIN 4551, 1975, *Office furniture: Revolving office chair with adjustable back, with or without armrests, adjustable in height*; and

Ergonomic guidelines for use by the Australian Public Service, prepared by the RSI Task Force Implementation Group, July 1987.

There were conflicting requirements in the data given in these documents, and a number of decisions had to be made on the basis of experience of the members of the Ergonomics Unit and consultation with other ergonomists.

The Australian Standard listed above had only just been published at the start of the development of the checklists. While this standard provides a useful starting point for a designer, it has some deficiencies which should be eliminated in future revisions. The checklists developed by the Ergonomics Unit recognise a range of approaches to design, and are more flexible in their requirements than the Australian Standard. Australian Standards are important source documents for designers and purchasers, but the responsibility for appropriate design is not necessarily met simply by adhering precisely to a standard.

Two checklists for chairs were developed: one for adjustable office chairs and one for fixed (visitor's) chairs.

Reasoning Behind the Dimensions

The aim of ergonomic design is to satisfy as large a proportion of the population as possible. This is usually not achieved by using the mean values of the appropriate anthropometric dimensions. Ideally, adjustability should be provided to cater for the wide variability of certain critical dimensions among the population. The adjustment ranges must then be carefully chosen. Even if a dimension of a chair is not made adjustable, careful choice of the best percentile on which to base the fixed dimension can minimise discomfort among the population using the chair. To illustrate the problems and the reasoning behind the recommendations, several of the dimensions and features are discussed below.

Seat Height

Seat heights are measured after loading the seat with the British Standard seat plate and compression weights, which simulate the compression resulting from a person sitting on the seat (see BS 5940: Part 1: 1980).

Consider first the height of the seat above the floor for a **fixed** height chair such as a visitor's chair. The anthropometric dimension which should be taken as the basis for this dimension is the popliteal height, shown in Figure 4. To this should be added the appropriate heel height. While heel heights vary with fashion, Stephen Pheasant recommends adding 25mm for men and 45mm for women.

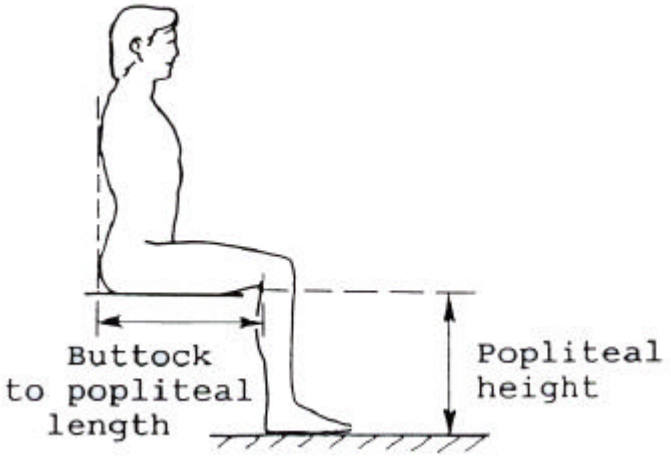

Figure 4. Some critical dimensions for chair design.

Since footrests are not generally available for visitor's chairs, and it is most undesirable for the weight of the legs to be taken through the thighs instead of the feet, the popliteal height value to use should be that of a small person. Large people would not be greatly inconvenienced by a relatively low seat, although there must be a limit to this because elderly people would have difficulty in getting up from a particularly low seat. Using data for British adults aged 19-45 years (Pheasant 1986), seat heights can be estimated as follows:

5th percentile male popliteal height:	395mm
Add heel height:	25mm
	420mm

5th percentile female popliteal height:	355mm
Add heel height:	45mm
	400mm

If data for Chinese adults are used, the height values as worked out above become 390mm for males and 370mm for females. These values may be considered too low because elderly people could have difficulty in getting up from such low heights. However, Australian's Asian community is a significant proportion of the population and should not be overlooked. It is interesting that the fixed seat height value which was recommended in Australian Standard 1837-1976, "Ergonomics in Factory and Office Work", was 375mm.

In his book, Stephen Pheasant (1986) recommends a value of 400mm for fixed seat height. The British Standard 5940 gives a value of 440mm, but this is based on a 5th percentile female popliteal height of 364mm, and was estimated in 1980 when, according to Pheasant, heels were higher. After due consideration of these and other figures, a value in the range 410mm to 430mm was recommended in the checklist.

When it comes to **adjustable** office chairs, such a compromise as described above for fixed height chairs is no longer necessary. The Australian Standard AS 3590.2-1990, gives chair height adjustment ranges which "are designed to accommodate a range of people between the 2.5 percentile female without shoes and the 97.5 percentile male with shoes". If the data for British adults is used, this would give:

5th percentile female popliteal height:	347mm
97.5th percentile male popliteal height:	500mm
Add heel height	25mm
	525mm

This range, 347 to 525mm, does not correspond with the range 380 to 510mm given in the Australian Standard, and it is difficult to understand what population data would have been used for this publication. It is of interest that the adjustment range given in the design guide, *Humanscale 1/2/3* by N. Diffrient and others, is 345 to 523mm.

Achieving an adjustment range of 347 to 525mm is not feasible with normal gas strut mechanisms, since the starting dimension of 347mm requires a gas strut of relatively short stroke (100mm), because larger strokes would result in excessive collapsed heights. Gas struts with strokes of 120mm were most common in the chairs evaluated for the government contract, with starting heights averaging 413mm. However, it is reasonable for chair manufacturers to supply two height ranges which would together cover the range determined by anthropometric data.

A range of 370 to 520mm was recommended in the checklist, but a lot of latitude was applied in assessing chairs for this dimension. It was assumed that purchasers of the chairs would assess for themselves what the best height range/s would be for their purposes. For example, some may prefer to purchase only one height range on the high side, and provide footrests for the shorter operators. This could be the best option if the chairs are to be used at fixed height desks or workstations (see Figure 1). Low height chairs for small people can only be successful if the desk can also be adjusted to a low level.

Seat Width

The checklists recommend a minimum width of 450mm. This gives a little extra space above the 97.5th percentile hip width for British women of 445mm. The 97.5th percentile hip width for British males is less than this (417mm).

Seat Slope

Related to seat height is the slope from front to back of the seat. Since the seat height should be selected to minimise pressure on the thighs, the backward slope should be minimised, and the front edge well rounded. It was noted that the option of making the slope adjustable is increasingly available on adjustable office chairs. Unfortunately, this results in the possibility of the slope being left at a setting where there is a substantial backward slope. This could lead to excessive pressure on the thighs and an impairment of blood circulation to the legs. For this reason, a maximum backward slope of 5 degrees was recommended in the checklist.

Provision for forward slope of the seat, up to a maximum of 10 degrees, is useful to reduce pressure on the thighs when working while leaning forward. However, purchasers should consider carefully whether this advantage warrants purchasing a chair with slope adjustment. Chair users already have trouble with the proper settings of seat height and backrest adjustment without adding a further control. For general purposes, a chair with the seat angle fixed and horizontal is probably best.

Seat Depth

Seat depth is measured from the front edge of the seat to the lumbar support region of the backrest. If the seat depth is excessive, small people will not be able to sit back far enough to get the benefit of the backrest. The appropriate anthropometric dimension to consider is the buttock to popliteal length, as shown in Figure 4.

In the case of **fixed (visitor's)** chairs, the design compromise should be directed well towards the smaller user, because large users are not greatly discomforted by a seat depth which is considerably less than the length of their thighs. Some values which are relevant are as follows:

Buttock-popliteal lengths

5th percentile British females:	435mm
2.5th percentile British females:	423mm
5th percentile Chinese females:	385mm
2.5th percentile Chinese females:	378mm

The checklist recommends that seat depth be within the range 380 to 420mm, but some minor deviations from this were tolerated. The British Standard, BS 5940:Part 1, recommends a similar acceptable range, viz. 380 to 430mm.

In **adjustable** chairs, the effective seat depth may be adjusted by fore and aft movement of the backrest. This movement is usually achieved by adjusting the angle of the backrest support column, the backrest itself being allowed to pivot on this column to some extent. The minimum value of 380mm selected for fixed chairs becomes the minimum point on the adjustment range for adjustable

chairs. The maximum value is more arbitrary since it is far from essential for large people to have full seat depth over the length of their thighs. However, it is desirable for a person's body to be centred approximately over the centre of rotation of the chair, that is, over the axis of the gas strut. The increase in seat depth caused by tilting the backrest column also allows for adjustments in posture, that is, leaning back. An important constraint to the amount of leaning back which should be possible is the point where the chair becomes unstable. Values for the adjustment range given in standards are:

British Standard BS 5940:Part 1:	380 to 470mm
German Standard DIN 4551:	380 to 420mm
Australian Standard AS 3590.2:	330 to 480mm

The Australian Standard seems to be the odd one out here, and the low value of its range cannot be justified by the anthropometric data. An adjustment range of 380 to 480mm is recommended in the checklist.

Height of Lumbar Support

Ergonomists are unanimous on the need to provide back support at the lumbar hollow in order to minimise the tendency to slump in posture. Unfortunately, many chairs have backrests which are essentially straight and cannot provide the local support which is necessary. High backrests are acceptable, provided the lumbar area protrudes clearly beyond the rest of the surface. Otherwise, contact higher up the back occurs first and prevents significant pressure being applied in the lumbar area. The height from top to bottom of the lumbar support area is recommended in the checklists, although this is difficult to measure accurately on a high backrest.

Unfortunately, there is little anthropometric data which give an appropriate dimension for the height of the centre of the lumbar support area above the seat. Some values recommended in standards are:

British Standard BS5940:Part 1:	
Fixed backrest:	210 + 15mm
Adjustable backrest, minimum range:	170 to 230mm

German Standard DIN 4451:	
Adjustable backrest, minimum range:	180 to 250mm
Australian Standard AS 3590.2	
Backrest height adjustment range:	220 to 250mm

Grandjean (1988), a well known international expert on seating, advocates a height of between 100 and 180mm. The adjustment range chosen for the checklist was 170 to 250mm. It is important to note that this height is to be measured from the compressed seat height, where the seat is compressed using a weighted seat compression plate according to BS 5940. The checklist values for lumbar support height, and for the shape of the lumbar support area, were tested in trials with a representative range of people. These suggest that the British Standard values are about right, and that the Australian Standard should be modified accordingly.

Some office chairs, particularly those designed for executives, lack an adjustment for the height of the lumbar support. This is unfortunate, since different people find the most comfortable backrest centre height in different positions when the backrest height is adjustable.

Shape of the Lumbar Support

Radii of curvature of the lumbar support area of the backrest are recommended in the checklists. These are based on standards and have been found to give satisfactory results. There is an interaction between the shapes of backrests and the softness of the cushion foams. If the foam is relatively hard, the radii need to be well suited to the user's body. Since less weight is applied to the backrest than to the seat, backrest foams can be softer than seat foams, allowing some margin for error in the backrest radii.

Backrest Angle

The backrest angle should be adjustable to ensure that good lumbar support is available, and that working posture can be varied. It is most helpful for comfort at different angular positions if the backrest attachment allows some flexibility. Many types of executive chairs do not provide backrest angle adjustment relative to the seat. Instead, the seat and backrest can both be rocked back together. This feature has no ergonomic justification. Executives

have similar tasks to all office workers; it is the relative mix of these tasks which is different. Executive chairs should therefore enhance comfort and efficiency in working postures for writing, keyboard work and interviewing.

Backrest Width

The upper limit of 400mm is based on the criterion of avoiding restriction to elbow movements during keyboard work. An increasing number of office workers are required to use a computer, so this feature is increasingly necessary.

Armrests

The use of armrests is controversial. Their height is fixed in nearly all designs, so they may cause some people to hunch their shoulders or raise their upper arms in order to freely use a keyboard. For this reason, it is often recommended that frequent keyboard users do not use chairs with armrests. However, some may find it comfortable to use armrests and prefer them. It would therefore be desirable for armrests to be easily detachable from the chair.

Armrests on most chairs on the market are made of a very hard plastic and are uncomfortable since they contact a bony part of the forearm. Although it is not mentioned in the present checklists, softer armrests would be preferred and are now becoming more common, presumably because of new moulding technology. Future versions of the checklists may call for this feature. The checklists should be dynamic documents, subject to change as better features become feasible.

Controls

Probably the greatest advance in the ergonomics of seating has been the application of the gas strut which has led to convenient adjustability. However, chairs will not be adjusted as frequently as desirable if suitable controls are not provided. Controls should be clear in their function and comfortable to operate. Even experienced chair users have difficulty in sorting out some chair controls. Preferably, instructions should be permanently displayed on the chair or each control labelled with its function.

Simplicity of controls is most desirable. A chair bristling with control stalks is not likely to be a good chair from an ergonomic point of view.

Comfort of operation requires that controls be easily reached, that they do not require excessive force to operate, and that there are no sharp edges or nip points which could damage a hand. These features should be evaluated with the assistance of typical users.

6. Try-outs and Consultation

It is hoped that selection of furniture and equipment will be helped by the checklists. However, it is still essential that trial workstations be set up for try-outs in consultation with the user population. Users are the ones who know most about their tasks and they should have every opportunity to advise on potential problems. In many cases there is little to chose between different products on ergonomic and cost criteria, and users should then be given the opportunity to make the final decision.

7. Concluding Remarks

It would be desirable for the checklists to be applied by qualified ergonomists or occupational health and safety professionals with some ergonomics training. The Ergonomics Unit at Worksafe Australia can provide a measurement service for a fee, but it has many other projects and cannot provide a quick turn-around. Also, manufacturers should be able to utilise ergonomic expertise in their own city rather than having to send their products to Sydney. Buyers of chairs and other furniture should not have to depend on Worksafe Australia to supply a certificate of compliance with ergonomic criteria.

It is important for manufacturers and purchasers to be well aware that the Worksafe Australia checklists, and the evaluations conducted by Worksafe Australia, only address ergonomic features; they do not address questions of strength and durability. These are important questions, and it would be highly desirable for an Australian Standard to be developed for this purpose. In the meantime, purchasers should seek information from manufacturers about their conformance with relevant overseas strength standards, for example, British Standard BS 5459, *Specification for performance requirements and tests for office furniture*.

8. References

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Ergonomics Unit
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November 1991

WORKSAFE AUSTRALIA
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USER CHECKLIST FOR ERGONOMIC DESIGN OF ADJUSTABLE CHAIRS

Chairs and seating should be designed primarily to provide adequate support for the user, without placing unnecessary stress on any part of the body. They should encourage a posture which allows for comfort, efficiency and minimal muscle fatigue.

There are three major anatomical/physiological factors which need to be considered in sitting posture:

* the posture of the spine;
* the type and amount of muscle work required to maintain comfortable postures;
* compression of the tissues (most particularly the blood vessels and nerves) at the back of the thigh and behind the knee.

People vary markedly in size, and a certain amount of adjustment in chair dimensions is desirable in order to ensure that 95% of the user population can be comfortably and suitably seated. With the increasing ethnic diversity of the Australian population there is a greater need to accommodate people at the extremes of the range, and this should be reflected in the critical dimensions of seating. Because Australian anthropometric data are not available, the accompanying guidelines are based on data from various sources so as to reflect the wider range of sizes.

The following checklist is based on the criteria developed by Worksafe Australia to assess the ergonomic design of adjustable office chairs. The checklist is concerned with the functionality of chairs. It deliberately avoids (except where stated) specifying how and with what materials a chair should be constructed. The back page contains additional explanatory notes on how measurements should be made, what measurements are based on, and why measurements are important.

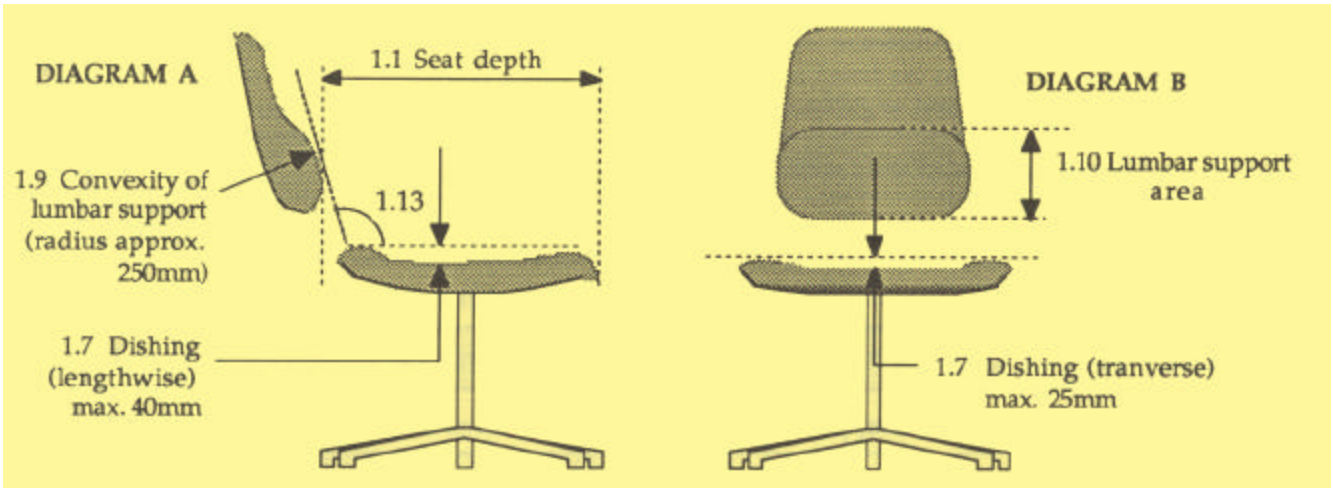
CHAIR IDENTIFICATION

Manufacturer:		Model no:	
Model name:		Date:	

Essential ergonomic requirements are marked with an **X**. Other criteria are considered desirable and their importance will depend on how and where the chair is to be used.			
SECTION 1.0 ERGONOMIC REQUIREMENTS: SEAT, BACKREST AND ARMREST			
SEAT		YES	NO
1.1 Is the effective seat depth adjustable from 380mm to 480mm? (see note) **X**			
1.2 Is the effective seat width at least 450mm? (see note) **X**			
1.3 Is the seat height adjustable from 370mm to 520mm? The achievement of this full range may require two complementary chairs. (see note) **X**			
1.4 Is the seat angle (if fixed) horizontal or tilted a maximum of 5° backward? **X**			
1.5 Is the seat angle (if adjustable) limited to between 10° forward and 5° backward? **X**			
1.6 Does the seat swivel through 360 degrees? **X**			
1.7 Is the seat flat or slightly dished? (Only minimal dishing is desirable; max. of 25mm in transverse direction and 40mm lengthwise). (see note) **X**			
1.8 FOR COUNTER CHAIRS: Is the chair fitted with a footrest adjustable from 370mm to 520mm below seat height? *(Special attention needs to be paid to the stability of such chairs)* **X**			
BACKREST			
1.9 Is the vertical convexity of lumbar support area approx. 250mm radius? (see note)			
1.10 Is the lumbar support area between 200mm and 250mm from top to bottom? (see note) **X**			
1.11 Is the backrest width between 360mm and 400mm? (see note). **X**			
1.12 Is the horizontal concavity of the lumbar support area between 400mm and 800mm radius? **X**			
1.13 Is the backrest angle adjustable between 85° and 115° to the horizontal? (see note).. **X**			
1.14 Is the height of the lumbar support area adjustable from 170mm to 250mm above the seat? **X**			
1.15 Does the backrest pivot in 3 dimensions to suit minor changes in upper body posture?			
ARMRESTS (IF FITTED)			
1.16 Is the armrest height between 200mm and 250mm? (see note)			
1.17 Are the armrests at least 50mm wide?			
1.18 Is the spacing between inside edges of armrests at least 485mm and no more than 560mm? **X**			
1.19 Are the armrests at least 200mm long and set back 100mm to 150mm from the front edge of seat? (see note)			
SECTION 2.0 QUALITATIVE ITEMS			
2.1 Can the seat height adjustment be made easily and quickly while seated? **X**			
2.2 Does the seat cushion effectively distribute pressure, and not “bottom out” with heavy users?			
2.3 Does the backrest cushioning effectively distribute pressure, and protect the user from the frame?			

		YES	NO
2.4 Can the backrest height and angle be easily adjusted while seated?	X		
2.5 Are the seat and backrest covered with a woven woolen fabric?			
2.6 Is the front edge of the seat rounded to avoid pressure on the underside of the thighs?	X		
2.7 Are the side edges of the seat turned downwards?	X		
SECTION 3.0 SAFETY AND STABILITY			
3.1 Does the chair have five base support points?	X		
3.2 Is the seat rotation axis on, or less than 30mm behind the midpoint of the max. seat depth?			
3.3 Is the seat assembled so that it cannot be unintentionally detached from the main frame?	X		
3.4 What is the safety dimension of the leg assembly of the chair? _____mm (see note).			
3.5 Is the safety dimension of the leg assembly greater than 42% of the maximum effective seat depth? [(value 3.4/max. value 1.1)*100]	X		
SECTION 4.0 GENERAL ASPECTS			
4.1 Can either castors or glides be fitted and readily changed so that the chair can be moved smoothly and controllably on its relevant surface?	X		
4.2 Are surfaces free of sharp edges which could snag clothing or cause discomfort or injury? (All edges should be curved or rounded).	X		
4.3 Are metal parts corrosion resistant or treated with a corrosion resistant finish?	X		
4.4 Are upholstery coverings either detached or fitted to a sub frame which is firmly fixed but easily detachable for replacement or cleaning?			
4.5 Are fittings and controls smoothed, rounded or shaped and positioned to avoid personal injury and damage to clothing?	X		
4.6 Can the controls or moving parts be operated without risk of trapping the fingers?	X		
4.7 Are adjustment instructions clear and permanently fixed to a visible part of the chair?			
4.8 Are the controls or moving parts designed so that they cannot be easily removed?			
4.9 Are there marks or labels showing information on care and cleaning?			
4.10 Is the design and construction robust? (see note)	X		
4.11 Does the chair feel solid and safe to the user?			
4.12 Is the chair silent in operation? Chair should not creak or squeak.			

SUMMARY	YES	NO
Does the chair satisfy all essential ergonomic requirements? (marked with an **X**)		
Does the chair pass the desirable criteria considered important?		
Comments:		



EXPLANATORY NOTES AND DEFINITIONS

(Paragraph numbers correspond to numbered items in the checklist).

1.1 SEE DIAGRAM A. The effective seat depth (adjustable by fore-and-aft movement of the backrest) is the horizontal distance, measured from the front edge to the foremost point of the backrest on the centre line of the seat's width. The minimum value of this dimension is based on the buttock to inside knee length of smaller users. It is essential that while sitting normally and using the backrest, the front edge of the seat does not press on the underside of the thighs or knees. The backrest should still be usable, i.e. supply lumbar support, in its most forward position.

1.2 Effective seat width is measured at a distance 125mm forward of the lumbar support when the backrest is in its most forward position. It is based on 98th percentile female hip breadth.

1.3 Seat height is measured from the floor to the centre of the seat surface **allowing for seat compression**. This can be achieved using the device described in BS 5940 Part 1 Section A.4. which simulates a seated 80kg person. Seat height adjustment range is based on the lower leg length of the range of users.

1.5 Excessive seat tilt is undesirable. A fixed seat angle satisfying 1.4 is quite acceptable.

1.7 SEE DIAGRAMS A & B. Some dishing may enhance the feeling of stability for users and assist in the even distribution of pressure on buttocks and upper thighs. Dishing, if it is too pronounced or incorrectly proportioned, may restrict freedom of body and leg movement on the seat. This is undesirable.

1.9 SEE DIAGRAM A. The lumbar support area is the minimum area required for adequate support and stability of the seated person. It is defined as the vertical convexity designed to fit in the small of the back. Some backrests consist entirely of lumbar support. The curvature can be easily measured with a flexible curve in comparison with a series of drawn radii.

1.10 SEE DIAGRAM B. The backrest may extend higher than this but where manipulative tasks are performed, such as keyboard work, the shoulder blades and upper trunk should be free to move while lumbar support is maintained.

1.11 Backrest width is the horizontal distance between the side edges of the backrest measured at the midpoint of the lumbar support. Its maximum dimensions are limited by the need for free arm movement by smaller users.

1.13 Backrest angle is the angle between the horizontal and a line tangential to the middle of the lumbar support.

1.14 The height range is measured from the mid-point of lumbar support area to the compressed seat with the backrest in the vertical position. It is based on the range of heights of the mid lumbar region (L2 - L4) of users.

1.16 Armrest height is the vertical distance between the centre of the compressed seat cushion and the fore-and-aft centre of the armrests. The use and dimensions of armrests are controversial and no hard and fast rules apply. However, they are not recommended for people who do manipulative tasks, such as keyboard work, as they interfere with arm movements. It would be desirable for the armrests to be easily detachable if required.

1.19 Armrests must be set back to enable the chair to be pulled in towards the desk. Where armrests are curved down towards the front, the distance from the front edge should be measured at 150mm above the seat.

3.4 The safety dimension of the leg assembly is the shortest distance from the centre of the seat rotation axis to a straight line joining two adjacent support points. If castors are fitted, these shall be turned in the direction resulting in a minimum value.

4.10 This criterion applies to obvious design or construction deficiencies which may lead to personal injury or untimely wearing or failure of components. Specific tests are needed to test strength and durability.

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November 1991

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CHECKLIST FOR ERGONOMIC DESIGN OF DOCUMENT HOLDERS

Document holders should be provided at workstations where VDU work and keyboard operations are carried out. They prevent excessive inclination of the head and unfavourable body rotation and help reduce the strain on the spine, shoulder and neck muscles. When positioned at the same level, distance and inclination as a VDU screen they reduce the need for rapid and frequent changes in focal accommodation, minimising the risk of eye strain.

There are two basic types of document holder; those designed to be positioned at the side of the VDU screen, and those designed to be positioned at the base of the VDU terminal, between the screen and the keyboard. Document holders which are positioned at the side of the VDU can be supported on a movable base which sits on the surface of the desk, or can be attached to an arm which is clamped to the edge of the desktop (see Diagram 1). The most suitable position for a document holder will depend on the type of task being performed and the user's preference. Side document holders are often preferred by touch typists and users carrying out data entry tasks. Users carrying out less intensive VDU tasks and those who spend more time looking at the keyboard or entering data from batches of dockets often prefer to use a terminal-base type document holder.

DOCUMENT HOLDER IDENTIFICATION

Manufacturer:		Model no:	
Model name:		Date:	

The following checklist is based on the criteria developed by Worksafe Australia to assess the ergonomic design of office accessories. It is concerned with the function of document holders and avoids (except where stated) specifying how and with what materials a document holder should be constructed. The back page contains additional explanatory notes on how the measurements should be made, what the measurements are based on, and why the measurements are important. Some terms and definitions have been explained in Diagram 2.

Essential ergonomic requirements are marked with an **X**. Other criteria are considered desirable and their importance will depend on what the document holder will be used for, and the associated equipment the document holder will be used with.			
GENERAL ERGONOMIC REQUIREMENTS: The following criteria apply to all three types of document holder illustrated in Diagram 1.			
SIZE:		YES	NO
0.1 Is the length of the back surface of the document holder at least 255mm? (see note) **X**			
0.2 Is the width of the back surface of the document holder at least 210mm? (see note) **X**			
SAFETY AND STABILITY:			
0.3 Can the holder support 1 kg, without loss of its set position? **X**			
0.4 Is the document holder designed so that it does not vibrate excessively when touched?			
0.5 Is the holder stable in all positions, at all times, for its specified weight bearing capacity? **X**			
0.6 Is the maximum weight bearing capacity clearly displayed on the holder?			
CURSOR LINE GUIDE AND CLIP:			
0.7 Is a horizontal cursor line guide provided with the document holder?			
0.8 Can the cursor line guide be moved easily up and down the side of the document holder while remaining parallel to the bottom ledge? **X**			
0.9 Can the cursor line guide be parked away from the source document when not in use?			
0.10 Is the cursor line guide transparent?			
0.11 Is the cursor line guide adaptable to different thickness of source document?			
0.12 Is the document holder fitted with a clip/attachment mechanism which allows the document to be temporarily attached? **X**			
0.13 Is the clip/attachment mechanism designed to cater for different sized documents?			
GENERAL ASPECTS:			
0.14 Is the back surface flat (ie. Free of bumps or grooves) so that users will not have difficulty making notes or corrections to thin source documents?			
0.15 Can height and angle adjustments be made easily and quickly while seated, without requiring excessive physical effort or any special tools/equipment? **X**			
0.16 Is the ledge running along the bottom of the holder at least 30mm wide and set at 92° (+ or - 2°) to the back surface? **X**			
0.17 If an additional upright lip is attached to the bottom ledge, is it removable?			
0.18 If the document holder has attached lighting read note 0.18.			
0.19 If the document holder comes in more than one piece, is it easy to assemble when initially received, with clear concise assembly and set up instructions provided? **X**			

0.20 Are clear and concise adjustment instructions and care information easily visible and permanently fixed to the holder?	YES	NO
0.21 Is the supplier's name and contact information permanently fixed to the holder?		
0.22 Is the document holder quiet during use and adjustment? Should not creak or squeak.		
0.23 Is the document holder free of sharp edges or corners, pinch points or projections that could damage clothing or cause injury to users or passers-by? **X**		
0.24 Are metal parts corrosion resistant and all surface finishes non-reflective and light in color? **X**		
0.25 Are applied surfaces (eg. labelling) affixed in such a way that they would not peel/fall off under normal use and environmental conditions?		
0.26 Is the construction durable?		

SECTION 1: SPECIAL REQUIREMENT FOR SWIVEL ARM SIDE DOCUMENT HOLDERS	YES	NO
1.1 Is the height of the document holder adjustable from the desk top surface to 250mm above the desk? (see note) **X**		
1.2 Is the back surface adjustable in tilt from 0° to 30° to the vertical? (see note) **X**		
1.3 Is the base attachment clamp designed so that it does not permanently fix to, or permanently damage/mark the desk top? **X**		
1.4 Is the base attachment clamp easily fixed to, and removed from the desk, without causing hand discomfort and without requiring excessive physical effort or any special tools?. **X**		
1.5 Does the holder have the <u>minimum</u> range of movement specified in note 1.5? **X**		
1.6 Can the surface of the document holder be turned to face the front for the full range of movement specified in 1.5? **X**		
1.7 Can the document holder be clamped to desks up to 40mm thick? **X**		
1.8 Is the base attachment clamp designed so that its protrusion beyond the edge of the desk is minimised? (see note)		
1.9 Is the document holder designed so that the position of the holder can be adjusted without the supporting mechanism extending beyond the edge of the desk? (see note)		

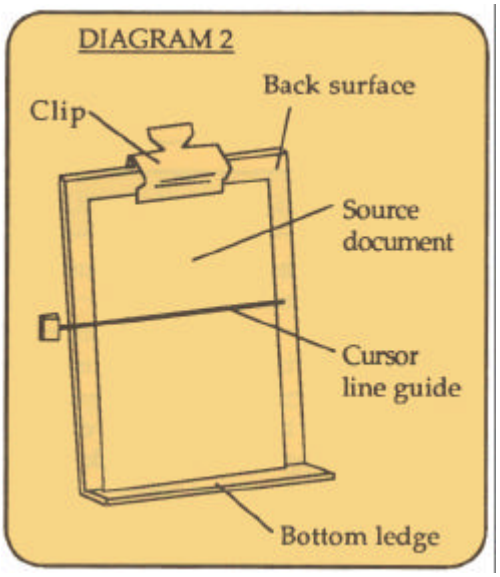
SECTION 2: SPECIAL REQUIREMENTS FOR MOVABLE BASE SIDE DOCUMENT HOLDERS	YES	NO
2.1 Is the height of the document holder adjustable from the desk top surface to 250mm above the desk? (see note) **X**		
2.2 Is the back adjustable in tilt from 0° to 30° to the vertical? (see note) **X**		
2.3 Is the base of a size and shape which ensures stability without taking up excessive desk space? **X**		

SECTION 3: SPECIAL REQUIREMENTS FOR TERMINAL BASE DOCUMENT HOLDERS	YES	NO
3.1 Is the height of the document holder adjustable from the desk top surface to 60mm above the desk? (see note) **X**		
3.2 Is the back surface of the document holder adjustable in tilt from 20° to 50° to the vertical? **X**		
3.3 Does the holder have a flat base which allows it to slide under keyboards and CPUs etc? **X**		

SUMMARY	YES	NO
Does the document holder satisfy all relevant essential ergonomic requirements? (marked with an **X**)		
Does the document holder satisfy the desirable criteria considered important?		
Comments:		

EXPLANATORY NOTES AND DEFINITIONS

(Paragraph numbers correspond to numbered items in the checklist)



0.1 255mm is the minimum height required to hold a thin, flexible A4 page upright. The height should be measured from the top surface of the bottom ledge.

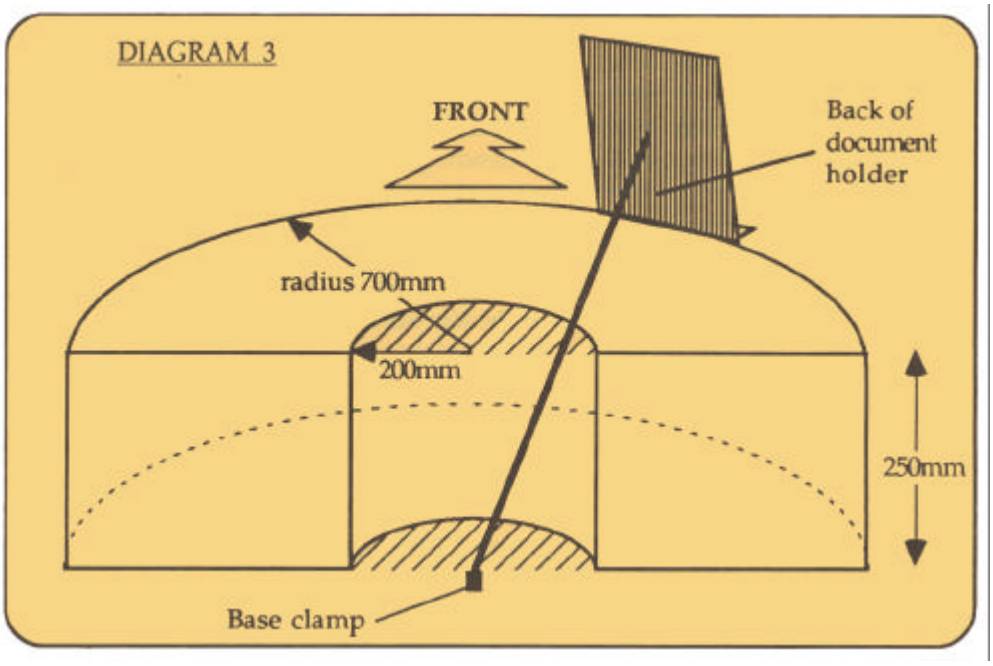
0.2 This is the minimum requirement. Holders designed to take A3 documents and A4 booklets should be at least 400mm wide.

0.18 The position of any attached lighting must be adjustable so that users will be able to avoid reflections on the source document. The lamp should cast an even light across the source document and should not cause any part of the document holder to become hot. It is desirable that the brightness can be adjusted with a dimmer switch.

1.1 The height should be measured from the bottom ledge with the document holder in the vertical position. Height adjustment enables the holder to be placed at the same level as the VDU screen allowing the eyes to move horizontally from the document to the screen.

1.2 A greater tilt range is desirable. The specified range ensures that the source document can be place in the same plane as the computer screen.

1.5 The bottom ledge of the document holder should be able to be positioned anywhere within a 700mm semi-circular radius from where it is clamped to the desk. It should be able to reach up to the maximum height requirement (250mm) in every position (except within a 200mm radius of the base attachment mechanism – represented by the shaded area in the diagram). (See Diagram 3). A reach of 700mm ensures that the backsurface of the document holder can be positioned just behind the keyboard when the holder is clamped to a desk 900mm deep.1.8 Most desks are pushed up against office walls or dividing panels so it is an advantage to avoid accessories which protrude excessively over the edge of the desk.



1.9 See note 1.8.

2.1 See note 1.1.

2.2 See note 1.2.

3.1 The height range should be measured with the holder at 20° to the vertical. 60mm allows clearance for most keyboards.

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CHECKLIST FOR ERGONOMIC DESIGN OF FOOTRESTS

Footrests may be necessary to ensure that all users are able to obtain an optimum sitting posture. They should be provided when the adjustability of the chair, or of the workstation, or both does not permit the user's feet to be placed flat on the floor. Footrests are generally only required by smaller users. The need for footrests is increased, however, when keyboard work is carried out at fixed height desks because people generally adjust their chair higher so that they can sit with their elbows just above the keyboard. At counters, all seated staff will require footrests and/ or footrings on the chairs.

The following checklist is based on the criteria developed by Worksafe Australia to assess the ergonomic design of office accessories. It is concerned with the function of footrests and avoids (except where stated) specifying how and with what materials a footrest should be constructed. At the end of the checklist explanatory notes describe how the measurements should be made, what the measurements are based on, and why the measurements are important.

FOOTREST IDENTIFICATION

Manufacturer:		Model no:	
Model name:		Date:	

Essential ergonomic requirements are marked with an **X**. Other listed criteria are considered desirable and their importance will depend on how, where and with what other associated equipment the footrest will be used.			
1. SIZE:		YES	NO
1.1 Is the footrest surface dimension at least 350mm deep by 450mm wide? (see note)	**X**		
1.2 Is the footrest small enough to fit under all desk arrangements, and not cumbersome to handle?			
1.3 Does the footrest weigh less than 12kg?	**X**		
2. HEIGHT:			
2.1 For clerical and keyboard operations: Is the footrest adjustable in height from 50mm to 185mm? (see note)	**X**		
2.2 For Counter operations: Is the footrest adjustable in height from 135mm to 415mm? (see note)	**X**		
2.3 Is the footrest adjustable in height by increments of 50mm or less? (see note)	**X**		
3. SLOPE:			
3.1 Is the slope of the footrest adjustable from 0° to 15° to the horizontal? (see note)	**X**		
3.2 Is the slope adjustable by increments of no more than 4 degrees?	**X**		
4. MEANS OF ADJUSTMENT:			
4.1 Can height and slope adjustments be made quickly and easily from the seated position, without requiring excessive physical effort or any special tools/equipment?	**X**		
4.2 Can the slope and height be adjusted independently of each other?	**X**		
4.3 Can adjustments be made without risk of trapping the fingers or feet?	**X**		
4.4 Are the controls or moving parts designed so that they cannot easily be removed?			
5. FOOTREST SURFACE:			
5.1 Is the footrest surface flat and level across its width?	**X**		
5.2 Does the surface allow for the circulation of air to stop the build up of heat in the feet? (see note)	**X**		
5.3 Is the footrest surface of high friction so that the feet cannot easily slip across it?			
6. STABILITY:			
6.1 Is the footrest stable and not easily overturned while being used?	**X**		
6.2 Is the footrest designed so that it will not slide easily on common floor surfaces (e.g. carpet, vinyl)?	**X**		
7. GENERAL ASPECTS:			
7.1 If the footrest comes in more than one piece, is it easy to assemble when initially received, with clear concise assembly and set up instructions provided?	**X**		
7.2 Are clear and concise adjustment instructions and care information easily visible and permanently fixed to the footrest?			

	YES	NO
7.3 Is the supplier's name and contact information permanently fixed to the footrest?		
7.4 Is the footrest quiet during use and adjustment? Should not creak or squeak.		
7.5 Is the footrest free of sharp edges or corners, pinch points or projections that could damage clothing or cause injury to users or passers-by? **X**		
7.6 Are all metal parts corrosion resistant or treated with a corrosion resistant finish? **X**		
7.7 Are applied surfaces (e.g. carpet or labeling) affixed in such a way that they would not peel/fall off under normal use and environmental conditions?		
7.8 Is the design and construction robust? (see note) **X**		
7.9 Does the footrest feel solid and safe to the user?		

SUMMARY	YES	NO
Does the footrest satisfy all essential ergonomics requirements? (marked with an **X**)		
Does the footrest satisfy the desirable criteria considered important?		
Comments:		

EXPLANATORY NOTES AND DEFINITIONS

(Paragraph numbers correspond to numbered items in the checklist)

1.1 This requirement allows the feet to be fully supported by the footrest and provides for some degree of movement. Adjustment mechanisms should not encroach on this minimum area.

2.1 The height adjustment range is measured from the floor to the **front edge** of the footrest. The upper limit was determined using 5th percentile female lower leg length and the fixed desk and compressed seat heights specified in Australian Standard 3590.2-1990. [NB: The German standard for office furniture specifies a height adjustment range of 50-100mm for clerical and keyboard operations. This is based on German anthropometric data only].

2.2 See note 2.1

2.3 It is desirable that the height adjustment be infinite over its range.

3.1 Preferably, the slope should be adjustable between the horizontal and 30 degrees.

5.2 Thin grooves, a slightly textured finish or carpet on a footrest allow air to circulate beneath the feet, flat solid surfaces do not allow this type of circulation.

7.8 This criterion applies to obvious design or construction deficiencies which may lead to personal injury or untimely wearing or failure of components. Specific tests are needed to test strength and durability.

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USER CHECKLIST FOR ERGONOMIC DESIGN OF NON-ADJUSTABLE CHAIRS

Chairs and seating should be designed primarily to provide adequate support for the user, without placing unnecessary stress on any part of the body. They should encourage a posture which allows for comfort, efficiency and minimal muscle fatigue.

There are three major anatomical/physiological factors which need to be considered in sitting posture:

the posture of the spine;

the type and amount of muscle work required to maintain comfortable postures;

compression of the tissues (most particularly the blood vessels and nerves) at the back of the thigh and behind the knee.

People vary markedly in size, and a certain amount of adjustment in chair dimensions is desirable in order to ensure that 95% of the user population can be comfortably and suitably seated. When chairs do not have adjustment, compromises must be made. As far as possible these compromises should not disadvantage any one user group in favour of another.

With the increasing ethnic diversity of the Australian population there is a greater need to accommodate people at the extremes of the range, and this should be reflected in the critical dimensions of seating. Because Australian anthropometric data are not available, the accompanying guidelines are based on data from various sources so as to reflect the wider range of sizes.

CHAIR IDENTIFICATION

Manufacturer:		Model no:	
Model name:		Date:	

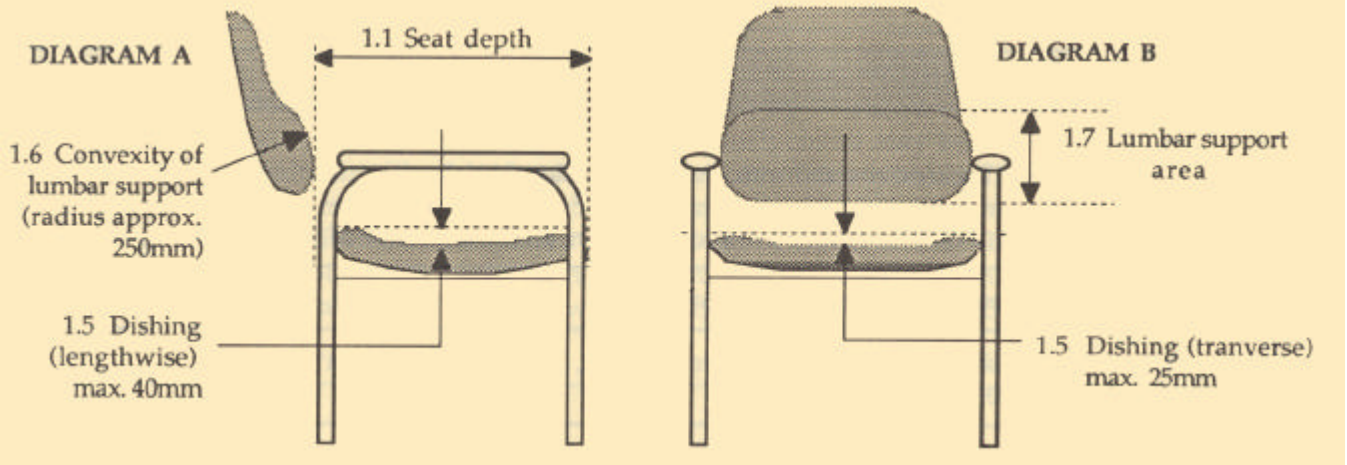
The following checklist is based on the criteria developed by Worksafe Australia to assess the ergonomic design of non-adjustable office chairs. Such chairs may be used in waiting areas, as visitors' chairs in offices, or in conference or committee rooms. The checklist is concerned with the function of chairs. It deliberately avoids (except where stated) specifying how and with what materials a chair should be constructed. The back page contains additional explanatory notes on how measurements should be made, what the measurements are based on, and why the measurements are important.

Essential ergonomic requirements are marked with an **X**. Other criteria are considered desirable and their importance will depend on how and where the chair is to be used.

SECTION 1.0 ERGONOMIC REQUIREMENTS: SEAT, BACKREST AND ARMREST		YES	NO
SEAT			
1.1 Is the effective seat depth adjustable from 380mm to 480mm? (see note)	**X**		
1.2 Is the effective seat width at least 450mm? (see note)	**X**		
1.3 Is the seat angle horizontal or a maximum of 5 degrees backward?	**X**		
1.4 Is the seat height between 410mm and 430mm? (see note)	**X**		
1.5 Is the seat flat or slightly dished? (Only minimal dishing is desirable; max. of 25mm in transverse direction and 40mm lengthwise). (see note)	**X**		
BACKREST			
1.6 Is the vertical convexity of lumbar support area approx. 250mm radius? (see note)			
1.7 Is the lumbar support area between 200mm and 250mm from top to bottom? (see note)	**X**		
1.8 Is the backrest width at least 360mm? (see note).	**X**		
1.9 Is the horizontal concavity of the lumbar support area between 400mm and 800mm radius?	**X**		
1.10 Is the backrest angle between 100° and 105° to the horizontal? (see note)..	**X**		
1.11 Is the centre of the lumbar support area between 190mm to 220mm above seat? (see note)	**X**		
ARMRESTS (IF FITTED)			
1.12 Is the armrest height between 200mm and 250mm? (see note)			
1.13 Is the spacing between inside edges of armrests at least 485mm and no more than 560mm?	**X**		
1.14 Are the armrests at least 50mm wide?			
1.15 Do the armrests extend at least 220mm forwards from the backrest?			

SECTION 2.0 QUALITATIVE ITEMS			
		YES	NO
2.1 Are the seat and backrest covered with a woven woolen fabric?			
2.2 Is the front edge of the seat rounded to avoid pressure on the underside of the thighs?	**X**		
2.3 Are the side edges of the seat turned downwards?			
2.4 Does the seat cushion effectively distribute pressure, and not "bottom out" with heavy users? (see note)			
2.5 Does the backrest cushion effectively distribute pressure, and protect the user from the frame? (see note)			
SECTION 3.0 SAFETY AND STABILITY			
3.1 Is the chair stable in all reasonable postures of the user?	**X**		
3.2 Is the seat assembled so that it cannot be unintentionally detached from the main frame?	**X**		
3.3 Is the base support diameter broad enough for stability without the supports projecting so far that they present a tripping hazard?	**X**		
SECTION 4.0 GENERAL ASPECTS			
4.1 Are the front legs of the chair free from horizontal struts which could obstruct leg movement? (see note)	**X**		
4.2 Do the feet of the chair allow smooth and easy horizontal movement?	**X**		
4.3 Are surfaces free of sharp edges which could snag clothing or cause injury?	**X**		
4.4 Are all edges curved or rounded?	**X**		
4.5 Are metal parts corrosion resistant or treated with a corrosion resistant finish?	**X**		
4.6 Are upholstery coverings either detached or fitted to a sub-frame which is firmly fixed but easily detachable for replacement or cleaning?			
4.7 Are there marks or labels showing information on care and cleaning of special finishes and upholstery?			
4.8 Are the controls or moving parts designed so that they cannot be easily removed?			
4.9 Is the design and construction robust? (see note)	**X**		
4.10 Does the chair feel solid and safe to the user?			

SUMMARY	YES	NO
Does the chair satisfy all essential ergonomic requirements? (marked with an **X**)		
Does the chair pass the desirable criteria considered important?		
Comments:		



EXPLANATORY NOTES AND DEFINITIONS

(Paragraph numbers correspond to numbered items in the checklist).

1.1 SEE DIAGRAM A. The effective seat depth is the horizontal distance, measured from the front edge to the foremost point of the backrest on the centre line of the seat's width. The value of this dimension is based on the buttock to inside knee length of smaller users. It is essential that while sitting normally using the backrest, the front edge of the seat does not press on the underside of the thighs or knees.

1.2 Effective seat width is the horizontal distance between the sides of the seat at a distance 125mm forward of the lumbar support area of the back-rest.

1.4 Seat height is measured from the floor to the centre of the seat surface **allowing for seat compression**. This can be achieved using the device described in BS 5940 Part 1 Section A.4. which simulates a seated 80kg person. Seat height is based on lower leg length. Seats that are too high create undue pressure on the back of the thigh and may encourage people to perch on the edge. This is potentially unstable. Seats that are too low or those that have an excessive backward tilt make it difficult for the elderly and handicapped to get up.

1.5 SEE DIAGRAMS A & B. Some dishing may enhance the feeling of stability for users and assist in the even distribution of pressure on buttocks and upper thighs. Dishing, if it is too pronounced or incorrectly proportioned, may restrict freedom of body and leg movement on the seat. This is undesirable.

1.6 SEE DIAGRAM A. The lumbar support area is the minimum area required for adequate support and stability of the seated person. It is defined as the vertical convexity designed to fit in the small of the back. Some backrests consist entirely of lumbar support. The curvature can be easily measured with a flexible curve in comparison with a series of drawn radii.

1.7 SEE DIAGRAM B. The size of the lumbar support is measured at the midpoint of its width.

1.8 Backrest width is the horizontal distance between the side edges of the backrest measured at the midpoint of the lumbar support area.

1.10 Backrest angle is the angle between the horizontal plane and a line tangential to the middle of the lumbar support area.

1.11 The height is measured vertically from the peak of the lumbar support area to the compressed seat plane. It is based on the average height of the mid-lumbar region (L2 - L4) of users.

1.12 Armrest height is the vertical distance between the centre of the compressed seat cushion and the fore-and-aft centre of the armrests.

2.4 Padding on chairs must be soft enough to allow a person to sit for up to an hour at a time comfortably. However overpadding restricts movement and makes it difficult for the elderly and handicapped to get out of the chair.

2.5 The backrest padding should be firm enough to provide support but at the same time allow for some moulding to accommodate different back shapes.

4.1 Obstructions between the front legs of a chair do not allow people to position their feet under the seat. The inability to bring the feet under the body increases the muscular effort required to rise from the chair..

4.8 This criterion applies to obvious design or construction deficiencies which may lead to personal injury or untimely wearing or failure of components. Specific tests are needed to test strength and durability.

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November 1991

WORKSAFE AUSTRALIA
NATIONAL OCCUPATIONAL
HEALTH & SAFETY
COMMISSION

CHECKLIST FOR ERGONOMIC DESIGN OF OFFICE DESKS

Desks set at the correct height help to reduce strain on the spine, shoulder and neck muscles. Adjustable height desks allow the work surface to be adjusted to an appropriate height for the individual and the particular task. They are generally recommended for multi-user workstations and for multi-task, e.g. clerical and keyboard, operations.

For keyboard tasks the desk height should be set so that, when the operator is sitting with feet flat on the floor, the home row of the keyboard is positioned at, or slightly below, their elbow height. A slightly higher desk is generally preferred for clerical work. Operators seated at fixed height desks may require a footrest so that they can adjust their chair to an appropriate height and maintain support for their feet.

The following checklist includes notes and criteria which can be used to assess desks fitted with independently adjustable support surfaces for keyboards and/ or VDU s. The ergonomic criteria associated with other possible features such as desk-top tilt, associated drawer units and desk-top returns are considered task dependent and are not covered in depth by this checklist.

The criteria in the checklist were formulated to accommodate at least 95 percent of the Australian workforce. The checklist is based on the criteria developed by Worksafe Australia to assess the ergonomic design of office desks. The checklist is concerned with the function of desks. It deliberately avoids (except where stated) specifying how and with what materials a desk should be constructed. At the end of the checklist explanatory notes describe how measurements should be made, what the measurements are based on, and why the measurements are important.

DESK IDENTIFICATION

Manufacturer:		Model no:	
Model name:		Date:	

Essential ergonomic requirements are marked with an **X.** Other criteria listed are considered desirable and their importance will depend on how and where the desk is to be used.

1.0 SPECIAL REQUIREMENTS FOR ADJUSTABLE HEIGHT DESKS OR SURFACES **(see note):**		YES	NO
1.1 Is the desk top surface adjustable in height through a range of at least 580mm to 730mm?	X		
1.2 Is there an easily visible scale/read-out giving the current position of the desk height?	X		

2.0 SPECIAL REQUIREMENTS FOR FIXED HEIGHT DESKS OR SURFACES **(see note):**		YES	NO
2.1 Is the height of the desk top surface between 670mm and 700mm?	X		

3.0 GENERAL ERGONOMIC REQUIREMENTS: These criteria apply to both fixed and adjustable height desks.			
LEGSPACE:		YES	NO
3.1 Is there at least 800mm width of legspace beneath the desk? (see note)	X		
3.2 Is the legspace at least 450mm deep, just below the underside of the desk top? (see note)	X		
3.3 Is the legspace at least 600mm deep, 460mm below the desk top surface? (see note)	X		
3.4 Is there at least 120mm toe clearance at the bottom of the desk? (see note)	X		
SIZE:			
3.5 Is the desk top no thicker than 26mm above the legspace area?	X		
3.6 Is the desk top surface at least 900mm deep? (see note)	X		
3.7 Is the width of the desk top surface at least: 1200mm if the desk is to be used only for keyboard work? **OR** 1500mm if the desk is to be used for both clerical and keyboard work?	X		
ADJUSTMENT CONTROLS:			
3.8 Are all adjustment controls convenient to operate from the seated position?	X		
3.9 Can all controls be easily operated from the seated position without requiring excessive physical effort or any special tools/equipment? (see note)	X		
3.10 Are the controls smooth and quiet in operation? (see note 3.9)			
3.11 Are the controls reliable and stable unless activated, e.g. are they designed so that they do not wind down under gravity alone? (see note 3.9)	X		
3.12 Are the controls smoothed, rounded, shaped and positioned to be comfortable to use and to avoid personal injury and damage to clothing? (see note)	X		
3.13 Are controls suitably positioned or shielded to avoid accidental operation?			
3.14 Is the function and direction of each control clearly marked or otherwise obvious?	X		
3.15 Can the controls and the associated moving parts be operated without risk of trapping the fingers?	X		
3.16 Are controls and handles designed so that they cannot be easily removed?			

GENERAL ASPECTS:	YES	NO
3.17 Are all the corners and the front edge of the desk top well rounded? (see note) **X**		
3.18 Are all surfaces of the desk (including the underside of the desk-top) free of sharp edges or corners, pinch points or projections that could cause personal injury or damage to clothing? **X**		
3.19 Is the surface of the desk a light neutral colour and non-reflective? (see note) **X**		
3.20 Is the desk top surface flat and smooth (i.e. free of bumps or grooves) so that users will not have difficulty writing on a single sheet of paper? **X**		
3.21 Is the desk top surface hard enough so as not to scratch easily, non-absorbent so as not to stain easily and heat resistant so that coffee cups would not mark it?		
3.22 Is there a "modesty panel" or can one be optionally fitted?		
3.23 Is the design and construction robust? (see note) **X**		

4.0 SPECIAL REQUIREMENTS FOR AN ADJUSTABLE VDU PLATFORM (IF FITTED)	YES	NO
4.1 Is the height of the VDU platform adjustable through a range of at least 100mm to 250mm above the desk top surface? (see note) **X**		
4.2 Does the VDU platform have at least 400mm sideways movement? (see note) **X**		
4.3 Can the front of the VDU platform be positioned through a range of at least 400mm to 700mm back from the front of the desk? (see note) **X**		
4.4 Can the VDU platform be tilted 5° forward and 15° backward? (see note) **X**		
4.5 Does the VDU platform swivel at least 90° about a central vertical axis? (see note 4.4) **X**		
4.6 Does the VDU platform clamp or otherwise ensure stability of the VDU? **X**		
4.7 Can changes be easily and quickly made to the position and orientation of the VDU stand from the seated position? **X**		

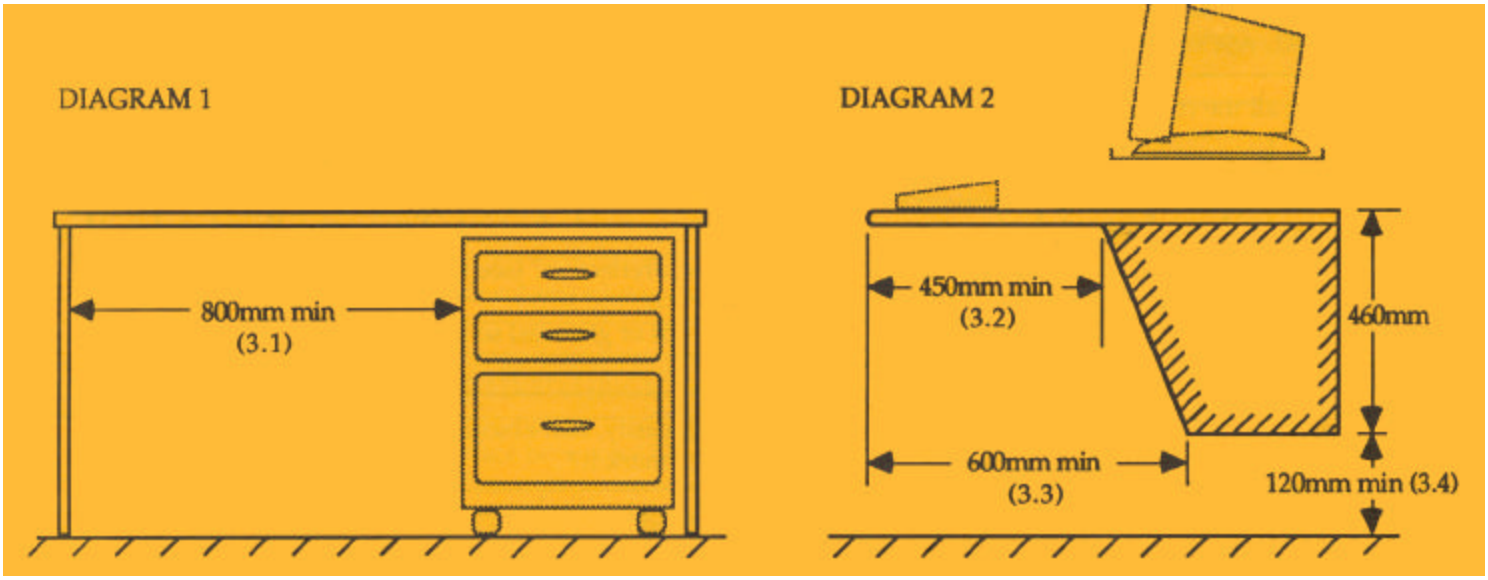
SUMMARY	YES	NO
Does the desk satisfy all relevant essential ergonomic requirements? (marked with an **X**)		
Does the desk pass the desirable criteria considered important?		
Comments:		

EXPLANATORY NOTES AND DEFINITIONS

(Paragraph numbers correspond to numbered items in the checklist).

1.0 Desks fitted with independently adjustable split portions or keyboard surfaces are generally **not** recommended because not only are they associated with greater risk of trapping the fingers and banging the knees but also they restrict the extent to which the user can reposition the computer on the desk (e.g. to avoid glare, change the workstation layout). If an independently adjustable keyboard support surface or split portion is fitted, it should have the same range of height adjustment as a desk-top surface which is entirely height adjustable.

2.0 Fixed height desks are generally not recommended for keyboard work unless they can be set at a height suitable for a particular individual. They should not be used at shared workstations where intensive keyboard tasks (e.g. touch typing, data entry) are carried out unless a footrest is available for use. A fixed top section of an adjustable desk (e.g. a fixed height return) should meet these height specifications.



3.1 SEE DIAGRAM 1. Legspace width is measured horizontally with any recommended mobile drawer unit in place. The minimum requirement is based on the dimensions of larger users and is necessary to allow changes in leg posture and to facilitate chair swivel for reaching to the side or for getting up from the chair. 600mm legspace width is sufficient for a return attached to a desk.

3.2 SEE DIAGRAM 2. Legspace depth is measured horizontally from front to back. This criterion ensures that larger users are able to sit at the desk without encountering restriction at knee level. Legspace depth should be available over the full 800mm width.

3.3 SEE DIAGRAM 2. This criterion allows for a certain amount of leg movement beneath the desk. Legspace depth should be available over the full 800mm width.

3.4 SEE DIAGRAM 2. Toe clearance should be available from the front to the back of the desk. It should be measured with the desk in its lowest position, if applicable, and any supplied modesty panel in place.

3.6 A depth of 900mm enables users to position their VDU screen at a comfortable distance from the eyes and provides more flexibility in the positioning of the keyboard.

3.9 & 3.10 & 3.11 These criteria should be tested when the desk is subject to a typical load of a computer, manuals etc.

3.12 Some desks are designed with adjustment handles that can be parked away under the desk after the correct height has been achieved. Where this is the case, it is desirable that the action of parking away the handle does not result in any significant alteration of the set height.

3.17 The front edge of the desk should not feel sharp to the underside of the wrist and arm.

3.19 A desk top surface that is too dark may cause excessive contrasts in the visual field and a surface that is too shiny could result in glare. Primary colours should be avoided as they can cause after-images. The reflectance of the desk top surface should be between 0.2 and 0.5.

3.23 This criterion applies to obvious design or construction deficiencies which may lead to personal injury or untimely wearing or failure of components. Specific tests are needed to test strength and durability.

4.1 The specified height range caters for different sizes of VDU. It is important that the centre of the screen can be placed 15 to 20 degrees below the line of sight of all potential users.

4.2 400mm sideways movement means that the VDU can be positioned l5° on either side of the directly ahead position. The full range of sideways movement should be available throughout the requirements for height and fore-and-aft movement specified in 4.1 & 4.3.

4.3 To meet this criterion the back of the platform will protrude over the back edge of the desk in some positions. The specified range is necessary to cater for the wide differences in preferred viewing distances. This range of fore-and-aft movement should be available throughout the requirements for height and sideways movement specified in 4.1 & 4.2.

4.4 & 4.5 Tilt and swivel enable the operator to change the orientation of the VDU so that the screen is perpendicular to the line of sight. They can also be used to help minimise reflections on the screen. If the monitor to be used at the desk has the full range of tilt and swivel built in, the VDU platform does not need to pass these criteria.

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