

Guide to

Ergonomics principles in the design and selection of office furniture

Committees responsible for this British Standard

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- AFRC Institute of Engineering Research
- British Airways
- British Industrial Truck Association
- British Occupational Hygiene Society
- British Telecommunications plc
- Chartered Institution of Building Services Engineers
- EEA (the Association of Electronics, Telecommunications and Business Equipment Industries)
- Engineering Employers' Federation
- Ergonomics Society
- Furniture Industry Research Association
- Health and Safety Executive
- ICE (Ergonomics) Ltd.
- Institute of Management Services
- Institute of Occupational Medicine
- Loughborough University of Technology
- Ministry of Defence
- National Union of Mineworkers
- Society of Motor Manufacturers and Traders Limited
- Society of Occupational Medicine
- Trades Union Congress

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Foreword

This British Standard has been prepared under the direction of the Personal Safety Equipment Standards Policy Committee. It supersedes BS 3044:1958 which is withdrawn. At the time of publication no international standards exist on this subject.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**. Tags indicating changes to text carry the number of the amendment. For example, text altered by amendment A1 is indicated in the text by **A1** **A1**.

This revision differs from BS 3044:1958 in the manner in which it covers the needs of both purchasers and designers of office furniture. The general recommendations deal with the importance of comfort and relate this to the task being done, the people for whom the furniture is designed and the furniture itself. Recommendations are given for the use and assessment of both user trials by purchasers and design trials by designers. Attention is drawn to further information on the use of ergonomics data given in the BSI Publication *Ergonomics*.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This British Standard provides guidance on the ergonomics principles important in the design and selection of office furniture to ensure that it will avoid any undue strain on the user.

The approach taken has been to provide the information necessary to give a general framework which will enable both purchasers and designers to understand and use ergonomics information applied to their work.

The standard does not provide a fixed set of prescriptive rules and, as a consequence, does not include detailed dimensional recommendations:

[A1] such details are given in BS EN 527-1 and BS EN 1335-1 and BS EN ISO 9241-2. **[A1]**

The standard indicates how designers and purchasers can ensure that the needs of the end-user are at the centre of their decisions, thus creating a situation where work can be carried out comfortably and efficiently.

NOTE The titles of publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the definitions given in **[A1]** BS EN 527-1 and BS EN 1335-1 and BS EN ISO 9241-5 **[A1]** apply, together with the following.

2.1

anthropometry

the branch of ergonomics that deals with body measurements, particularly those of size, strength and physical capacity

2.2

musculo-skeletal system

responsible for maintenance of posture and for movement of the body through space. The term musculo-skeletal disorders is used to encompass a range of conditions affecting the soft tissues (striated muscle, tendon, nerve, blood supply) affecting the upper or lower limbs, the back, trunk, neck and shoulders, which can range in severity from relatively minor aches and pains to chronic disabling diseases such as rheumatoid arthritis. Such disorders typically present themselves with loss of function

2.3

modern office systems

a system of furniture that not only incorporates the office desk and chair but considers the lines of communication, the lighting levels, noise interference, and the user's personal environment

2.4

static loading

exerting a force for a period of time without producing motion

2.5

body seat height

the maximum height of the undersurface of the thigh behind the knee (from the ground) when seated

NOTE The technical term for this dimension is "popliteal to floor height".

2.6

seat length

the maximum length of the seat front to backrest

NOTE The technical term for this dimension is "buttock to popliteal length".

2.7

hip width

the width across the hips

NOTE The technical term for this dimension is "width of bitrochanter".

2.8

operator eye height

either the erect eye height from the floor (of a seated person) or the erect eye height from the seat squab (of a seated person)

NOTE The technical terms for this dimension are "sitting eye height" or "plane of vision to the seat".

2.9

body armrest height

this dimension is best described by the height of the elbow above the seat

NOTE The technical term for this dimension is "elbow to seat height".

2.10

body armrest length

the depth of the trunk or stomach regions of the body

NOTE The technical terms for this dimension are "trunk thickness" or "abdominal depth".

2.11

armrest separation

the distance between elbow and elbow

NOTE The technical term for this dimension is "elbow to elbow breadth".

2.12

shoulder height

either the sitting shoulder height from the floor or the sitting shoulder height from the seat squab

NOTE The technical term for this dimension is "sitting shoulder height".

2.13
seat to underside of desk

the maximum thickness of the thigh above the seat, with a further allowance made for movement

NOTE The technical term for this dimension is “maximum height of thigh”.

2.14
kneehole depth

the distance between the back of the buttocks and the front of the knee, with a further allowance made for movement

NOTE The technical term for this dimension is “buttock to front of knee”.

2.15
seat backrest height

to establish this dimension, two measurements are needed:

- a) the minimum lower boundary;

NOTE 1 The technical term for the minimum lower boundary is “buttock height above seat level”.

- b) the maximum upper boundary.

NOTE 2 The technical term for the maximum upper boundary is “height of the bottom corner of the scapula”.

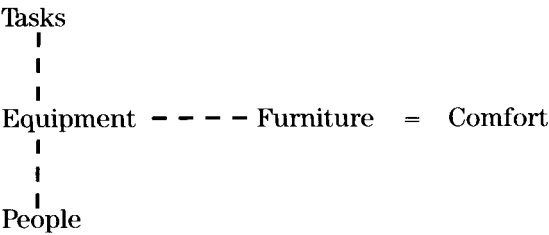
3 General

3.1 Basic elements

Office furniture exists to enable people to carry out their work efficiently. To achieve this objective the furniture has to be able to cope adequately with two variables:

- a) it should accommodate the range of tasks in a particular job and the equipment associated with those tasks;
- b) it should accommodate, comfortably and safely, all people who are likely to use the furniture on a regular basis.

These two apparently obvious, but often overlooked, statements immediately identify the design, purchase and use of office furniture as an interaction between the following.



The skills required in good office furniture design, therefore, involve the matching of the needs of a range of tasks with the requirements of a variety of users. Similarly, the primary decision in the purchase of office furniture has to be based on the suitability of each item of furniture to enable the range of people in the job to carry out their tasks efficiently and comfortably. Equally, as it is unlikely that this objective can be achieved without some form of adjustment by the user, they should also be aware of the reasons for, and benefits of, the adjustment available and be trained in the correct use of such adjustment. Only when all three groups (designers, purchasers and users) are working toward optimizing the inter-relationship between furniture, tasks and people will efficient and comfortable working postures be achieved.

The extent to which furniture provides a good match between the people and their work should always be the primary consideration. Other issues commonly given high levels of importance in the purchase of office furniture, such as the status of the user, should be of secondary importance. Moreover, achieving this match is not necessarily more expensive.

There is a need to involve actual or potential users at all stages in the design and purchase of office equipment.

3.2 Importance of comfort

The significance of comfort for efficiency is often underestimated.

There are many well-documented examples which show the value of expenditure on carefully chosen furniture (to improve the working comfort of office staff) on improving overall business efficiency.

The returns can be seen in four areas:

- a) direct improvement in efficiency, in terms of both output and error reduction arising from reduced fatigue;
- b) increase in general well-being, thereby reducing absenteeism and short periods of sickness absence;
- c) reduction in the probability of the incidence of certain prescribed industrial diseases associated with some forms of office work, such as cramp of the hand or tenosynovitis. Not only does this reduce often lengthy spells off work but also avoids potentially expensive compensation costs;
- d) improved morale and general job satisfaction and, thereby, reduced labour turnover, in addition to the benefits of a more motivated workforce.

Although the emphasis has been placed on the returns to the employer, who will have to finance any improved provision, each of the above points is also clearly beneficial to the workforce. These benefits also provide a good marketing base for designers and manufacturers.

Improving the comfort of the office worker is therefore an important goal for all those involved in design, provision and use of office furniture.

As a high proportion of office work is sedentary, the factors which govern comfort are those primarily concerned with the seated posture. Comfort is, however, extremely subjective and people vary considerably in terms of what they consider comfortable. Fortunately, it is now possible to define the major parameters which will create discomfort. It is therefore possible to ensure that the major potential problems can be avoided by the careful use of the general principles of good seated posture which have been derived by research in ergonomics and related sciences.

3.3 Good seated posture

The three most important considerations in the pursuit of good seated posture are as follows.

- a) The working arrangement should impose the minimal static loading on the joints and muscles of the body, as this type of load is particularly fatiguing.
- b) The working position should allow the posture to be varied at will by the person during his/her work.
- c) The range of postures that can be adopted should not be artificially constrained by the furniture or equipment used.

At work, seated office workers are in direct contact with their environment in three places: the floor; the seat; and the desk (or, more specifically, in some tasks the keyboard). To achieve the objectives described in items a) to c), at least two of these three contact points should be adjustable. Unless at least two are adjustable it is unlikely that static loading of muscles and joints can be avoided. For example, a seat height which is too high will create pressure on the under side of the thighs which will reduce circulation to the lower legs causing "pins and needles", swollen feet and considerable discomfort. Alternatively, a seat height which is too low will cause greater flexion of the spine, leading to backache, and will also require more leg room.

Incorrect adjustment of one element will also interact with the other factors, e.g. too low a seat height will also tend to raise the required hand position thus increasing the load placed on the shoulder and arms.

More details of the critical dimensions to ensure good posture are given in sections 2 and 3. It should, however, be remembered that adjustment can often be provided by relatively simple provisions. It may seem extreme, for example, to imply that the floor level should be adjustable, but it can be successfully achieved in many instances simply by providing a foot-rest.

In many modern office tasks, the eye position is also an important factor in addition to the points of physical contact. For example, in word processing and data entry tasks, if the source documents are placed horizontally on the desk while the keyboard is positioned correctly for the hands, considerable static load can be placed on the neck. Once again relatively simple provisions, such as document holders, can be extremely effective.

3.4 Tasks and equipment (and the application of task analysis)

3.4.1 Task analysis

Before the designer makes any irrevocable design decisions, or the purchaser seriously considers any choice from the wide range of products on the market, each should examine, in detail, the type of work to be undertaken with the furniture they are about to design or purchase. This can only be done properly on the basis of a task analysis, which is a systematic breakdown of the job elements to identify the operational sequence of the work and the way in which the worker uses the information and equipment provided. This process is important for detailing the features of those jobs which can differ in content. Even jobs which have the same title can vary significantly in the way the work is carried out or scheduled. This is especially true of those in modern office systems.

The task analysis should include consideration of:

- a) the major tasks within the job, all the associated equipment and their relative frequency and duration of use;
- b) the inter-relationship between tasks, e.g. is there a need for access to a visual display terminal (VDT) while answering the telephone;
- c) visual attention areas, e.g. traditional office tasks based primarily on writing on a desk need different consideration to the more recently introduced tasks involving regular use of a VDT screen;
- d) the position and use of hands in the tasks to be carried out. This can be particularly important, e.g. the best height of the keyboard will be lower than that obtained by simply placing it on a conventional desk;

e) the availability, size and frequency of use of support equipment and documentation. A workplace which is perhaps adequate most of the time can become extremely cluttered and the worker inefficient and uncomfortable when certain tasks are carried out which involve additional equipment or material.

The importance of a detailed task analysis will vary with the complexity of the job, the variety of tasks and the range of equipment and materials needed. However, as with the variation in people, the variation in tasks can often be accommodated within a series of general categories. For the majority of jobs the major benefit will arise simply as a result of listing the above as a checklist to be used as an aide-memoire in design or purchase decisions.

3.4.2 People

People vary in size and shape. Moreover they vary in quite complex ways, e.g. two people of the same height may have a quite marked difference in leg length. The sexes differ in body size, with females generally being smaller than males. Similarly there are racial differences in body dimensions. However there are considerable areas of overlap so most of the variation usually can be accommodated by adjustment and careful layout of the workplace. Nevertheless it is inevitable that some individuals will not be within the area of overlap. It is extremely important, however, to emphasize that even these individuals are not necessarily disadvantaged in practical terms, their workplace will simply be slightly less than ideal.

In extreme circumstances, however, it may be necessary to tailor solutions to individual needs.

In order to define the range of adjustment and/or flexibility of layout required to accommodate the workforce, it is necessary to have information on body size and shape.

The main source of information on body dimensions is in the form of anthropometric tables.

The definition of the range of the population covered by the tables is usually given in the form of percentiles. A percentile is a statistical expression which defines the size of the population covered by that particular measurement. So, for example, a table which states that the 5th percentile height of the UK adult male is z , means that 5 % of that group will be smaller than the figure stated. Similarly, the statement that the 95th percentile UK adult male height is z means that only 5 % of that population is taller than the figure given. It follows therefore that the average height, which is given by the 50th percentile, will cover only 50 % of the population. These points are shown graphically in Figure 1.

In order to ensure that there is adequate consideration of the variation in the size of the people, it is necessary first to know the general nature of the population involved, e.g. is it predominantly male or female or is a mixture of both sexes involved? Alternatively, are there significant numbers of a particular racial group involved? This information will enable the purchaser to interrogate his suppliers more effectively, thus ensuring his users are adequately catered for.

The designer will, of course, need to go further using anthropometric tables to derive the actual dimensions suitable for the population for whom he is designing. The crucial dimensions are those which have a bearing on good seated posture as outlined in 3.3 and are examined in more detail in sections 2 and 3 (for purchasers and designers respectively).

Particular attention should be paid to users and user groups with special needs, e.g. disabled people, pregnant women.

3.4.3 Furniture

The knowledge gained from an understanding of the tasks (see 3.4.1) and people (see 3.4.2) can be applied, together with the general principles of good posture (see 3.3), to provide the criteria for good furniture design.

The primary criterion should always be that the furniture aids the workers to complete their tasks easily and comfortably. Other considerations, often associated with the choice of furniture, e.g. cost or status, should always be secondary.

An invoice clerk in a modern, computer-based operation, for example, could well need the following to be located on his/her desk:

- a) VDT and keyboard;
- b) A3 computer print-out records;
- c) A4 files of correspondence;
- d) internal and external telephones;
- e) note pad and writing space;
- f) files on customer/supplier information (addresses, telephone numbers);
- g) code listings;
- h) source files of procedural updates, etc.