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ABSTRACT

A 1982 British study examined the furniture needs of 16-19 year-old students. This report presented the findings on the technical and performance requirements in terms of durability and ergonomics. This report examines the furniture requirements in teaching spaces, social, refreshment and private study areas, storage requirements for pupils' personal belongings, and functional requirements. It highlights the common difficulties and shortcomings currently being encountered, covers the general background to the work, provides commentary on current practice as witnessed during the visits and gleaned from the discussions during the project, and concludes with specific recommendations on technical and ergonomic matters. Numerous photographs and diagrams are contained throughout the report. (Contains 33 references.) (GR)

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ED 434 482

Design Note 30

Educational Furniture for the 16-19 Age Group: Specification and Design

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EDUCATIONAL FURNITURE FOR THE 16–19 AGE GROUP
Specification and Design

Design Note 30

Department of Education and Science
Architects & Building Group

FOREWORD

Since 1977 a small multi-disciplinary team within the Architects and Building Branch of the Department of Education and Science has been looking into the accommodation requirements of the 16-19 age group. The results of its work to date have been published[1]. This remains an area of concern particularly in the context of the recommendation in the recent review undertaken for the government and local authority associations[2] that each authority should examine its 16-19 provision.

Studies undertaken by the team show that an appropriate provision of furniture for this age group is essential. Furniture can play an important part in determining both the overall character of a college and the space required for particular activities. For this reason the Department commissioned the Furniture Industry Research Association (FIRA) to carry out two projects.

The first deals with the specification and design of furniture for 16-19 year olds. This report sets out the findings. The second is concerned with space requirements and the relationship between group sizes and room and furniture dimensions; it will also be published.

1 Design Note 22 – NAFE: Designing for Change
Design Note 23 – Four Colleges in 1980
A & B Paper No 4 – Stockton Sixth Form College Space Utilisation Survey
A & B Paper No 6 – Hounslow Borough College Space Utilisation Survey

2 Education for 16-19 Year Olds (Available from DES)

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EDUCATIONAL FURNITURE FOR THE 16–19 AGE GROUP

SPECIFICATION AND DESIGN

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Introduction

1. Educational provision for the 16–19 year age range is receiving wide attention at the present time. This report reflects just one aspect of that provision and must be interpreted in the light of the wider social and educational considerations which are associated with this age group but which cannot form part of this study.

2. Furniture provision had been identified as an area requiring investigation in a preliminary survey carried out by a team from the Department of Education and Science. It quickly became apparent during this study that furniture did indeed pose major problems for schools and colleges. Many of the problems are not exclusive to 16–19 year provision but are common to all educational institutions, so that the information in this report has a wider application, particularly in respect of strength and durability of furniture.

3. As the study progressed it became increasingly clear that shortcomings in the performance of furniture were mainly due to the inadequacy of the advice on specification and design available to those with responsibility for selection and purchase. Moreover what relevant advice is available appears to be either unknown or to a large extent unused. This unsatisfactory situation has been the main influence in the shaping of this report, which examines technical and performance requirements so that fitness for purpose, in both ergonomic and durability terms, becomes the paramount influence on the design and selection of furniture. This report sets out to achieve these objectives, firstly by highlighting the common difficulties and shortcomings now being encountered, and secondly by providing practical advice in the form of specifications and references.

4. Section One of the report covers the general background to the work. Section Two is a commentary on current practice as witnessed during the visits and discussions made during the project. Section Three presents specific recommendations on technical and ergonomic matters. These are based both on the evidence collected during this study and on previous work carried out by the Furniture Industry Research Association and the Department of Education and Science over a number of years.

5. This report cannot meet all circumstances to be encountered in the great variety of provision for the 16–19 year olds. The individual character and organisation of each institution will have a bearing on the right choice and mix of furniture. Solutions must take into account specific circumstances: for example, the likelihood of exceptionally heavy usage or a degree of vandalism. However, the report does set out to present specific recommendations for general and basic requirements, in a way which permits a variety of interpretations for particular circumstances.

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Section One: **Background to the Study**

Scope of the Study

6. The study is concerned with furniture for post compulsory education whether in school sixth forms or in colleges Institutions catering for higher education did not form part of the brief. Furniture for a wide range of activities was examined but certain categories of highly specialised provision were excluded, for example, items such as tracing tables or fume cupboards which could be classified as equipment rather than furniture, and accommodation in departments such as hairdressing and catering where the provision is intended to simulate commercial practice and therefore cannot be regarded as educational furniture. The subject of storage has been confined to provision for pupils' personal belongings and extends an earlier study by FIRA which is published as Building Bulletin 58: The Storage of Pupils' Personal Belongings (HMSO 1980).

Range of Institutions Covered by the Study

7. Table 1 gives particulars of the 16 institutions which were visited and from which data were obtained. The accommodation seen ranged from modern purpose-built colleges to old buildings on split sites and included rural, urban and inner city situations.

Aims of the Study

8. The main objective of the study was to produce a guide to furniture selection and design which could be used by buyers. suppliers and designers of educational furniture. More specifically the aims were:

a. To identify furniture requirements in teaching spaces, social, refreshment and private study areas, taking into account the size of students and the range of activities likely to take place, together with educational and social needs;

b. To examine storage requirements for pupils' personal belongings;

c. In the light of the requirements established in the foregoing, to describe functional requirements and to provide advice on furniture specification in respect of size and performance requirements.

Method

9. Two approaches were used:

a. **Visits to Institutions**

Most of the information was acquired during visits to institutions which took place between November 1978 and October 1979. No strict procedure was adopted but normally a visit involved discussions with a senior member of staff, the caretaker, the member of staff responsible for furniture purchasing, the sixth form tutor where appropriate, teaching staff and students. Detailed measurements of existing furniture were taken and the condition and age of the furniture were examined. Discussions were held during the visits and independently, between Her Majesty's Inspectors (HMI), research officers and architects.

b. **Application of Previous Research**

Data from previous DES/FIRA projects (see References) was available and was directly relevant to the present study. This and appropriate British Standards were used in the light of the information obtained during visits to draw up the furniture specifications in Section Three.

TABLE 1 INSTITUTIONS VISITED

TYPE	NAME OF INSTITUTION	LEA	SITUATION	CHARACTERISTICS
11–18 School	Holy Trinity School	Sussex	Urban	Single site
6th Form Centre	Kings Manor School	Sussex	Urban	Single site
	Stockwell Manor School	ILEA	Inner City	Single site
	Roseberry 6th Form Centre	Surrey	Urban	Single site
6th Form College	Peter Symonds	Hants	Urban	Single site
	St Austell	Cornwall	Urban	Single site
FE College	Hounslow Borough College	Hounslow	Urban	Split site
	North Oxfordshire Technical College	Oxfordshire	Rural	Single site
	Southgate Technical College	Enfield	Urban	Single site
	De Havilana College	Hertfordshire	Urban	Split site
Tertiary College	Cricklade College	Hants	Rural	Single site
Polytechnics	Bristol Polytechnic	Avon	Rural	Single site
	Polytechnic of the South Bank	ILEA	Urban	Multi-site

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Section Two: **Existing Furniture Provision**

10. This section is a summary of the experience gained from visits and discussions. (These were recorded in detail which is not given here.) All the generalisations which follow in this section are backed by itemised evidence, some of which will form the starting point for a further study of space standards and space occupancy. The material in this section is under seven headings, the first two of which are concerned with general matters of current standards and practice. The remaining five headings dealing with the furniture studies have been categorised, and under each there is a general commentary on dimensions (ergonomic aspects) and durability.

Existing Furniture Provision

11. The visits to institutions described in Section One covered a wide range of furniture and accommodation both old and new, but only a minority of furniture exemplified a high standard in that it was selected with a knowledge of how it would perform, and that fitness for purpose was evident in this use. The mismatch between specification, design selection and use was most noticeable for standing working plane activities and in social and refreshment areas. This apparent disparity in the 16–19 sector of education is in marked constrast to the situation in schools for the younger ages in which a continuity of association between education, design and industry has established a practice and a tradition which is understood by all parties and above all is educationally stimulating.

Furniture Selection, Purchase and Replacement

12. Selection and purchase are frequently made by those who are not familiar with the technical guidance which is available, although it must be admitted that there are many gaps in this guidance and its sources are widely scattered. As stated in the introduction one important function of this report is to amplify and bring together the necessary technical guidance. This has been done in Section Three which follows.

13. As awareness of the relevant standards and specifications is rare, selection is excessively influenced by cost and appearance, neither of which is necessarily an indication of good value or satisfactory performance. It would be irresponsible not to recognise the paramount preoccupation with costs at present. But nonetheless, it must be said that the only way of resolving cost and performance problems is for users to be very clear about their requirements and to persist in and insist on their satisfaction, until design and industry together find ways of meeting them. This approach to furniture provision for younger age groups has resulted in common ground being established between education and industry, which is supported by standard specifications, building bulletins and technical reports. There is no comparable policy for furniture at the post–16 level.

14. In some institutions the individual responsible for furniture is a member of the administrative staff such as the Services Officer. In others it is the Principal or a Head of Department who makes the final decisions. Help is often given by the County Supplies Officer; indeed in some instances it is obligatory for colleges to select furniture from ranges specified by the Supplies Officer. Furniture for a new building is usually specified by the architect after consultation with departmental heads. At this stage the choice of furniture may be given very careful consideration and some may even be specially designed. However, such praiseworthy consideration may be compromised by non-compliance with the relevant British Standards and by the lack of appreciation in a new design of day-to-day practical problems. Even furniture which is suitable for a specialised educational purpose may present problems if the relationship between furniture size, room size and room occupancy has not been thoroughly studied, and if it is incompatible with furniture in other parts of the institution. When an extensive refurnishing programme is being undertaken on a departmental scale, a specialist HMI may be asked to give advice. This is likely to be invaluable for specialist educational purposes, but such advice may not embody the necessary experience in ergonomics or design for durability.

15. The budget for new buildings makes it possible to achieve higher standards initially, but it is often difficult to maintain these in sub-

sequent replacements and additions. Gradually, therefore, in the course of an institution's life, the furniture and consequently the character of the interior becomes more miscellaneous as the stock becomes a mixture of new, old, inherited and adapted furniture. These purchases which are made ad hoc over the years result in inevitable untidiness, but more seriously in inefficiency because interchangeability and versatility are difficult to achieve. Were a common dimensional basis properly established for such replacements the problem would be minimised. Improvisations and adaptations by teaching staff, technicians and maintenance personnel are employed to good effect, particularly in the older colleges. Such activity is partly due to a lack of funds for replacement and to the fact that local initiative and skill can often succeed in achieving better results than proprietary sources.

16. The problem of replacing genuinely worn out or obsolete furniture is compounded when failures are excessive. When wholesale replacement is too expensive, resort is sometimes made to local repair but much of this cannot give lasting satisfaction because of the inherent weakness of the furniture. Repair work is often hampered by the unavailability of some parts and the slow delivery of others. Broken furniture can be cannibalised and skills such as welding which are available in the college can be employed to reduce the high cost of replacement. However, care must be taken to ensure that such repairs are competently carried out as legal liability could follow accidents caused by inadequately repaired items. The inability to get broken furniture repaired or replaced quickly is a major contribution to dissatisfaction and slovenliness and to the acceleration of damage. In some parts of colleges, vandalism can be almost insurmountable, but the majority of failures could be avoided by the initial specification of furniture of adequate strength and durability.

General Classroom Activities

17. Furniture in this category consisted mainly of tables and chairs and tablet chairs. The majority of activities took place in the seated position.

Dimensions

The overall height of tables was generally satisfactory for the 16–19 years range where BS 5873 Size 5 (formerly BS 3030 Size 5) was provided with the corresponding chair height. Most old tables, however, were not only excessively high, but offered inadequate leg room (See Plate 1). The plan sizes of most tables are unsatisfactory because the former BS 3030 specified a minimum length per person of 550mm which is too short for the 16–19 age range, and a minimum depth of 550mm which is greater than strictly necessary. The current BS 5873 specifies the minimum plan sizes for size 5 (recommended for the 16–19 year olds) which are shown on Figure 1 in Section Three.

Plate 1. *These tables are too high (800mm) and the excessive thickness of the top (200mm) interferes with knee room.*

This raises the interdependence of furniture size and proportions and room size and occupancy. Larger tables would lead to unacceptable overcrowding in already crowded rooms.

18. Tablet chairs are a common form of provision for the 16–19 age range. Some good examples were seen which allowed for both left and right handed use and enabled the writing flap to be stowed under the chair when not required (see Plate 3). Chair designs were satisfactory but some writing flaps were too small and others were too low and did not allow sufficient leg room. Swivelling flaps were found to be unsuitable in confined spaces (see Plate 4). One good feature of many chairs was the use of

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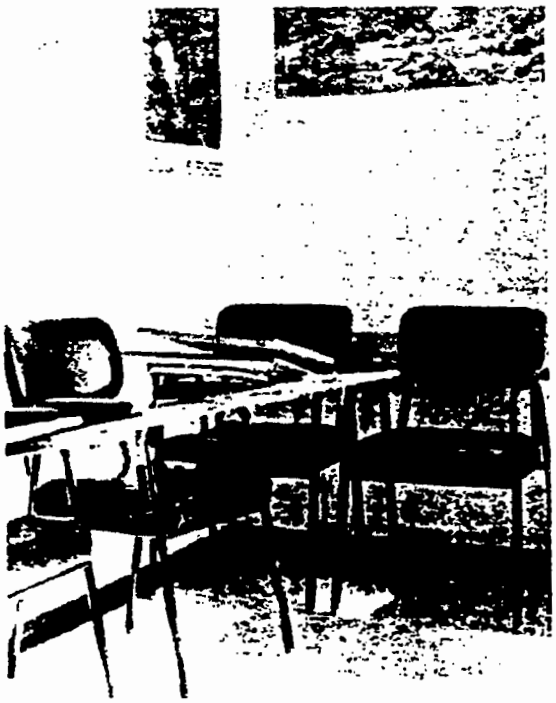
Plate 2. *The table being used has a plan size of 1100 x 50mm which does not conform to the current British Standard. The length is clearly inadequate for these students.*

Plate 3. *These tablet chairs cater for left and right handed use. The tablets are generously proportioned (410 x 370mm) and can be stored between the front and back legs when not required. The swivel action, however, would be a problem in confined spaces.*

Plate 4. *These swivelling writing flaps can interfere with adjacent workplaces. Lift-up flaps would be more suitable in this situation.*



light padding which added considerably to the comfort afforded by the chair.(See Figure 2 in Section 3 for the recommendations.)

Durability

Frames

19. Extensive damage to the frames of classroom tables and chairs was seen, very little of which can be attributed to deliberate vandalism. Nor can the number of failures be due entirely to ageing as most of the damaged furniture observed was not more than 10 years old. The evidence suggests that underspecification is the main cause; that is, much of the furniture was not strong enough to use in classrooms where tables and chairs are subjected to heavy treatment by both pupils and cleaners. Such

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treatment cannot, however, be considered unreasonable, indeed educational furniture should be designed to withstand occasional misuse. Damage to furniture was more common in areas used predominantly by males. This is probably due to the greater average weight of male students.

20. The most common failures were bent table and chair legs, the separation of seat and back rest from chair frames and broken or cracked polypropylene chairs. Some institutions reported an average of 8–10 items becoming unserviceable every week with many more still in use but suffering from varying degrees of damage. Failures in chairs were commonly found to occur in the rear legs, caused by students rocking on these when seated.

Damage to the tablets of tablet chairs, which by nature of their design are vulnerable to abuse, was unexpectedly low. In fact, damage to the frames of tablet chairs was also low, in spite of the fact that the identical chair design when used without tablets at tables failed regularly. It is possible that the obvious lack of robustness of tablets encouraged careful use of this type of furniture. In addition, pupils are less likely to rock on the back legs of tablet chairs since there is no table edge to push against.

21. The extent of damage to table and chair frames was of some concern yet most institutions seemed to accept furniture failure as inevitable. However, examples of strong tables and chairs which stood up to heavy use were seen and it is clear that the number of failures could be significantly reduced by ensuring that furniture is of adequate strength (this is dealt with in paragraphs 52 – 55).

Table Surfaces and Edges

22. Much of the damage to table tops was disfiguring but did render the table unserviceable. Common types of damage included mechanical damage such as scratching or carving by pupils on wooden surfaces, and the delamination of edges. The former can be classified as deliberate damage by pupils while the latter is more likely to be due to glue failure with no doubt some help from busy fingers. Plastics laminates proved to be the most durable of finishes for general classroom use but examples were seen of delamination, scratching and staining which proved to be unsightly and difficult to repair. Ageing of furniture is certainly a factor here but inadequate resistance to delamination was apparent in some cases. Linoleum was found to perform well but was prone to staining.

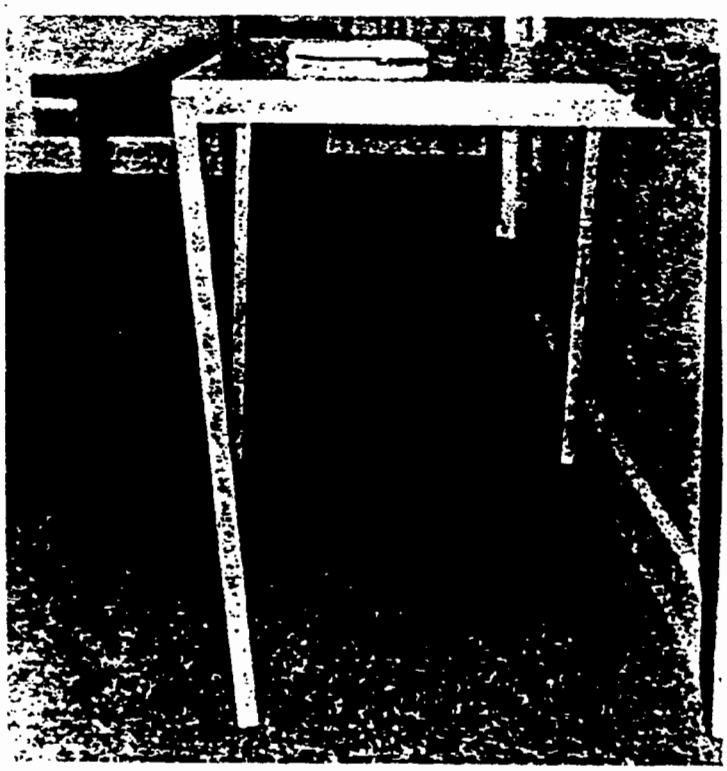

Plate 5. *This type of damage to tables was all too common.*

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23. Major problems were experienced with edge treatments for tables, many of which proved to be vulnerable. This was normally where damage first occurred. There was widespread lack of awareness of the relative merits (see page 35) of different table surfaces and edgings and this fact was reflected in the extensive damage which was seen.

Activities at the Standing Working Plane

24. Most of the standing work plane furniture was used for the different branches of science, but some was for the various light crafts. Furniture consists mainly of fixed benching and loose tables and stools.

Dimensions

25. Furniture in this category was found frequently to be of bad design and drew many complaints of discomfort from students. Such complaints appeared to be justified by evidence of bad working posture. The height of the work surfaces was satisfactory for most standing work but the absence of adequate leg room and badly related seating made them unsuitable for seated work. It was observed that in laboratories a significant amount of time was spent in the seated position. Many students claimed that they frequently remained seated throughout double periods. This fact is not appreciated by designers who assume that all work will be at the standing plane, consequently underbench storage compromises leg room (see Plate 6) with at best occasional knee holes which only permit

Plate 6a and b. *Absence of an adequate knee space results in bad working posture for these students who frequently spend long periods note-taking. Note the bags scattered on the floor.*

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Plate 7. *Knee holes allow adequate leg room but students can only sit at specific positions.*

Plate 8. *Two heights of stool are provided for use at the same work surface. The shorter stool should be used at a lower work surface, but has been introduced here because the excessive depth of the table construction interferes with the leg room of pupils using stools at the correct height.*

comfortable sitting at specific positions (see Plate 7). Even where the furniture did afford sufficient leg room, as in newer laboratories where the trend towards flexibility called for free standing tables, stools at the correct height (280mm below the table top) were not provided. It was not uncommon to find two heights of stool for use at the same work surface (see Plate 8). In short the picture was a gloomy one, with inflexible space-consuming benching, little consideration given to how the furniture is really used, and only lip service paid to the requirements for seated work.

Durability

Frames

26. Much of the furniture seen was in the form of fixed benching which was extremely strong and remained structurally undamaged after many years of use. Loose tables were of a sturdier construction than those supplied in general teaching areas and there was little evidence of structural damage. Discussion with staff revealed an awareness of the importance of strong furniture in view of the heavy equipment and hazardous substances which will be placed on standing work surfaces, and institutions were prepared to pay for quality. There is also the need for robustness and steadiness for practical work and scientific experiments. Stools for use with standing surfaces performed well, the only damage seen being the odd broken seat which was allegedly caused by pupils or cleaners accidentally knocking stools over.

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Plate 9. *Water seepage has caused excessive swelling and disintegration of the particle board core.*

Occasional knocks, however, should not cause failure. The close supervision of practical work reduces the possibility of wanton damage and the stronger furniture which is normally provided for standing work would account for the low incidence of structural failure.

Working Surfaces and Edges

27. Although expensive, solid hardwood provided the most satisfactory and durable surface of the materials observed. While susceptible to damage from heat and spillages it has an inherent durability and is easily furbished, so that solid hardwood surfaces can give long and satisfactory service. Plastics laminate covered surfaces had varied success and were suitable for many activities. Delamination of both surfaces and edge strips was not uncommon. Exposed sharp edges were dangerous, dirt tended to accumulate in the rough edges of the core material. Spillages, particularly around sinks, caused swelling and in some cases disintegration of the core material (see Plate 9). Solid wood edges were found to be durable, as were edgings formed from a plywood core (see Section Three for recommendations).

Private Study

28. Two general categories of private study were observed, for each of which particular furniture is appropriate. The first is for individual and private work where seclusion and absence from distraction is necessary. The second is more casual and may involve co-operation and discussion between students. All the institutions seen provided for private study in the more individual and secluded sense, usually in the library, with tables and chairs and individual carrels. Provision for the more casual and relaxed private study was rare and was more often to be found in sixth form colleges close to the social area than in colleges of further education.

Plate 10. *A good example of relaxed seating in a library, which is appreciated by browsers.*

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Plate 11. *These library tables were in two plan sizes. (a. 1830 x 900mm, b.1220 x 610mm) which are good for normal use but are unsuitable for periods of peak use. Both sizes are too shallow for double sided use and if grouped back to back, size a.in particular would be excessively deep.*

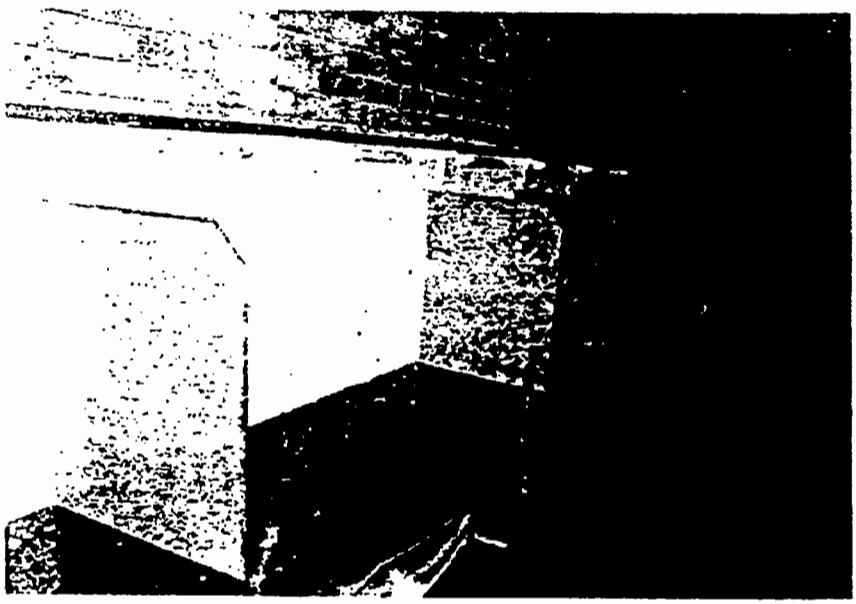
Dimensions

29. Library tables, normally larger in plan size than those provided in classrooms, were found to provide adequate space for normal use although few institions manage to cope adequately with the demand during the weeks preceding examinations. As in classrooms, there is need for fuller study of plan sizes and their relation to room size. Tables were often too shallow for pupils to work at opposite sides, while grouping tables resulted in an excessive table depth (see Plate 11). Such considerations do not matter when library use is light, but at peak times the number of students which can be accommodated comfortably is reduced.

30. Most institutions had carrels either in the library or in areas specially designated for private study. The scale of provision varied very widely and there was evidence of over provision in some cases. Reactions to carrels were mixed. Students at certain times when an extra degree of concentration was required welcomed the seclusion they offered, but many complained of feelings of claustrophobia and preferred to work at tables and chairs leaving many carrels unused.

31. There are several factors to consider. Firstly, the dimensions of carrels were usually unsatisfactory. Plan sizes were inadequate (see Plate 12), often leg room was compromised by an excessive top thickness and writing surfaces were too high.

Plate 12. *These carrels are not popular with students, possibly because of inadequate plan size (710mm long x 530mm deep). The divisions are removable in this case, (as in the one in the foreground) and better use could be made of the space without them.*



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The position of carrels is important. In one example banks of carrels had been placed within earshot of teaching areas so that they were never used. Bad maintenance (lamp failures) was a problem, particularly in respect of individual lighting so that students worked in their own shadow. Carrels placed in front of windows were preferred to those against a wall. There is evidence, however, that carrels which are generously dimensioned (ie at least 900 x 600mm) and well sited are liked and are particularly appreciated for examination preparation and for the use of audio equipment. The allocation of carrels to individuals as a private base is appreciated but space does not permit this in most institutions.

Durability

32. Little damage either to frames or work surfaces was seen with furniture provided for private study. This applies equally to furniture in libraries and to other private study areas which may not always be supervised, and possibly reflects the more careful use which can be expected in such circumstances. In one institution long library tables (1820 x 900mm) were found to be bowed in the centre. This was due to faulty design and inadequate materials specification rather than any form of abuse by students.

Social and Refreshment Areas

33. Good purpose-designed provision for social and refreshment activities was seen in sixth form centres where special attention had been given to the design and layout. These centres usually included provision for social activities, private study, dining and light refreshments. These were popular with students. By contrast social accommodation in colleges of further education was depressing and ill used (see Plate 14) while dining was of an institutional and noisy nature. Not all social provision at sixth form level is well designed but experience from this investigation suggests that accommodation in sixth form centres reflects the needs of students more closely than any seen in the limited number of colleges of further education which were visited.

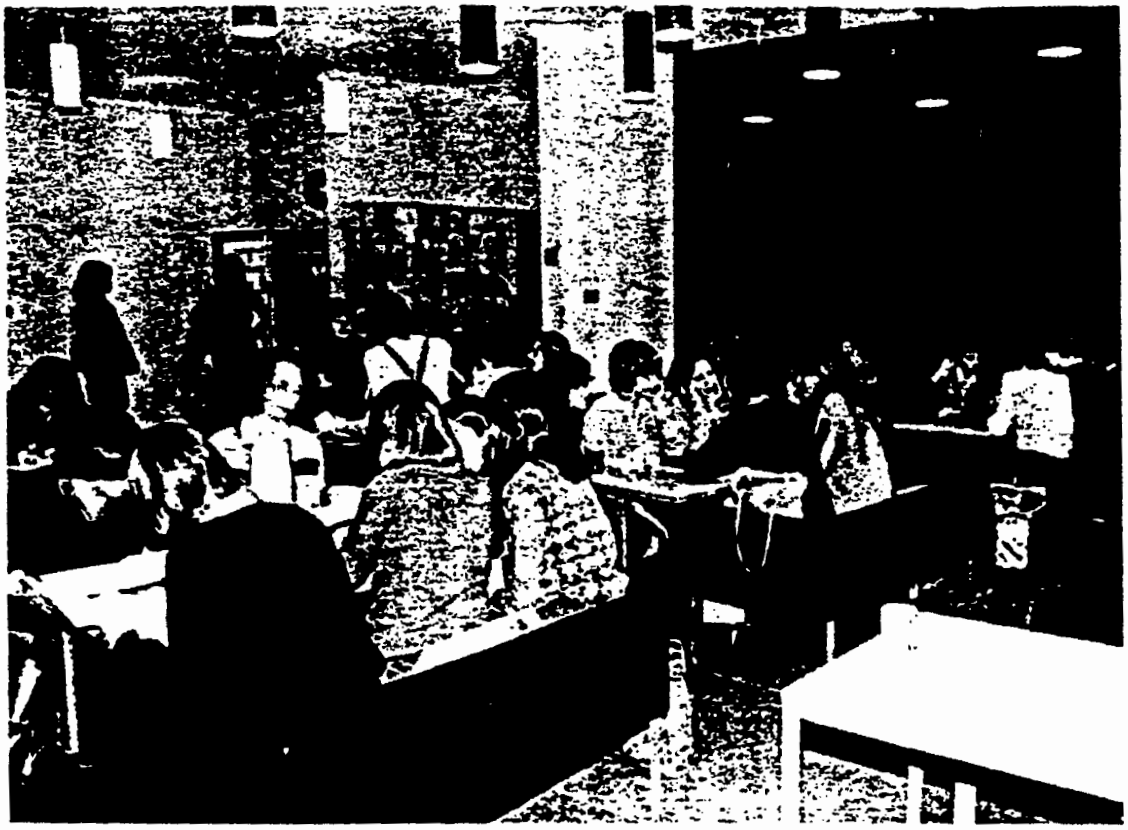

Plate 13. *This sixth form centre offers a variety of furniture and facilities for social, refreshment and informal private study activities. The photograph shows the refreshment area being used mainly for informal private study.*

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34. Most institutions provided canteen facilities offering a variety of hot and cold meals. Facilities for snacks and coffee varied. Several sixth form centres had provided limited facilities within social areas for students to organise their own snacks but in many cases these were used only to provide hot water for coffee. It appears that initial enthusiasm waned as students discovered that some organisation is required to run a snack bar. In colleges of further education, coffee and snacks were mainly available in canteens or coffee bars at specified times. Vending machines were becoming increasingly popular and although the quality of hot drinks was often inferior, such machines did save space. A good example of the use of vending machines was seen in a polytechnic, where circulation spaces in the science block had been used to provide four different refreshment points. The addition of tables and stools helped to create a pleasant facility for casual refreshment. In general social provision tended to be more satisfactory and better cared for when it was not isolated or remote from the centre of life of the building.

Plate 14. *Much of the original furniture in this common room has been replaced by a miscellany of cast-off easy chairs. There are virtually no tables and the area has a forsaken and depressing look.*

35. Coping with the peak use of social spaces in breaks and at lunchtime is a real problem because it is not feasible to provide easy chairs for all. Settees or bench seating are more efficient in this respect than individual chairs but the possibilities for the arrangement of furniture became limited. Stools were seen to be used to good effect at peak times but are only suitable for short term sitting. The dimensions of dining furniture were satisfactory. A variety of table shapes and sizes was seen catering for different group sizes. No seating problems were seen at peak times although queues at food service points were not uncommon. Students stagger lunch where possible. In one 11–19 school, sixth formers dined with other pupils in classrooms. Such provision was not typical and was seen in an institution where 16–19 year olds had few privileges.

Dimensions

36. Furniture in this category includes dining tables and chairs, low upholstered seating and benching, coffee tables and stools. What was seen was generally satisfactory. Requirements need not be so rigidly defined, as use may not be for long periods and in any event students can move around or change their posture freely – a luxury not enjoyed for example by those monitoring a long experiment in a laboratory.

37. Views differed about the comfort afforded by easy chairs. This was to be expected as individual preferences vary. There were, however, no serious complaints with regard to comfort. In one institution the backrest of the upholstered chairs was found to be too low (the height to top of backrest was 234mm above the seat) and proved uncomfortable for long periods of sitting; nevertheless students found the seating quite acceptable for normal social use. Most complaints came from staff who considered that in some cases the seating capacity of spaces was reduced by the excessive overall size of the chairs. This study confirmed that such complaints were often justified.

Durability

Upholstered Furniture

38. In some institutions, mainly technical colleges, damage to furniture was severe in social

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and refreshment areas, much of it due clearly to vandalism. Upholstered seating was inevitably vulnerable, and the rate of destruction and replacement was high. Cutting of PVC covered chairs was prevalent. Chairs covered in fabric fared better, but were less common presumably because of the problems of spillage and staining which make them unsuitable for use in dining areas. This extreme abuse of furniture, although common was not universal. Where furniture had been carefully designed and partly shared by staff, it generally commanded more respect. Nonetheless, damage was seen in institutions where use could be considered legitimate. Damage to corners and sharp edges was common with PVC coverings which are prone to knocking damage at points where the foam is completely compressed. Such damage could be reduced with improved design. Once damage of this kind occurs, the temptation to pick at the underlying foam filling is irresistable thus accelerating the damage (see Plate 15). Examples of this were not confined to student areas – seating in staff rooms suffered likewise. Collections of damaged furniture are frequently found in store, some of which is eventually repaired (but see paragraph 16).

Frames

39. Damage was extensive and it is difficult to know to what extent persistent abuse as opposed to inherent weakness is responsible. Use in social areas is certainly heavier than in teaching areas and this fact was not always reflected in the furniture provided. Tables and chairs fixed to each other or to the floor fared badly. These had been installed in some institutions and appeared to encourage misuse. Large forces can be exerted on such furniture without fuss or visible evidence whereas to inflict similar damage on loose furniture would attract attention. In addition it is irritating not to be able to push away a table or chair or adjust the relationship between them. Bent table and chair legs were common but one piece polypropylene chairs performed well in dining areas. Many dining tables were sturdy and some had given satisfactory use for some ten years thus underlining the importance of initial specification. Pedestal tables, whether intended for dining or for use as occasional tables, were found to be particularly unsuitable and had a high failure rate (see Plate 17). Furthermore they are easily tipped over when they are carelessly used.

Plate 15. *Damage to upholstery covers and exposure of underlying foam is common in social areas.*

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40. In social areas wooden arms on upholstered chairs were frequently loose or missing, suggesting that chairs without arms are more suitable where exceptionally heavy use is expected.

Plate 16. *Wooden arms can become loose and detached. Note the bent table leg.*

Tables – finishes and edgings

41. Plastics laminate was the most common surface for dining tables and had the merit of being resistant to heat and spillage and easily cleanable. However, the incidence of delamination and the failure of edges was unacceptably high and was similar to that experienced with furniture for general teaching (see Plate 17).

Personal Storage

42. The storage of personal belongings can be a major problem for all educational institutions and the visits made during the present study confirmed that 16–19 provision is no exception. Many of the problems observed were similar to those observed on a previous study in secondary schools*.

Dimensions

43. Lockers and coat pegs were the most common form of personal storage. In some institutions open shelving or pigeon holes were seen to be successful. Dimensions of lockers varied considerably ranging from small book lockers which could not accommodate coats or bags, to full length lockers with coat pegs and a shelf for books. The generous dimensions of the latter type were frequently rendered ineffective by the need for two or more pupils to share

* Building Bulletin 58 'Storage of Pupils' Personal Belongings' HMSO 1980

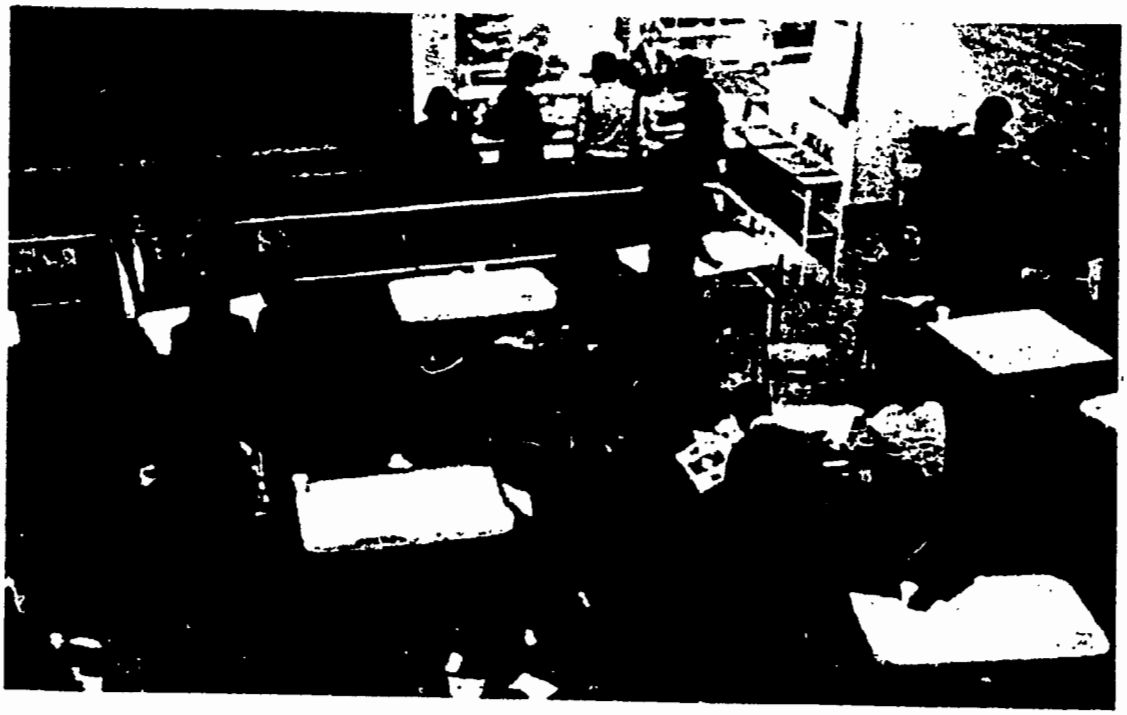

Plate 17. *Delamination and the failure of edges was high in refreshment areas. Many of these pedestal tables were unsteady, others had failed completely and had been replaced by tables with four legs.*

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accommodation. Lack of space for lockers was a common problem and in some institutions the size of lockers was reduced so that every student could have some storage provision. However, this is rarely successful because lockers which are too small are often not used. The storage requirements of students following different courses vary considerably and a more rewarding approach would be to reflect these requirements more closely in the type of provision. Although examples were seen of lockers which were clearly inadequate, provision was generally more generous than in secondary schools. Nevertheless, adequate provision could be misused, confirming that other factors such as organisation and security have a bearing on achieving satisfaction.

44. The question of bag storage has not been answered so that in every institution there was the familiar sight of bags littering classrooms and corridors (see Plate 6a). One institution had attempted to cope with this by providing shelf racks for bags outside the library. These were good in principle but inadequate in quantity.

45. Coat storage was another problem which was more often caused by inappropriate siting of pegs than by lack of provision. Where cloak areas were provided for the storage of outdoor clothing, their success depended to a large extent on convenient siting. Unused coat pegs are fairly common with students electing, for reasons of security and convenience, to keep their coats with them during the day.

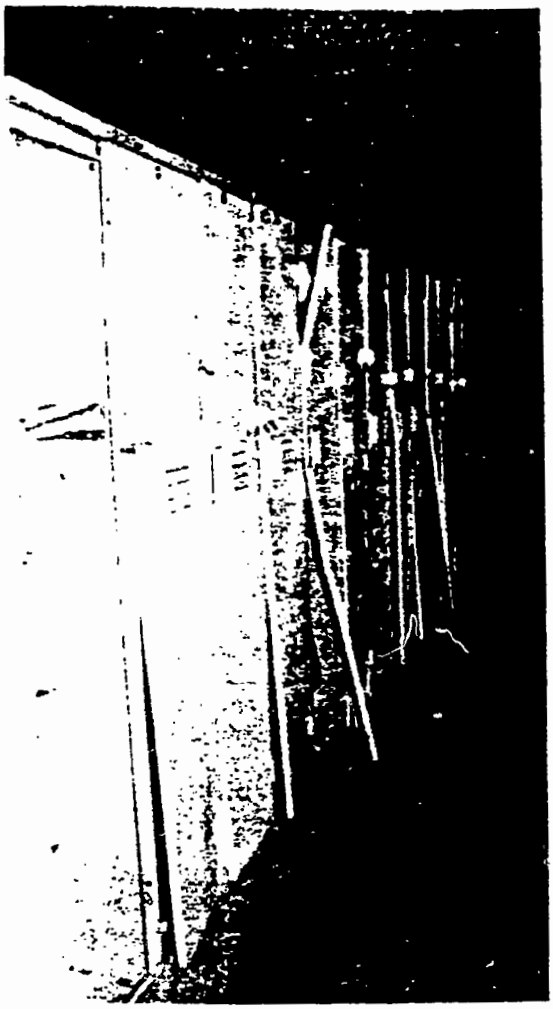


Plate 18. *Locker doors are easily damaged. These lockers, which are sited in 'no man's land' have suffered badly. Some home-made repairs have been attempted but this has resulted in sharp metal protrusions at eye height.*

Durability

46. Damage to lockers was severe – particularly to doors. Much of the damage appeared to have been caused by students having lost the key, forcing the door open. A common fault in the design of many lockers was the failure to provide a means of holding the door without a key. Thus many doors could swing open, causing an obstruction and an invitation to abuse. Lock mechanisms too were found to be of inadequate strength and much time and effort had been spent on 'home made' remedies, some of which resulted in very dangerous sharp metal protrusions.

While some of the damage to lockers was undoubtedly the result of vandalism, some was the result of the inherent weakness in design. Full length lockers in particular are too easily bent. Careful siting which avoids clandestine positions is a more practical remedy than the excessive expense of very robust lockers.

47. Coat pegs were frequently found to be bent or broken, indicating that stronger or better designed pegs are required. This damage was mainly seen in unsupervised areas where students may have engaged in trials of strength.

Planning of Storage

48. This is the most important influence in determining the success of storage provision for personal belongings. Much underuse and abuse can be attributed to lockers being sited where circulation by the owners is infrequent, in areas which could be designated as no man's land and where casual supervision is rare. Provision which was seen to be well used was found in areas which permitted some degree of supervision,

such as within departments or sixth form bases, where access to storage was restricted to students who regularly used these areas. By contrast banks of lockers placed close to entrances were liable to claim the attention of intruders.

49. The main lesson to be learned is that successful locker provision requires not only correct dimensioning but must also satisfy the two important criteria of convenience and security, which depend largely on lockers being sited in small groups and close to the working areas of those to whom they are allocated. Recommendations for storage for personal belongings can be found in Section Three of this report.

Section Three : Recommendations for Furniture Design and Specification

50. The recommendations are in two parts. Part one gives advice of a general nature on aspects of furniture durability while part two examines functional and dimensional requirements for specific activities. The recommendations which follow are based mainly on British Standards, previous research by the Furniture Industry Research Association and on information collected during the present study. Technical references, where appropriate, are given at the beginning of each section.

Durability of Furniture

51. Furniture for educational institutions must be fit for purpose in terms of durability, strength and stability. This section discusses the different aspects which must be considered to ensure that these requirements are met. Performance specifications can be quoted in some instances but in others, such as finish or upholstery covers, such precision is not possible. Much will depend on circumstances affecting anticipated use, wear and tear, cost, appearance and so on. Where there is no one specific recommendation a balance between all the relevant factors must be sought.

Strengths of Furniture Frames

Technical References

52. 1 BS 5873 Educational Furniture

Part 2 (1980): Strength and Stability of Chairs

Part 3 (in course of preparation): Strength and Stability of Tables

2 BS 4875 Strength and Stability of Domestic and Contract Furniture

Part 1 (1972): Seating

Part 2 (1977): Tables and Trolleys

Part 3 (1977): Cabinet Furniture (Specifies strength requirements for other items of furniture some of which have relevance to educational institutions)

3 BS 4680 (1971): Clothes Lockers (Of limited value as performance tests do not cater for heavy use. BS 4875 Part 3 gives more realistic performance requirements).

Tables and Chairs

53. To ensure adequate strength of tables and chairs, only those designs which meet BS 5873 (Ref 52/1) should be considered for use in educational institutions. This standard provides for both normal and severe use thus reflecting the varying circumstances to which the furniture may be subjected. ('Normal' use allows for rough treatment and careless handling while the 'severe' rating is intended for exceptionally severe use.) For many situations furniture of 'normal' strength is appropriate, but where exceptionally rough circumstances are to be expected, purchasers are advised to specify the 'severe' rating in the interests of longer life and lower replacement costs. This would not necessarily involve a significant increase in cost, but the choice of furniture may be limited.

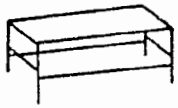
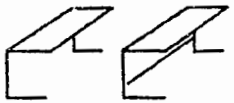
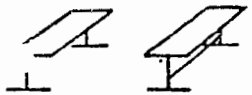
54. Other items of furniture such as easy chairs, stools, settees, and trolleys should meet the requirements of BS 4875 (Ref 52/2). This standard specifies five ratings ranging from light and delicate furniture (Rating 1) to severe contract use (Rating 5). It is recommended that furniture for educational institutions should meet Rating 4 requirements at least while Rating 5 furniture should be provided in areas of heavy use such as student common rooms.

55. Table 2 has been included for guidance and shows a selection of common designs of tables which were seen in use. These designs may have metal or timber underframes, as can chairs and stools.

i. Wooden Underframes

Timber varies in density and strength as well as having different strengths in different directions, and it is also liable to split. It is dimensionally affected by changes in atmospheric humidity. The properties of timber are also dependent upon the species and often the history of the tree itself. The timber should be dried before use and this is particularly important where dowel or mortise and tenon joints are concerned. Poor drying will cause other faults such as loose

TABLE 2 TABLE FRAMES

DESIGN	STRENGTH	STABILITY	APPLICATIONS
a	The top of the leg is the weakest point in this design. The legs are liable to bend, break or become detached at this point.	Good but depends on thickness of legs and method of attachment.	Good for situations where pupils will sit at all sides. May be stackable.
b	Stronger than (a) in the transverse direction but susceptible to the same type of damage in the longitudinal direction.	Good	Pupils can only sit at the long sides of this table. Can be stacked if the legs extend beyond the top.
c	Similar to (d) although not quite as strong with only one stretcher. This design is at its strongest when the stretcher is placed centrally.	Very good	Pupils can only sit at the long sides of this table.
d 	Potentially the strongest and stiffest framework.	Excellent	Only suitable for standing work because stretchers will interfere with leg room.
e 	Weak where the leg joins the top. This design is often tipped over easily and the top may become damaged or detached. Strength will be slightly better if the design includes a stretcher.	Fair	Suitable for sitting work. Will probably be too unstable if made at a height suitable for standing work.
f 	Suffers from the same problems as (c) but will be slightly stronger because of the central placement of the leg.	Good	Suitable for sitting work (at long sides only) and standing work.
g	Top tends to detach when knocked over or sat upon.	Very poor	Unsuitable for use in educational institutions.

Note: All tables should have strong underframes unless the top has exceptional strength.

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joints and splits. It is important to ensure that the building is dry and heated prior to delivery of furniture. The deflection of timber structures increases gradually with time and tables which support a large load for a long period may sag visibly. Timber structures can be technically of simple manufacture and, when properly designed, can be of handleable weight and sturdy with the resilience to resist shock loading. In this respect unnecessarily massive members may make an otherwise satisfactory structure vulnerable to joint failure under shock loading conditions.

ii. Metal Underframes

Metal underframes are more consistent, since the only variable is joint weld strength. Metal is structurally unaffected by atmospheric moisture or temperature although it does require corrosion protection and its strength properties can be expected to be consistent in all directions and throughout all batches of material to a given specification. Metal, however, suffers from fatigue failures and permanent distortion at loads which are only a fraction of the ultimate failure load. Metal is potentially heavy and can only practically be used for underframes in the form of relatively small diameter tubes. Such underframes therefore tend to be more springy than timber frames unless specifically designed for rigidity, in which case they are more likely to suffer permanent deformation under shock load than either a light wooden frame or a springy metal frame. The manufacture of simple metal underframes requires a minimum of metal working equipment, but more sophisticated frames may require a variety of bending and jointing machinery not normally within the experience of furniture manufacturers. Metal parts for furniture are therefore often made under subcontract.

Lockers

56. Little experience has been gained to date in testing lockers for educational institutions so that it is difficult to relate test levels to actual performance. Although a British Standard BS4680 (Ref. 52/3) exists, the performance requirements are not appropriate for the type of use which can be expected in schools and colleges. Recent experience suggests that the Rating 5 performance requirements in BS4875 (Ref. 52/2) should be met to ensure adequate strength of the cabinet and shelves. An additional test is required, however, to assess the impact resistance of doors. Standard apparatus is available for this purpose but door impact tests do not at present form part of any British Standard. Impact damage is common, doors of full length lockers being particularly vulnerable, so it is important to ensure high impact resistance. Advice on this matter can be sought from FIRA, as no suitable document can be referred to.

57. The majority of locker failures are due to damaged doors. Two main causes have been identified.

i. Front impact damage — often caused by kicking.

ii. Damage caused by breaking open lockers.

i. Minimising Front Impact Damage

Steel sheet is currently the most popular material for lockers. Resistance to impact damage can be improved by choosing a heavier gauge of metal or alternatively the strength of light gauge metal can be greatly increased by contouring and pressing the door into a ribbed pattern. Other materials with good resistance to impact damage can be used. These include veneered particle board (12mm thick minimum for book lockers, 18mm minimum for full length lockers), polycarbonate sheet, plywood and polypropylene (recommended for doors only). Doors should be designed with some form of catch to remain shut even when not locked. Open doors encourage slamming or kicking.

ii. Minimising Break-in Damage

Good key management, the use of combination locks, or padlocks which can be removed by metal cutters will help to reduce break-ins due to loss of keys. In addition there are a number of design features which can improve locker security. The hinges and locks should be riveted through the door. Screws should not be used with timber based materials or plastics. The doors should extend over the front of the locker carcass. If the doors are fitted inside the carcass, the sides of the locker need to have additional rigidity to discourage the insertion of a lever. Finally, when locked the door should be secured with a number of bolts along its length including the top and bottom edges. The espagnolette type of locking mechanism is a relatively inexpensive and common means of doing this.

Metal Coat Hooks

58. In practice, coat hooks should be expected to withstand a certain amount of misuse but it is difficult to say what is reasonable. In general terms, and neglecting the advantage which may be gained from careful design, the strength of a coat hook can be expected to be proportional to its cost. Table 3 gives properties of different metals from which coat hooks can be made. The right design may largely compensate for the weaknesses of particular materials. For instance, a cast coat hook may be designed to be thick where bending moments are large and therefore may have satisfactory strength when attached by two screws on the horizontal centre line of a relatively small bearing area. If a simple hook is to be made from sheet material it is necessary for the fastening screws to be as close as possible to the top and bottom edges of the bearing area in order to reduce the bending moments, because the material thickness cannot be changed to compensate. It may be advisable to specify tamperproof screws.

TABLE 3 METAL COATHOOKS

MATERIAL USED	FAILURE CHARACTERISTICS	CORROSION PROBLEMS	DESIGN CONSIDERATIONS
(1) Cast iron	Brittle-vulnerable to shock loads.	Less corrodible than sheet steel – can be adequately protected by paint.	Should be thick where bending moments are large.
(2) Cast steel	Strongest method of construction, but likely to be expensive.	Will corrode markedly in the presence of moist air. Stainless steel will be corrosion proof.	Suitable for most designs.
(3) Sheet steel	Easily bent.	Will corrode markedly in the presence of moist air – can be zinc, chromium or cadmium plated for protection. Stainless steel will be non-corrodible.	Fastening screws should be as close as possible to the top and bottom of the bearing area in order to reduce bending moments
(4) Cast aluminium	Alloys can be stronger than (3) and (1) but not as strong as (2). Pure aluminiums are easily bent.	Pure aluminiums do not corrode to a visibly detectable extent. Aluminium alloys tend to dull with time unless painted. Sea air will be harmful.	See (1)
(5) Sheet aluminium	Easily bent – weaker than (3). Alloys will be stronger than pure aluminium.	ditto	See (3)
(6) Die cast zinc alloy	Brittle – vulnerable to shock loads.	Will dull with time unless further treated. Paint will prevent visible deterioration almost indefinitely.	See (1)

Stability of Furniture

Technical References

59. 1 BS 5873 Educational Furniture

Part 2 (1980): Strength and Stability of Chairs

Part 3: (in course of preparation): Strength and Stability of Tables
(Gives stability requirements for classroom tables and chairs)

2 BS 4875 Strength and Stability of Domestic and Contract Furniture

Part 1 (1972): Seating

Part 2 (1977): Tables and Trolleys

Part 3 (1977): Cabinet Furniture
(Good for furniture other than seating where stability requirements are confused)

3 Research Manual 24: Revised Stability Standard for Chairs and Stools. FIRA February 1981.
(Proposal for rationalising the various British Standards dealing with the stability of seating)

4 BS 5459 Performance Requirements and Tests for Office Furniture

Part 2 (1977): Adjustable Chairs
(Gives geometric requirements for stability based on vertical loads only. It is possible that an adjustable chair might be declared unstable because of the position at which the centre column was attached to the seat, even though it could in reality have been more stable than chairs which did satisfy the standard)

60 Adequate stability is important for all furniture but even more so in educational institutions where there is considerable risk of accidental knocking. Stability, particularly where tables are concerned, is often taken to mean the stiffness or rigidity of the frame; however, the latter properties are catered for in the strength tests. Stability is defined here as the ability of a piece of furniture to withstand forces which tend to cause it to tip over.

Stability requirements for classroom tables and chairs are laid down in BS5873 (Ref. 59/1). Tables other than those used in general teaching areas are covered by BS4875 (Ref. 59/2) but the situation with regard to easy chairs, high chairs and stools is more complex. This is because for some years there have been at least three British Standard methods of assessing the stability of seating, each producing different results so that it was possible for the same chair to satisfy the requirements of one method and fail another. However recent work on International Standardisation has led to a new standard which will consist of a single test method of stability which is generally applicable.

61. It is impossible to make a chair which cannot be overturned and so absolute safety requirements cannot be used as a means of defining stability. Recent work has indicated what level of stability might reasonably be expected from different heights of seat and the proposed Standard is based on these results (Ref. 59/3).

The higher the seat the more unstable it becomes so that a high stool cannot be expected to have the same degree of stability as a low seat of similar design. However, the degree of stability which normal use demands of a high seat is less than that of a low one. Users tend to be conscious of the more vulnerable nature of a high stool and adjust their behaviour accordingly. Elderly or infirm people require the greater stability which is inherent in a low seat. It is therefore appropriate that the stability requirement on low chairs should be greater than that for high seats. It is recommended that until a new British Standard on stability is published, advice on the stability of seating for items other than classroom chairs be sought from FIRA.

Upholstery Covers

Technical References

62. 1 BS 2543 (1970): Woven Upholstery Fabrics
(Requirements for woven warp-pile and non-pile primary covering fabrics for domestic upholstery)

2 BS 4723 (1971): Nylon Stretch Covers for Upholstered Furniture
(Requirements and making-up recommendations: Methods of Test)

3 BS 5790 Coated Fabrics for Upholstery

Part 1 (1971): Specification for PVC Coated Knitted Fabrics
(Requirements for three qualities of PVC coated single jersey weft knitted base cloths)

Part 2 (1979): Specification for PVC Coated Woven Fabrics

TABLE 4 PROPERTIES OF UPHOLSTERY COVERS

FABRIC TYPE	WEAR	RESISTANCE TO SOILING[1]	EASE OF CLEANING[2] (in situ hand cleaning)	DAMAGE CAUSED BY SMOKERS' MATERIALS[3]	COST (for good quality)	APPLICATIONS
WOOL - woven	good	good	fair	fabric will char, but charred fibres can be rubbed off	expensive	suitable for all applications except canteen use
PVC	good – but may become brittle and crack where head and hands contact fabric	good, but depends on lacquer type used	excellent, but depends on lacquer type used	poor – will melt and form a 'blob'	reasonable	good for canteen use, unsuitable for long term sitting
SYNTHETICS						
- nylon moquettes	good	fair	fair	all will melt and form a permanent hard ring	cheap	especially suitable for areas where misuse by students will necessitate frequent replacement of covers
- polyester	good	fair	fair		reasonable	
- polypropylene	good	poor, but has good resistance to staining	fair		reasonable	
CELLULOSICS ie cotton, flax viscose, modal and combinations	fair – good some combinations may be better than others	poor	fair	will burn and form holes, but these will have a clean edge	reasonable	not suitable for use in educational institutions
PILE FABRICS - cotton	good	poor	fair	will burn and form holes, but these will be left with a clean edge	reasonable	not suitable for use in educational institutions
- wool	excellent	good	good	will char, but charred fibres can be rubbed off	expensive	suitable for all applications except canteen use
- synthetic ie acrylic, nylon	good – excellent	fair	fair	will melt and form a hard permanent ring	fairly expensive	suitable for all applications except canteen use
- viscose	fair	poor	poor	will burn and smoulder but burnt fibres can be rubbed off	reasonable	not suitable for use in educational institutions
AUTOMOBILE UPHOLSTERY FABRICS ie warp knitted fabric with raised loop pile	excellent	excellent	good	will melt and form a hard permanent ring	fairly expensive	suitable for all applications except canteen use

1 Patterns and dark colours show dirt and marks least.
2 Professional cleaning will give better results.
3 This column is concerned only with damage to the appearance and not with the propensity of the fabric to burn.

(Requirements for PVC coated woven fabrics)

4 FIRA Buying Specification for Upholstery Covers. (A useful guide to purchasing covering materials which encompasses the requirements in Refs 62/1 and 3).

63. On upholstered furniture in educational institutions where use can be expected to be heavy, it is the covers that are the source of most complaints. There is justification for specifying upholstered furniture if prolonged use is expected but consideration should be given to the type of institution and the amount of wear and tear expected. Upholstered furniture is vulnerable to wilful damage and where this is feared, its use should be avoided. Although upholstered furniture has a place in social areas, it is here that damage is most likely to occur.

64. Standard tests which are designed to assess such properties as resistance to abrasion, soiling, pile loss, tearing and so on are a valuable guide to suitability of fabrics for different applications. High resistance to abrasion, tearing and fraying is essential and only covers which meet the most severe test requirements, thus showing their suitability for contract use, should be considered. At present three British Standards cover Requirements and Specification for different types of material (Refs 62/1–3). A more comprehensive British Standard is being prepared which is based on a FIRA document (Ref 62/4). This proposes specifications of upholstery covers which are based on various conditions of use.

65. There are a number of general points to be considered in the selection of upholstery covers. Firstly there is no upholstered chair which will resist slashing by knives but fabric covers fare better than PVC in this respect. Fabric also has a more pleasant feel, is less prone to knocking damage at edges and corners and is easier to repair. On the other hand the simplest covering material for easy care would be heavy duty expanded PVC. This resists abrasive wear well, is easy to clean and could be made to resist knocking damage by the elimination of sharp edges and by a generous padding of foam at the edges.

66. The most hard wearing fabric is a combination of cut and uncut pile with yarns containing wool, nylon or acrylics. These are used on public transport and would be satisfactory but expensive. A good quality acrylic velvet will provide a comfortable hard wearing cover. At less cost but still relatively hard wearing and well constructed viscose rayon fabric of contract quality would give good service. With all woven fabrics it is advisable to choose chairs with non-upholstered arms and backs sufficiently low to eliminate head contact because these surfaces receive a lot of wear, get dirty and are difficult to clean. There could be some initial advantage in purchasing woven covers with a soil repellent treatment but ultimately in wear the treatment will become less effective due to flexing and abrasion. Such covers could not be expected to have the life of hard wearing cloth.

67. Consideration should be given to removable covers which offer the advantages of easy replacement, cleaning and repair. If burning by cigarettes was considered a major problem then an all wool fabric would show less damage because the burnt fibres will rub off in wear whereas the hard wearing synthetics will melt and form hard black beads and melted edges which will be permanently disfiguring. Where food and drink are liable to be spilt PVC covers would be the most practical choice. In libraries or classrooms, however, a hard wearing fabric is more suitable as PVC tends to become sticky and moist when sat on for long periods. The properties of different upholstery materials are summarised in Table 4. This list is not exhaustive but is intended to give guidance of a general nature on how covers will perform.

Specification of Upholstery Foams

Technical Reference

68. 1 BS 3379 (1975): Flexible Urethane Foam for Load Bearing Applications
(Classifies material primarily on performance during a fatigue test).

69. The filling medium most frequently used on modern furniture is flexible polyether foam, which is available in a very wide range of grades and formulations. The most obvious differences between them is the difference in feel – factors such as the hardness and resilience. However, the performance of different foams varies significantly and this cannot be estimated by subjective assessment. It is important therefore that the specification ensures adequate performance.

70. In use, a foam softens and loses height. It does this rapidly in the early period of use, but after a few months this rate slows down until the material becomes fairly stable and thereafter

changes are small. Therefore, performance is gauged, not by estimating 'life' but by the total change to properties that will occur with use; excessive softening will allow the user to feel the seat support structure and excessive thickness loss leads to cover wrinkling, cushion shape distortion and a generally unsatisfactory appearance. The heavier the use application, the greater the changes will be, so it is important to specify for the seat, which is the most heavily stressed part of a chair, a foam with sufficiently high performance rating, whereas lightly loaded uses – arm padding – can satisfactorily employ lower rated foams.

71. A simple guide to the specification of foams is available in BS 3379 (Ref 68/1). A foam may be fully specified by the following three properties: type, grade and class.

Type: There are five types of urethane foam available – slabstock (B) or moulded (M) conventional foam; slabstock (CB) or moulded (CM) cold cured/high resilience foam; reconstituted (RE) foam.

Grade: This is based on the indentation hardness index of the foam and is best judged as a numerical indication of 'feel'; the lower the number the softer the foam. The selection, both type and grade, is dependent only on the design and the feel required; there is no generally correct or limiting value that can be applied, nor do these factors relate to durability.

Class: This is an evaluation of the expected service of all types and grades of foam measured primarily by a pounding test but also setting limits for a series of other property tests. The standard gives the following broad recommendations of the class of foam required for various applications.

Class	Type of Service	Recommended Applications
X	Extremely severe	Heavy duty contract seats. Heavy duty public transport seats.
V	Very severe	Public transport seats, cinema and theatre seats. Contract furniture seats.
S	Severe	Private or commercial vehicle seats. Public transport backs and armrests. Cinema and theatre backs and armrests. Contract furniture backs and armrests.
A	Average	Private vehicle backs and armrests. Domestic furniture backs and armrests.
L	Light	Padding, scatter cushions, pillows.

72. Although with certain features of design it is possible to use a lower class of foam than indicated above, this should form the basis for general specification. There are two main categories of educational furniture for which upholstery is appropriate, namely low seating and settees and upright chairs for dining rooms and teaching areas. For the low seating it is recommended that class V foam be used for the seats while class S is suitable for backs and armrests. In practice, however, unpadded armrests are generally recommended. For upright seating, where the foam only forms a thin padding on the seat base, class S foam may be satisfactory. It is not considered necessary to specify class X foam for educational furniture.

Flammability of Furniture

Technical References

73. 1 BS 5852 Part 1 (1979): Methods of test for the ignitability by smokers' materials of upholstery composite seating

2 DD 58 Tests for the ignitability of upholstered seating (recommends methods for assessing the ignitability of material combinations when subjected to ignition sources that might be applied accidentally – wider in scope than BS 5852).

3 DD 64 Guidelines for the development and presentation of fire tests and for their use in hazard assessment.

4 DOE/PSA Fire Retardant Specification No 6: Ignition Standard for Seating.

5 Woolley, W D et al. The behaviour of stacking chairs in fire tests. BRE Information Paper IP 26/79
(Describe fire tests to assess ignition and burning characteristics of stacking chairs made from various materials).

74. The flammability of furniture is a subject that has been of growing concern with the awareness of the potential hazards of some new materials. New tests have been developed and there are now legislative controls on domestic upholstered furniture. A clear distinction must be made between upholstered furniture and what can be termed 'hard' furniture, and within both categories it is important to distinguish their various fire properties and the hazards they might represent.

Fire Properties and Hazards

75. Fire properties can be divided into two main groups, ignitability and flammability. **Ignitability** is simply a measure of the ease with which a material or item will catch fire, but there is the added complication that there are three types of ignition source. These are a flaming source, smouldering source or radiant heat source. **Flammability** on the other hand covers the situation after ignition has taken place and encompasses all properties during the stages of fire growth, the steady established fire phase, and the extinguishment phase. Examples are heat production, smoke production and production of (toxic) gases and, under each of these categories, factors such as the amount and production rate are relevant.

76. The hazard represented by these properties depends on their relationship with people; how likely each property is to endanger life in a particular environment. To evaluate the hazard is difficult; one may envisage particular circumstances, but the evaluation is subjective. Alternatively, fire statistics published annually by HMSO provide objective data but the acceptability to society is still subjective and cannot be quantified in a comprehensive manner.

77. Nonetheless, it is this assessment of hazard that must determine the specification. Every condition of use poses its own particular sets of circumstances in which different fire properties assume different magnitudes of importance in evaluating hazard. Some attempt has been made in the following discussion to highlight the important features, although these can only be of a general nature and cannot meet particular circumstances.

Upholstered Furniture

78. It has been clearly demonstrated that tests on upholstery materials in isolation are of limited value. In use, the materials interact with each other, and any test must reflect this interaction by at least testing composite lay-ups of cover and filling. The development of such tests is most advanced for ignitability and there are now available BS 5852: (Ref 73/1) which covers ignitability by burning cigarette or lighted match, and DD 58 (Ref 73/2) which provides a range of seven flaming sources up to the equivalent of four double sheets of newspaper.

79. Since the publication of 'Report of the technical sub-committee on the fire risks of new materials' by the Home Office Fire Department in November 1978, which specifically recommended that the ignitability of upholstered furniture should be controlled and its ability to smoulder eliminated as a matter of urgency, successive governments have actively pursued a policy of introducing appropriate legislation. Regulations made under the Consumer Safety Act 1978 entitled the Upholstered Furniture (Safety) Regulations 1980 were approved by Parliament on 22 May. These provide controls which are introduced in two stages.

Stage 1: (From October 1980).

All combinations of upholstery materials used in the seat, back or arms to be proof against ignition by both cigarettes and butane gas flame No 1 (match equivalent) when tested according to BS 5852 Part 1 or else to carry appropriate (specified) warning labels.

Stage 2: (From December 1982)

All combinations of upholstery used in the seat, back or arms to be proof against ignition by cigarettes when tested according to BS 5852 with no labelling alternative. Additionally they must resist ignition in the BS 5852 flame test or carry the specified labels.

80. Although these regulations will only apply to domestic furniture, it seems reasonable to expect educational furniture at least to reach these same standards. Since labelling in this context will not be available to warn the user, the combinations of upholstery materials used in educational furniture should be resistant to ignition by a lighted cigarette and gas flame No 1 (standardised match equivalent). This requirement must be regarded as a minimum and it can be argued that the level of protection should be set higher. In a common room for example the users are likely to be more casual and less careful with their smoking materials,

and the quantity of paper about – books, magazines and waste bins – will act as tinder and effectively provide a larger source of ignition to the furniture than a match. This situation can be covered by requiring protection against a higher flaming source than No 1 – possibly No 5 – which would be more in line with the Property Services Agency's requirements. In this case the test method would be DD 58 until its future conversion to another part of BS 5852.

81. Taking into account ignitability may not cover the whole problem; if a fire is started and the furniture becomes involved, high rates of fire development and thick black smoke production can be expected with some types of modern furniture. This situation is likely to lead to people being trapped and the possibility of loss of life usually by inhaling toxic gases (generally carbon monoxide though other gas may occur in smaller quantities). Unfortunately, there are no British Standard methods of test available at present to measure these factors and so provide controls. The only specifications on this subject have been devised by the Property Services Agency of the Department of the Environment for use when buying for Government Agencies. Their specification FR6 (Ref 73/4) is carried out on a complete item of furniture and first examines additional features of ignitability with the sources placed under the chair or the outside arm and so on and can also examine rates and amounts of heat and smoke production. The use of such a specification will provide the most effective protection, but the requirements are stringent and as a result the final choice of complying furniture may be unduly limited. There is no absolute level of protection that can be proposed; as stated above, the hazard assessment must be closely linked to the use, and to the seriousness with which society views the hazard. An objective conclusion comparing the hazards with others encountered in daily life may well be at variance with, say, the opinion of emotionally involved parents. In the end, the solution must be a compromise between what is socially desirable, technically feasible and financially acceptable.

Non-upholstered Furniture

82. In general, with the exception of certain high risk areas such as hospital wards, cabinet furniture and tables are not considered to present any undue hazard and flammability controls are not normally considered necessary. In the case of non-upholstered seating, however, the situation is rather different. Seats made of traditional materials such as timber and plywood are acceptable in view of their long history of satisfactory use. Problems, if they do occur, are with newer synthetic materials, a good example of which is the use of polypropylene in chairs. This material increases the hazards associated with ignitability and heat, smoke and gas production, with the result that some education authorities have banned its use in spite of the advantages of strength, durability and colour choice possessed by polypropylene.

83. The flammability of polypropylene is not necessarily a hazard. While exposed, feather edges can be ignited by a deliberately held match, polypropylene is not easy to ignite accidentally. The incorporation of flame retardant additives will make ignition more difficult, but in a fire they are likely to increase the amount of smoke and toxic gases. One solution may be to cap the feather edges with metal trim as a protection against deliberate ignition, but this will not deter the determined arsonist. High stacking of polypropylene chairs increases the fire hazard. Stacks should therefore be limited and should where possible be kept in a closed store.

84. As there are no standard tests against which to assess 'hard' chairs, experienced judgement must guide specification and purchase. However, a BRE information paper (see Ref 73/5) gives some indication of comparative behaviour in fire of stacking chairs manufactured in different materials.

Surface Materials and Finishes

Technical References

85. 1 BS 3794 (1973): Specification for Decorative Laminated Plastic Sheets. (Mechanical properties and resistance to outside agencies.)

2 BS 3962 Methods of Test for Clear Finishes for Wooden Furniture –

Part 1 (1980): Test for low angle glare

Part 2 (1980): Resistance to wet heat

Part 3 (1980): Resistance to dry heat

Part 4 (1970): Resistance to marking by liquids

Part 5 (1972): Resistance to marking by oils and fats

Part 6 (1975): Resistance to mechanical damage

3 BS 5910 Part 1 (1980): Methods of Test for Surface Finishes for Furniture. Assessment of surface resistance to cold liquids. (Similar to BS 3962 Part 4 but wider in scope than the earlier standard which only covers clear finishes for wooden furniture.)

4 BS 4965 (1974): Decorative Laminated Plastics Sheet Veneered Boards and Panels. (Specifies requirements for eight types made from various core materials veneered on one or both sides. Covers use in conditions of normal and high humidity.)

86. Tests to assess the durability of all types of furniture finishes are well established but no British Standard specifications which define the durability of finishes for specific circumstances are available at present. However, this situation is changing and the British Standards Institution is currently preparing a specification for finishes as part of a comprehensive standard for furniture.

87. Durability tests (see Refs 85/2,3,5) which test the degree to which finishes can withstand abrasion, liquid attack, mechanical damage and other hazards, are only of limited value for educational furniture. Good performance on these tests does not automatically indicate suitability for a particular working surface. For example, solid wooden surfaces will show poor resistance to scratching and staining but other properties of wood such as its ease of furbishing makes it a suitable material for many applications.

88. Occasionally, various faults can arise in educational furniture not only from incorrect choice of materials but from the use of inappropriate combinations of materials or unreliable assembly of parts. For example, it is easily overlooked that wood and other materials can be susceptible to swelling and shrinking according to the variation in the environmental humidity and particularly when in direct contact with water near sinks and other wet situations. Thus wood-to-plastics joints and even joints in timber assemblies are liable to open up in wet or humid conditions, resulting in serious gaps. The adhesives used to bond surfacing and edging materials to panels used for educational furniture need to be selected carefully having regard for the temperature and moisture conditions in the service environment.

Wooden Surfaces

89. Individual views on the best finishing material for wood do vary and a number of surface coatings are available. These include teak oil, linseed oil, thermosetting lacquers, different waxes and paints. Clear lacquers and paints can be formulated with sufficient durability for most domestic and some contract applications but they may not have sufficient resistance to mechanical damage such as scratching and initial carving to justify their use for horizontal working surfaces on desks or classroom tables. Laboratory and engineering work benches are an exception to this rule and the solid wood tops which are well suited to this application can be finished with clear lacquer, oil or wax finishes to give protection against moisture penetration. The finish may be damaged by scratching or attacked by corrosive liquids, but it can be furbished annually by sanding. Lacquers and paints are suitable for finishing surfaces of wood veneers and plywood furniture but for increased durability including higher reistance to mechanical damage, acid catalysed lacquers should be used wherever possible (see Ref 85/3). Resin impregnated plywood provides a surface which has high resistance to most types of damage and is easily cleaned and repaired. The cost, however, tends to be high.

Plastics Laminates

90. Plastics laminates are the most durable of the range of finishing materials used in the furniture industry but damage such as delamination, scratching or staining cannot easily be repaired. They clearly provide the best surface for refectory tables which are subject to frequent washing down and have a clear advantage over other materials in areas such as microbiology laboratories where non-porous surfaces which remain free from cracks and indentations are required. Plastics laminates are also suitable for classroom tables although some object to the cold hard 'feel' of the surface; in addition they are noisier than wood and it is difficult to pick up items such as pins from a smooth and slippery surface. The laminates should preferably be bonded with urea formaldehyde (UF) or polyvinyl acetate (PVA) adhesives as neoprene adhesives may soften when the tops are exposed to strong sunlight increasing the risk of delamination either spontaneously or with the aid of a knife inserted in the glueline.

TABLE 5

TYPES OF FINISH	RESISTANCE TO MECHANICAL DAMAGE	RESISTANCE TO HEAT DAMAGE	RESISTANCE LIQUID ATTACK	NEED FOR EDGE TREATMENT
1. Linoleum – without lacquer	good – tolerates damage	fair	fair	yes
2. Linoleum – with lacquer	fair-good	poor-fair	fair-good depending on lacquer type used (see 7 below)	yes
3. Plastics laminate	good – but any scratches will show clearly on plain dark surfaces, and especially on glossy surfaces	very good	very good	yes
4. Melamine surfaced chipboard	fair-good	good	good	yes
5. PVC (on chipboard)	good – but can be easily peeled from substrate and may scratch badly	poor-fair	poor-fair	yes
6. Stainless steel	good	very good	good but may be attacked by some chemicals	no
7. Solid wood				
a) with precatalysed lacquer	fair	fair	fair	no
b) with acid catalysed lacquer	fair	fair	good	no
8. Veneer				
a) with precatalysed lacquer	fair	fair	fair	yes
b) with acid catalysed lacquer	fair	fair	good	yes
9. Plywood with lacquer (see veneer)	fair	fair	with precatalysed lacquer – fair with acid catalysed lacquer – good	no
10. Oil-tempered hardboard	good	good	good	no
11. Resin impregnated plywood	good	good	good	no

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FINISHES FOR WORK SURFACES

EASE OF CLEANING (abrasives may scratch the surface finish)	REPAIR POSSIBILITIES	APPLICATIONS	COST
Fair	new linoleum would have to be laid	suitable for craft, needlework. This material is pleasant to write on and is warm to the touch	medium
Good	can be re-lacquered	suitable for non-practical teaching areas where heavy use is not anticipated. Not suitable for laboratory use	medium
Very Good	difficult – a new sheet of laminate would have to be laid	suitable for dining tables, cookery rooms, general teaching areas and for any science activities which demand a high degree of cleanliness. Disadvantages – noisy and slippery, tends to have a hard cold feel, but textured finishes may not have these problems to the same degree	high
Very Good	impossible	similar to those for plastics laminate with exception of cookery areas and some science areas	low
Good	new PVC would have to be laid	not suitable for areas used by students because surface can be easily peeled off	low
Very Good	difficult	suitable for catering departments	high
Good	can be sanded and re-lacquered	suitable for most craft and science activities. Not suitable where a high degree of cleanliness is required (see laminates above)	high
Good	can be sanded and re-lacquered a limited number of times	suitable for non-practical use – but not where abuse of furniture is anticipated because the core material would soon be exposed	medium
Good	can be sanded and re-lacquered a limited number of times	suitable for most activities with the exception of catering areas, laboratories and needlework rooms	medium
Fair	difficult	suitable for craft and general teaching tables. Unsuitable for laboratory use	low
Good	fine sanding possible	suitable for most activities but cost may be prohibitive for some applications	high

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PVC and Paper Foils

91. PVC foils are not considered to be suitable for educational furniture as their flexible nature allows them to be peeled from the substrate once the edge has been lifted. Higher peel resistance can be obtained by using an epoxy adhesive instead of a water based emulsion system. PVC foils can be easily cut by sharp objects and the damage would be difficult to repair. Paper foils are used for vertical surfaces on some educational furniture but their resistance to mechanical damage is limited. Where the use of paper foil is permitted, fully impregnated and surface coated types should be specified as the core material may easily be exposed when the thinner surface coated papers are used.

Lineoleum

92. Linoleum is a good material for working surfaces not subject to heavy duty use. It is scored and cut easily but its thickness (approximately 2.5mm) normally ensures adequate protection for the underlying substrate. Its properties make it particularly suitable for surfacing tables used in fabrics and possibly arts and crafts departments. For classroom tables, linoleum provides a hard-wearing alternative to plastics laminates.

Other Finishes

93. As can be seen from Table 5 a variety of finishing materials could be considered for work surfaces. The properties of each are briefly summarised.

Core Materials

Technical References

94. 1 BS 1142 Specification for Fibre Building Boards

Part 1 (1971): Methods of Tests

Part 2 (1971): Medium Board and Hardboard
(Board types defined; coding system for test requirements. Range of possible performance levels of hardboard.)

2 BS 5669 (1979): Specification for Wood Chipboard and Methods of Test for Particle Board.
(Appendix C2 is relevant to the use of chipboard in furniture applications.)

3 Handbook No 1 Medium Density Fibreboard. FIRA (1980). (Discusses medium density fibreboard in the furniture industry.)

4 Handbook No 2 Specification of Chipboard for Furniture. FIRA (1981). (This is a more comprehensive specification than BS 5669 (Ref 2 above) and includes additional tests.)

95. All the normal core materials such as blockboards, particle board and plywood can be used for educational furniture but when using chipboard care should be taken to select types with adequate strength. Medium Density Fibreboard (MDF) is a relatively new sheet material and its high strength and good machining characteristics should make it suitable for use in school furniture, particularly as its tightly compacted core obviates the need for bonding a protective edging strip, which, experience has indicated, is liable to be peeled off in some educational establishments. The initial cost of this material, however,is likely to be high.

Edging Materials

96. Although the surfaces of edging materials are not subjected to the same hazards as horizontal surfaces on desks, tables and benches used in educational establishments, the joints between the surfacing materials and the edgings can be a source of weakness. Failures of edgings, assisted by willing hands or exposure to extreme conditions of moisture or temperature can have a detrimental effect on the appearance and, in some applications, the performance of the furniture. Experience has indicated that some edge treatments are more effective in surviving the hazards of use than others so that guidance regarding the relative durability of different edges can be given (see Table 6).

97. Clearly the problem of edging failure can be avoided by making tops with the edges moulded directly on the core material. The success of this approach, however, depends upon the core strength of the panel material used for the top. Birch plywood is known to be satisfactory but the edges of blockboard and chipboard would not have sufficient strength for this application apart from any considerations of appearance. The edges of chipboard can, however, be reinforced by injection of urea formaldehyde (UF) resin which is then cured in situ. The potential of the recently developed medium density fibreboard (MDF) should also be considered as this material with a density of

TABLE 6

EDGING TREATMENTS FOR TABLE TOPS

EDGE TREATMENT		STRENGTH OF JOINT BETWEEN CORE AND EDGING	STRENGTH OF RESULTING EDGING	COST	APPLICATIONS
Plywood or MDF core with no edging		–	good	core – high edging – low	Suitable for all applications. Makes comfortable working edge when rounded.
Blockboard or chipboard core with solid wood lipping	a)	fair to good	good	high	a) Is a good choice for all table tops, b) is also good but is unsuitable for areas where surface cleanliness is important because dirt tends to collect in the join.
	b)	fair to good	good	high	
Chipboard, plywood or MDF core with plastics laminate edging	a)	poor with a hot melt adhesive	good	average	a) Suitable for all areas when bonded with PVA/UF adhesive. Edgings bonded with hot melt adhesives are not recommended. b) as a) except where surface cleanliness is important.
	b)	good with a PVA/UF adhesive	good	average	
Chipboard core with post formed plastics laminate top		fair to good	good	average-high	Unsuitable for free standing tables because only one edge can be post formed. Suitable for wall-fixed benching and any table which has only one working edge.
Shrunk-on plastic edging		poor to fair but nature of construction results in durable edging	good	high	Good for general teaching tables, difficult to remove because joins in edging strip are welded. High resistance to impact damage.
Thermoset resin impregnated paper strip		fair	fair	low	Only suitable where careful use is anticipated.
PVC strip		easily peeled	fair	low	Not suitable. Too easy for restless fingers to remove.

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about 800kg/m^3 is stronger than chipboard and edges moulded directly on the board would probably be satisfactory for some educational furniture.

98. Where chipboard or blockboard is used, the edges will normally be protected with a lipping or edging. Solid wood lippings clearly are more durable but the cost of the application of lippings to panels is higher than the equivalent cost of bonding thin edging strips. The construction with the lipping bonded to the core material before surfacing with plastics laminate is generally more durable and more resistant to bond failures than the construction with the lipping applied after surfacing. Preferably, lippings should be cut from small movement timbers, kiln dried to about 10% moisture content, to reduce the stressing of the glueline when the lipped tops are used in varying conditions and to minimise showthrough. A UF or cross-linked PVA glue should be used as hot melt bonded lippings can be removed more easily.

99. Similar considerations apply to thin edging strips. Plastics laminate materials will be more durable in service. Ideally they should be bonded to the core materials before surfacing using UF or PVA glue. PVC edgings bonded with hot melt adhesives are widely used on domestic furniture but these flexible edgings can be peeled from the panel with some assistance and they would therefore be unsuitable for tops used on educational furniture. Shrunk on plastic edging has proved to be durable in service and although the cost tends to be high, it could well be justified in situations where heavy use is expected. It is resilient, absorbs knocks well and the facility to round corners is an advantage.

100. Worktops from post-formed plastics laminates are widely used in domestic and contract kitchens and this type of construction clearly has some advantage over constructions with bonded edgings. The main disadvantage at present is that they can be formed economically in one direction only so that a free-standing table with a post-formed top would have two exposed edges which would be difficult to treat satisfactorily. In addition, such treatment would not allow tables to be butted together.

General Functional Requirements

101. Requirements are discussed for the following general categories:

1. Reading and writing at the sitting working plane
2. Practical activities at the sitting working plane
3. Practical activities at the standing working plane
4. Private study
5. Social/refreshment activities
6. Storage of personal belongings

The recommendations are intended to be as specific as possible although the varied nature of some activities, such as in social areas for example, precludes one optimum specification. But there are a number of choices available. In each case the recommendations have been confined to basic dimensions in order to give the designer maximum freedom. The illustrations are diagrammatic and are not intended to indicate designs. In addition to dimensional requirements, attention is drawn to any special requirements such as extra stability. These are intended to supplement the information given in Section 3. The recommendations are based on static and dynamic anthropometric data for the British student population and on British Standards. References are given at the beginning of the appropriate section.

Reading and Writing at the Sitting Working Plane

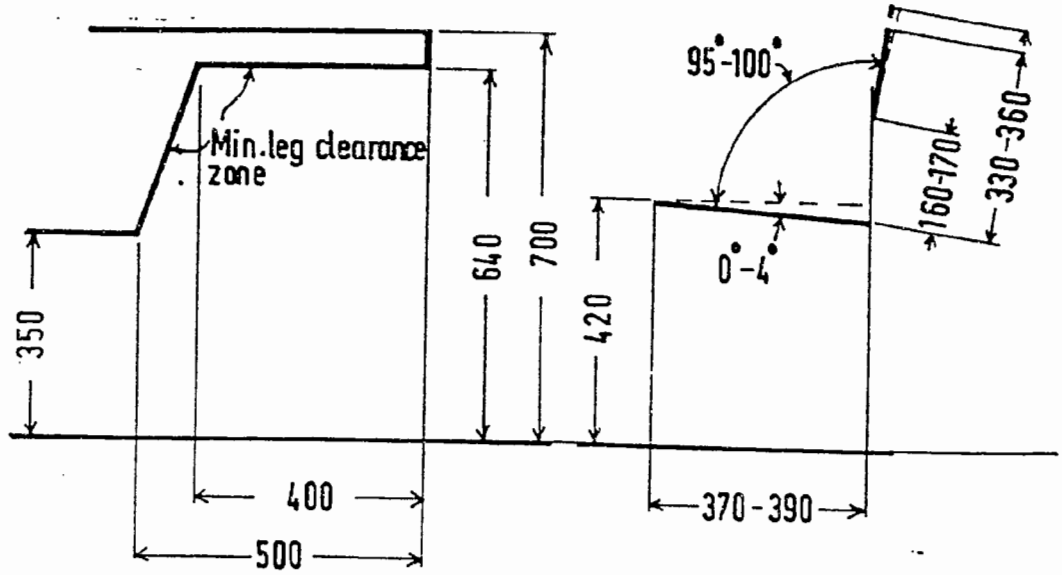
Technical References

102.1. BS 5873 Educational Furniture

Part 1 (1980): Chairs and Tables for Educational Institutions.
(Specifies five sizes of table and chair.)

2. FIRA 6 Functional Sizes of School Tables and Chairs.
(Examines the suitability of the five sizes in BS 5873 and studies specifically the questions of plan sizes and leg clearances.)

3. Wotzka G et al. 1969: Investigations for the Development of an Auditorium Seat. Ergonomics 12.2.1969. (Relevant to the design of tablet chairs. Recommendations based on ergonomic research are given.)



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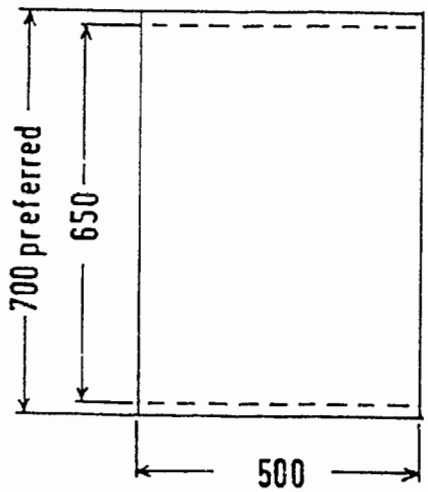
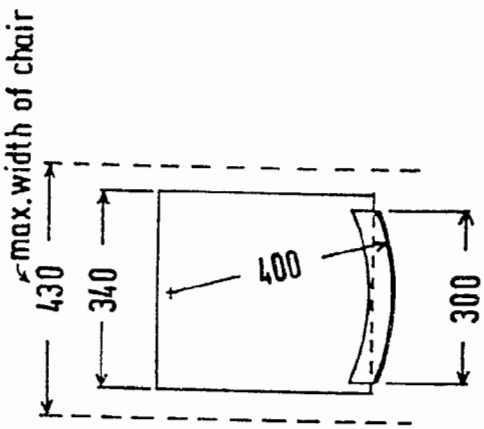




PLAN

Dual table 1300 or 1400 x 500

For spec. details see BS 5873 Pt1.
Dimensions in mm.

Functional Dimensions

TABLE & CHAIR FOR GENERAL USE

Figure 1

Classroom Work Involving Mainly Reading and Writing

103. Tables and chairs for general classroom work are specified in BS 5873 (Ref 102/1). The largest size (size mark 5) is suitable for use by the 16–19 age group (see Figure 1). The minimum dimensions of table tops are specified as follows:

	Single Table	Double Table
length	700 mm	1300 mm
depth	500 mm	500 mm

These dimensions differ from those previously recommended by British Standards.

BS 3030: Part 3 (now superseded by BS 5873) specified a minimum table plan size for two places of 1100 mm x 550 mm. This size was based on the need for tables to be grouped and sat at from all sides and is particularly suitable for use in primary schools. A table length of 1100 mm is, however, inadequate as a double table for older students (see Plate 2). This is recognised by the current British and International Standards (ISO 5970) for school furniture which specify the dimensions given above for tables intended for use by one or two pupils at one side only. The table depth of 500 mm is adequate for work involving mainly reading and writing provided that the table length is at least 1300 mm for two students. These sizes do not reflect special requirements as for example map work or the handling of models or large specimens.

Special Requirements

104. Stackable furniture is preferred by many institutions to facilitate cleaning and storage.

A surface material with high resistance to scratching and carving is desirable (see Table 4).

Tutorials/Discussions

105. Tables and chairs are suitable, but for less formal work tablet chairs or even easy chairs can be used. Recommended dimensions for tablet chairs are given in Figure 2 (Ref 102/3). It will be seen that the dimensions of the chair itself conform to those shown in Figure 1.

Special Requirements

106. Upholstered seating is recommended for tablet chairs. The covering material should be permeable to moisture, thus PVC type coverings are not as satisfactory as cloth.

The tablet is intended to take light loads only but should be capable of withstanding a force of 70N applied over an area 100 x 100 mm at the centre adjacent to the unsupported edge which is furthest from the point of support.

To satisfy left and right handed students it is preferable to have a detachable tablet which can be mounted on either side of the chair. A selection of left and right handed tablets is less satisfactory.

The height of the armrest should be the equivalent to an extension of the slope of the tablet. The backrest may be higher than 360 mm (see Figure 2) in which case it should be curved in such a way as to avoid uncomfortable contact with the shoulder.

Examinations

107. Ordinary classroom tables and chairs (see Figure 1) can be used. Since, however, separation of pupils is necessary, single as opposed to double tables are required. If special purpose tables are provided these can have a reduced plan size (550 x 550mm minimum) to enable the maximum number of pupils to be accommodated. Such tables need to be stackable or folding.

Practical Activities at the Sitting Working Plane

Technical References

108.1 BS 5873 Educational Furniture

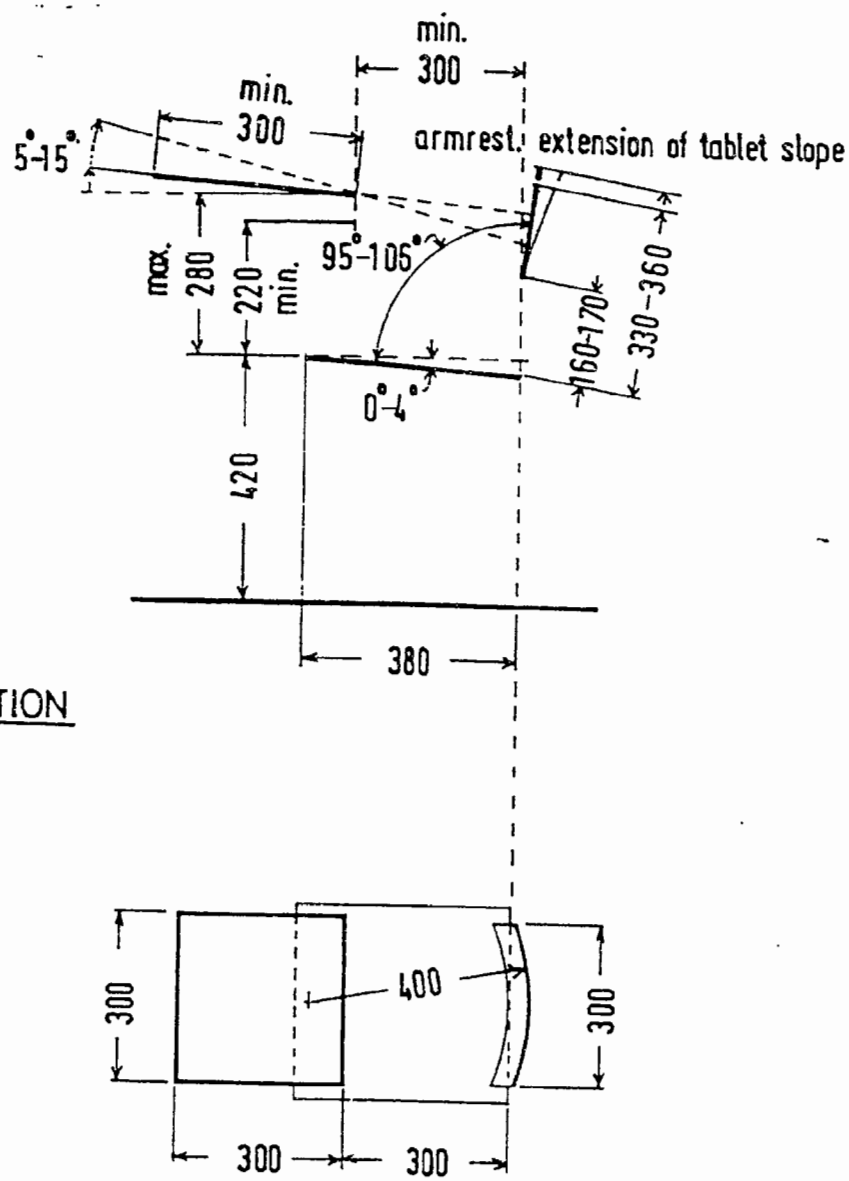
Part 1 (1980): Chairs and Tables for Educational Institutions. (Specifies five sizes of table and chair.)

2 FIRA 6 Functional Sizes of School Tables and Chairs. (Useful for detailed information on plan sizes and leg clearances.)

3 BS 5940 Office Furniture

Part 1 (1980): Specification for Office Workstations, Desks, Tables and Seating. (Specifies dimensions and other design requirements for office workstations including desks, tables, worktops, drawers, chairs and footrests.)

4 BS 5459 Specification for Performance Requirements and Tests for Office Furniture.



For spec. details see BS 5873 Pt.1.
Dimensions in mm.

Functional Dimensions
TABLET ARM CHAIR

Figure 2

Part 1 (1977): Desks and tables

Part 2 (1977): Adjustable chairs

(Test methods and acceptance criteria for strength, design requirements for stability. General design requirements applicable to commerce rooms.)

5 Building Bulletin 38 1974 (Metric Edition) School Furniture Dimensions: Standing and Reaching. HMSO. (Guidance on furniture and equipment dimensions for common activities mainly performed at the standing working plane. Also relevant for sewing and technical drawing.)

Practical Activities of a General Nature

109. This category covers subjects which may combine formal teaching and practical work. Geography for example may call for the handling of rock and soil specimens, model making or map work. Similarly agriculture may entail examination and dissection of plants and hairdressing may invoive board work (eg wigmaking). These activities and many more are carried out at the sitting working plane and may require more generous plan sizes than are shown in Figure 1. In such instances a minimum working surface of 900mm length and 600mm depth should be allowed per pupil. It may be possible to achieve adequate table area either by butting tables together or with one pupil working at a double table where numbers permit. For geography, the need to refer to large maps dictates the optimum plan size. The recommendations below are intended to be adequate for use of Ordnance Survey 1/50,000 Series maps and will cover most other requirements.

1000 x 600mm+ single size
1500 x 600mm+ double table*

Special Requirements

110. Where plant or soil specimens are used a smooth easily cleanable surface is recommended. Where rock samples are handled a wooden surface is more suitable because any scratches can be sanded out from time to time.

+ This will adequately support an O/S 1/50,000 map but to eliminate overhang the table depth would have to be increased to 900mm. This will result in a plan size which is unnecessarily large for other purposes.

* It is assumed that students sitting at a double table will share maps.

Typing

111. The importance of providing suitable furniture for this activity cannot be overstressed as typing rapidly leads to discomfort unless suitable support is provided for the body and the work surface is at the correct height. For this reason an adjustable, rotatable chair is recommended. Figure 3 gives basic dimensions for typing tables. The plan size shown is smaller than that required in offices as space for items such as telephones and filing trays is not needed. Typing requires a lower table height than writing so that typing tables are not dual purpose. A higher work surface should be placed at right angles to the typing tables (see Figure 3), if activities other than typing take place. Those typing tables which aim at being dual purpose by housing the typewriter under the top preclude a satisfactory posture for both typing, reading and writing. A footrest (see Figure 3) should be provided so that shorter users can maintain a comfortable leg position and at the same time be at the correct height for typing.

Special Requirements

112. Furniture should pass the performance specification for office furniture given in BS 5459 (Ref 108/4).

Sewing Machine Work

113. Tables on which portable sewing machines are to be placed should be at a lower height than those used for reading and writing – 640mm is recommended. All other dimensions should be as shown in Figure 1 except for the knee clearance height which is reduced from a minimum of 640mm to a minimum of 600mm. A minimum plan size per pupil of 1000 x 600mm is required.

Hand Sewing

114. Tables and chairs as shown in Figure 1 are recommended. Normally only the edge of the table is used for this activity so that a table which would be used by two pupils sitting at one side for formal teaching can be used from all sides for hand sewing.

Special Requirements

115. A lineoleum table top is recommended. This will stand up well to damage from pins and

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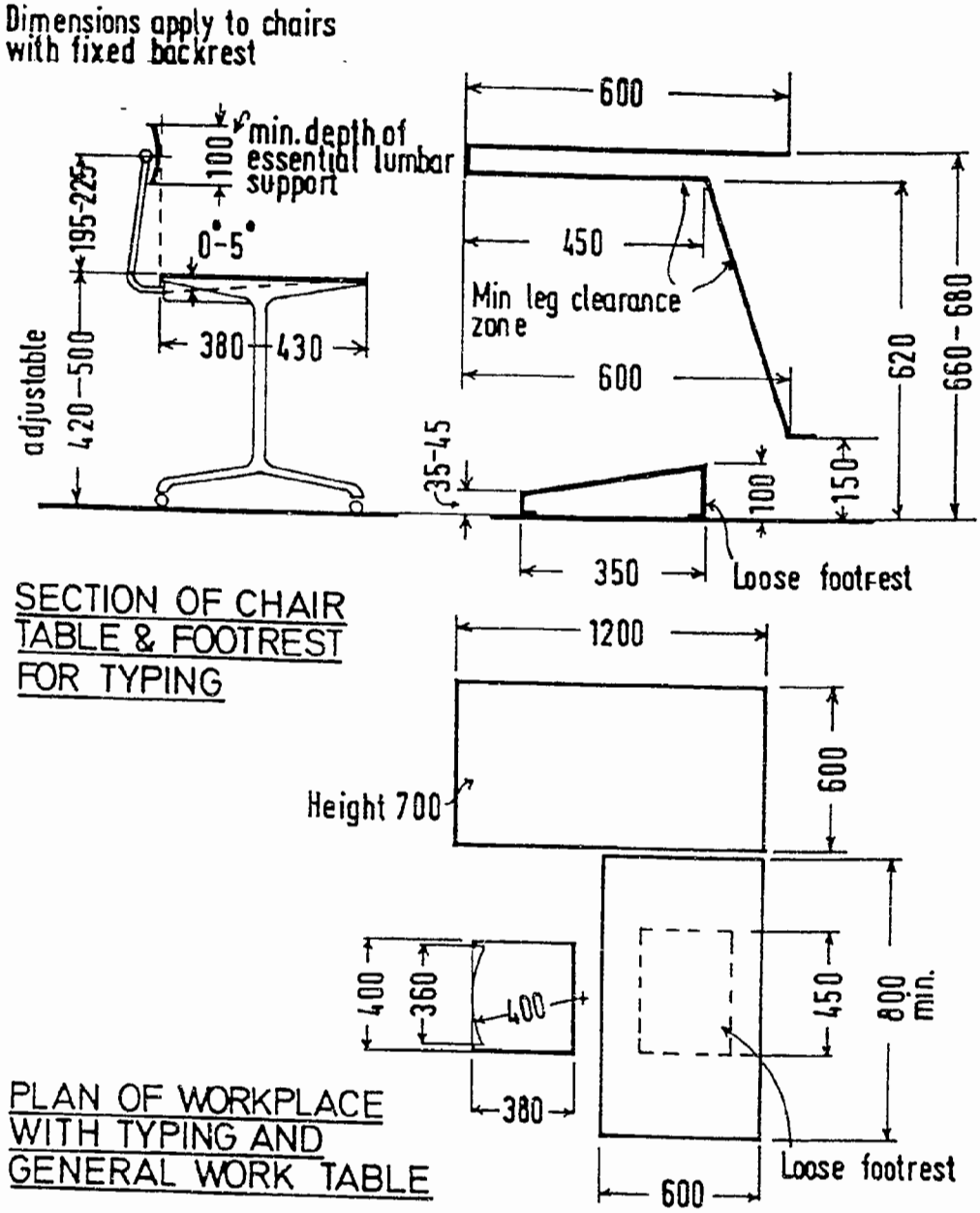
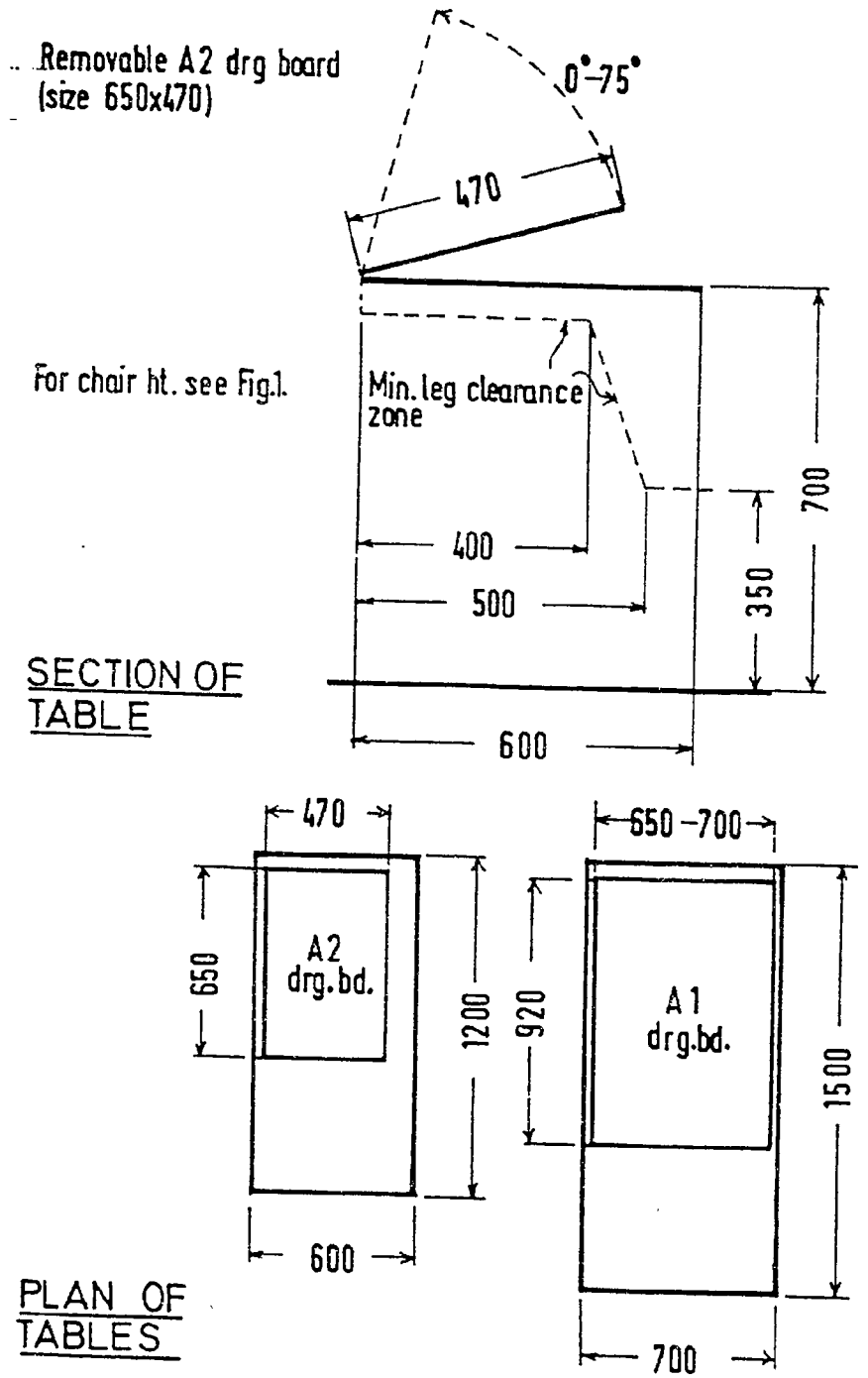


For spec. details see BS 5940 Pt.1
Dimensions in mm.

Functional Dimensions

TYPING & GENERAL TABLE WORK

Figure 3



Dimensions in mm.

Functional Dimensions

TABLES FOR TECHNICAL DRAWING

Figure 4

other objects and such items can be picked up more easily than from a very smooth and slippery surface.

Technical Drawing

116. A good relationship between the drawing board, hands and eyes is important. This will vary depending on which part of the drawing is being worked on, therefore an adjustable angle drawing board is required, particularly for large drawings. Figure 4 shows a suitable workplace which incorporates an adjustable board, a generous table surface for notes, drawing instruments etc. Seating at the correct height is important (see Figure 1). Preferably an adjustable height chair should be provided. Additional features may be desirable for advanced work where a workplace is allocated to each pupil, for example a storage drawer/tray (which must not compromise leg room) and display facilities.

Special Requirements

117. A table surface constructed from an easily cleanable material such as plastics laminate is desirable, as the workplace may be used for messy jobs. However, the drawing board itself should not have a hard slippery finish – linoleum or wood would be more suitable.

A removable or integrated drawing board will allow the table to be dual purpose.

Practical Activities at the Standing Working Plane

Technical Reference

118.1 Building Bulletin 38: (Metric Edition) School Furniture Dimensions: Standing and Reaching. HMSO (1974).(Gives guidance on work surface heights for many standing activities.)

2 Building Bulletin 44: Furniture and Equipment Dimensions: Further and Higher Education, 18 to 25 age group. HMSO (1970). (Gives sunukar data ti BB 38 but the range of activities covered is not as extensive as in BB 38, so this report is more limited in its application.)

3 Bu[illegible] [illegible]lletin 50: Furniture and Equi[illegible] Working Heights and Zones for Practical Activities. HMSO (1973). (Detailed study of the complex nature of activities carried out at the standing working plane. Broad recommendations are given.)

General Standing Work

119. A great variety of activities is carried out at the standing working plane; some of these require special provision and are dealt with separately. This category is concerned with furniture for general standing work which involves a medium volume of vertical space with a relaxed eye position (apart from occasional close inspection) and does not demand the exertion of heavy downward force.

Height of Worktop

120. The surface height should allow the task to be carried out at elbow height. In practice this means that the worktop should be below elbow height as much of the work itself will be carried out above the work surface. Most common activities take place approximately 200mm above the worktop so that a height of 940mm would be suitable (see Figure 5).

Depth of Worktop

121. A worktop depth of 600mm is adequate for most purposes. If the worktop is deeper the back of it will be beyond the limits of comfortable reach and the space will be used for dead storage. For some large pieces of equipment a worktop depth of 750 – 800mm may be required.

Length of Worktop

122. A worktop length of 900mm per pupil should be allowed. This can be reduced to 600mm per pupil if work is carried out in pairs. For certain activities such as advanced laboratory work a minimum worktop length of 1200mm should be provided.

Seating

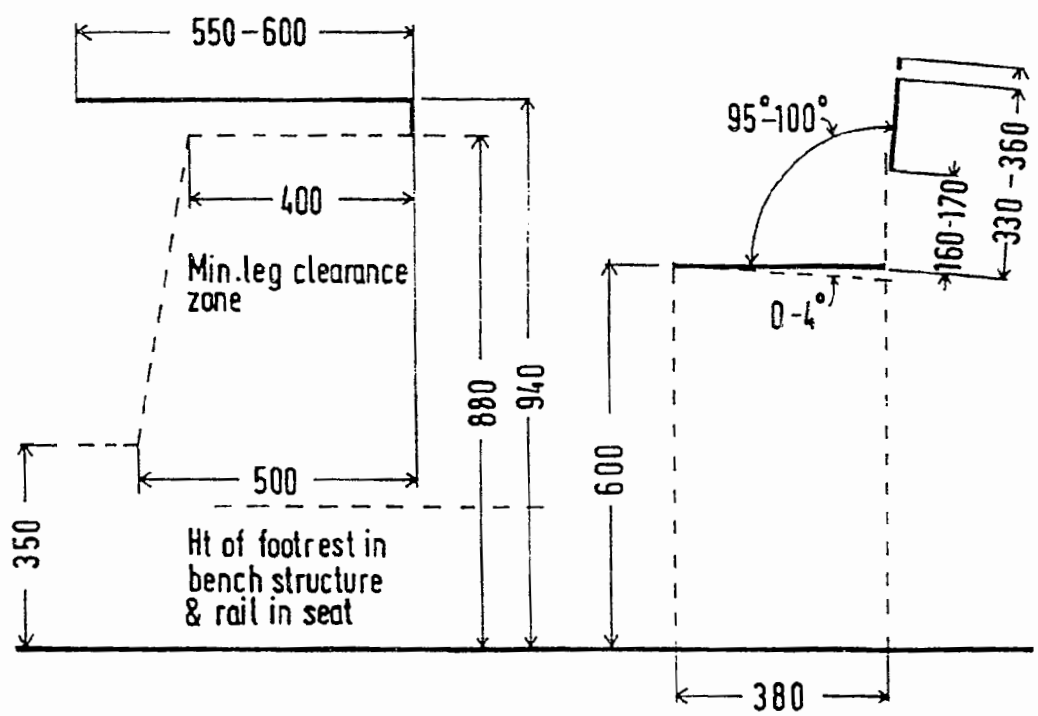
123. The provision of seating in relation to standing worktop heights is important particulary in laboratories where pupils will not only wish to sit while monitoring experiments but

may regularly experience long periods of note taking. Ideally, separate provision should be made for non-practical work but in practice pupils will be expected to sit taking notes at standing worktops. It is thus essential that any seating be correctly related to the worktop height and incorporate a foot support to ensure that a comfortable working posture can be maintained. Perhaps the most important factor in this respect is the provision of adequate leg room (see Figure 5). In practice this means that there should not be storage underneath any worktop at which pupils are likely to sit – knee holes between cupboards or pull-out writing flaps are not satisfactory. It is felt that the removal of such storage space would be no great loss as experience has shown that it is usually either under-used or becomes a repository for infrequently used items. The foot rest height specified in Figure 5 also applies to any such provision that may be made in the bench structure.

Special Requirements

124. Tables should be stable and reasonably heavy so that they may be acceptable to staff accustomed to fixed benching. Fixed benching is suitable from the functional point of view as long as it conforms to the dimensions in Figure 5, but will greatly reduce the flexibility of the room, particularly when floor-mounted equipment is required.

Durable worktop surfaces must be provided and traditional solid wood tops are ideal for many applications. Although these will gradually become stained, they can be sanded down and relacquered annually. Plastics laminates are also suitable and should always be used where hygiene is important, for example in a microbiology laboratory. In such conditions wood is unsuitable as substances can get trapped in the grain. Care should be taken to seal all edges adjacent to sinks to avoid damage to the sub-

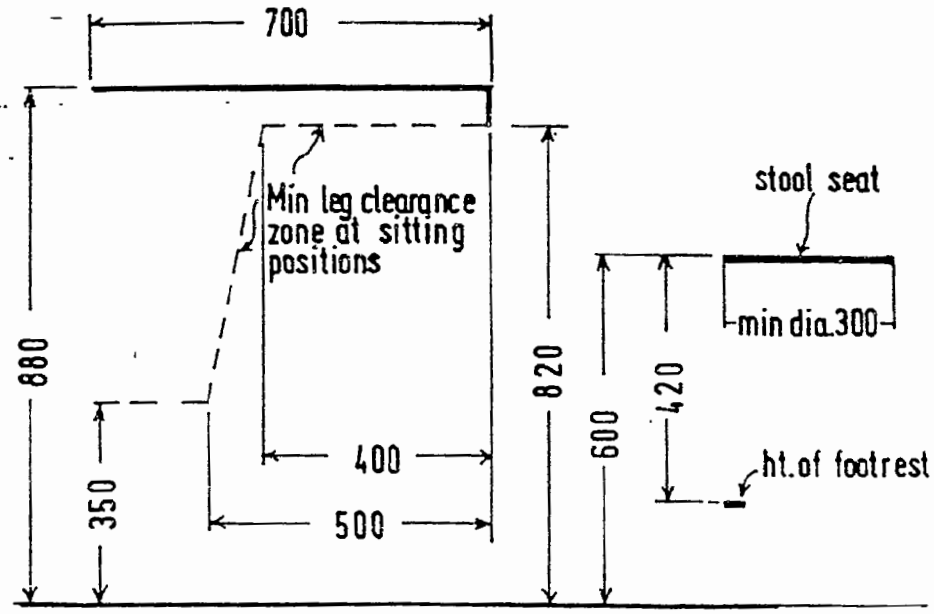


Dimensions in mm.

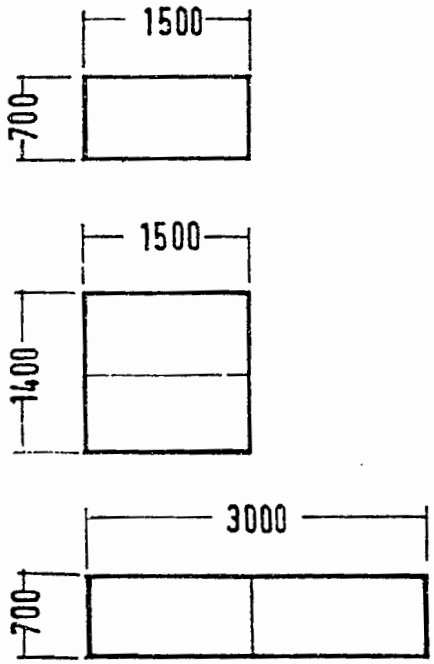
Functional Dimensions

STANDING WORKING PLANE HEIGHTS

Figure 5



SECTION



Normal fabric widths

36 inches		90cm.
45	"	115 "
48	"	122 "
54	"	140 "
60	"	150 "

PLANS OF TABLES

Dimensions in mm.

Functional Dimensions

TABLES FOR FABRICS, PATTERNS etc.

Figure 6

Laying Out Patterns, Cutting Fabric, Laying Out/Gluing Veneers

128. These activities involve working over a large area close to the table surface. A large flat surface is required which can be used from any side. A table height of 880mm is recommended (see Figure 6). This height is a compromise between the need for short people to reach across the table and the necessity to avoid excessive bending of the trunk for tall people. The required plan size will vary depending on the work to be done, but the table should be at least 200mm long. The maximum depth of top is determined by the reach limits of users and should not exceed 1400mm or the width of the material to be laid out, but should not be less than 700mm. Figure 6 shows minimum plan sizes required for different purposes. These can be achieved by butting tables together. A basic size of 700 x 1500mm would allow this as shown by the dotted lines. However, this may result in a slightly uneven surface and continuous runs although less flexible are more suitable.

Special Requirements

129. The table surface should be smooth and have no rough joins or surface protrusions. Linoleum tops are good for cloth cutting while a plastics laminate or melamine surface is more suitable for work with veneers where glue will be used.

All edges which could come into contact with the body should be slightly rounded as it will be necessary to lean on these when reaching across the table.

Private Study

Technical References

130.1 BS 5873 1980 Educational Furniture Part 1 Chairs and Tables for Educational Institutions (for table and chair size).

2 FIRA 6 Functional Sizes of School Tables and Chairs (for plan size).

3 BB46 British School Population Dimensional Survey (1971). HMSO. (Anthropometric data, including sitting eye height.)

Work at Carrels/Audio Booths

131. This type of work requires a degree of seclusion and privacy but care should be taken to avoid creating a claustrophobic work place. The carrel plan size must be sufficiently generous to allow students to spread work out and to consult reference books. A length of not less than 900mm is recommended for carrels intended for private study but this can be reduced to 700mm in booths which are used exclusively for audio work where a smaller plan size is acceptable. Figure 7 gives recommended dimensions for study carrels. In language laboratories where the teachers may wish to maintain eye contact with students the height of the partition should be no higher than 400mm. It is important that any installation of hardware in audio booths should not compromise the minimum leg clearance dimensions shown in Figure 1. These should be adhered to as far as possible. An adjustable chair is recommended for use with audio booths where posture can be constrained by the need to operate switches.

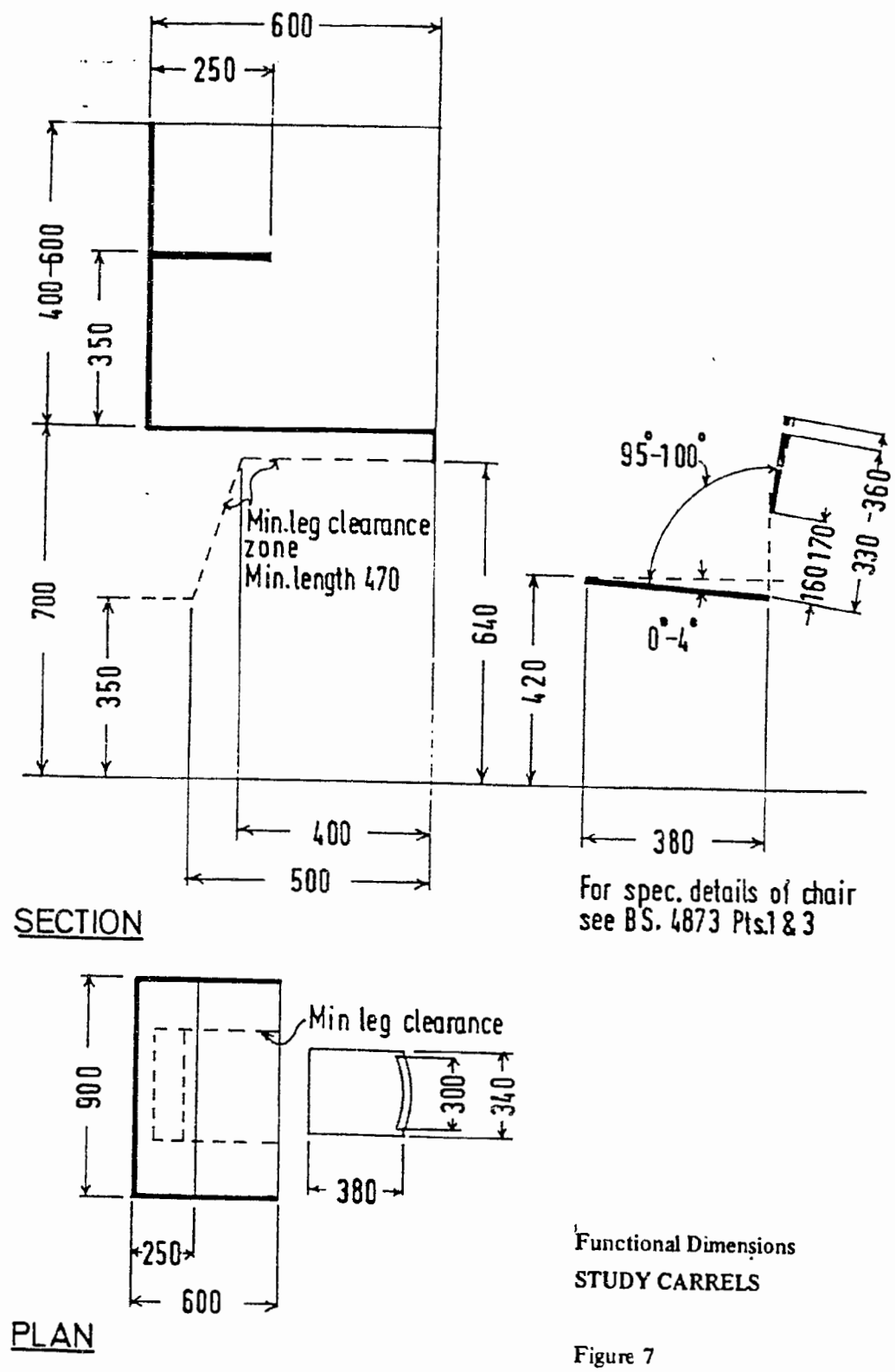
The book shelf shown in Figure 7 is optional but is recommended where carrels are allocated as individual study bases.

Work at Library Tables

132. A suitable area per place is 700mm long x 600mm deep. These dimensions may prove too generous in practice (bearing in mind that an adjacent vacant place may on occasion be used to give more room) so that double tables may be 1300mm long, and where these are fitted together or designed to allow use from opposite sides a reduced work place of 700mm long x 500mm deep (giving an overall table depth of 1000mm) would be acceptable. Previous work on plan sizes (Ref. 2) indicates that any further reduction will result in unacceptably cramped work places at times of peak use. Figure 8 shows recommended table sizes for different groups. More flexibility is achieved by butting tables together than by the use of very large ones. Table depth should not exceed 1200mm or the space in the centre will be wasted.

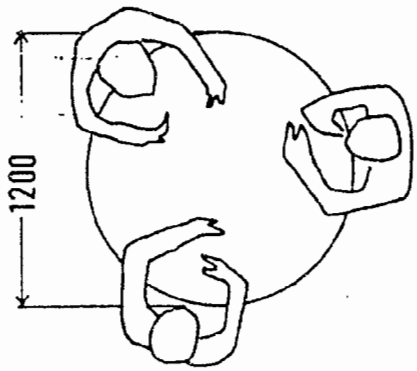
Informal Private Study

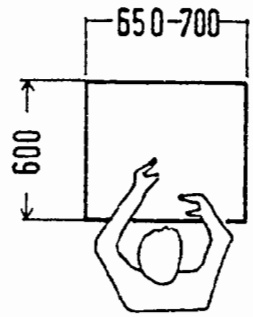
133. It is difficult to give precise recommendations for activities in this category. Each institution can best judge for itself the extent and type of provision required. A range of

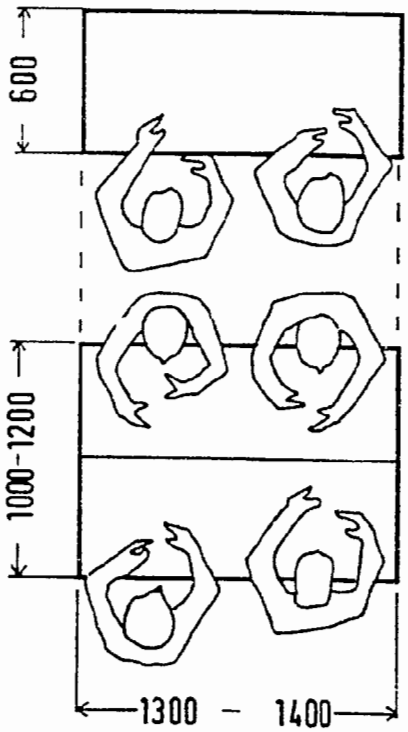


Functional Dimensions
STUDY CARRELS

Figure 7







Sitting at one side only

Sitting at opposite sides

Dimensions in mm

Plan sizes
LIBRARY TABLES

Figure 8

activities is involved which may take place on a individual or group basis and may or may not require the use of a table. A variety of furniture should therefore be available to students. Low upholstered seating as illustrated in Figure 9 is suitable for relaxed reading or discussion, while tables and chairs as shown in Figure 1 are needed for other purposes. Provision needs to be made for group work so that a case could be made for generous plan sizes which would allow students to sit at two sides of the table (see Figure 8). However, the informal nature of these activities allows students to improvise so that various types of furniture will be used successfully. Low upholstered seating in libraries will be welcomed by browsers, but such provision is not essential. Provision for informal private study can be sited in a number of areas – within departments, social areas or sixth form centres. Any nooks or crannies which provide limited seclusion are popular with students.

Social/Refreshment Activities

Technical References

134.1 Le Carpentier E F Easy Chair Dimensions for Comfort. Ergonomics 12.2.1969. (Based on research into subjective judgements of comfort carried out at FIRA. Recommendations are given for dimensions of easy chairs.)

2 BS 5873 Educational Furniture

Part 1 (1980): Chairs and Tables for Educational Institutions (sizes of dining tables included).

Social Activities

135. Furniture provision plays a major role in the character of social spaces. The aim of the designer should be to create an environment which encourages a sense of personal responsibility and belonging among students. It is the responsibility of designers and purchasers alike to ensure that social provision reflects some confidence that students can behave in a responsible manner. Sensible precautions can of course be taken and the importance of durability and ease of maintenance and repair cannot be overstressed. In one sense these together with aesthetic considerations are more important than perfect dimensioning. This is not to say that furniture dimensions are not important, quite the contrary, but they are less critical than in other areas where users do not have the same freedom to move around and change posture freely.

136. A mix of furniture is required which could include low upholstered chairs and settees occasional tables (which should be strong enough to be sat on), stools (which are useful at times of peak use), and upright chairs and tables for light refreshment or informal private study. Recommended dimensions for easy chairs and settees are given in Figure 9.

Special Requirements

137. Particular attention should be given to the recommendations given in Section 3 regarding the durability of furniture and selection of materials.

Dining

138. Dining areas are frequently used for purposes other than dining and this needs to be considered in the choice of furniture. Where there is a need to clear the area for other activities this will dictate light stackable or folding furniture. Large tables will restrict the possibilities for rearrangement and alternative use. Fixed tables should be avoided. Figure 10 shows a variety of plan sizes which would be suitable for dining. Recommended table and chair heights are 700mm and 420mm respectively.

Special Requirements

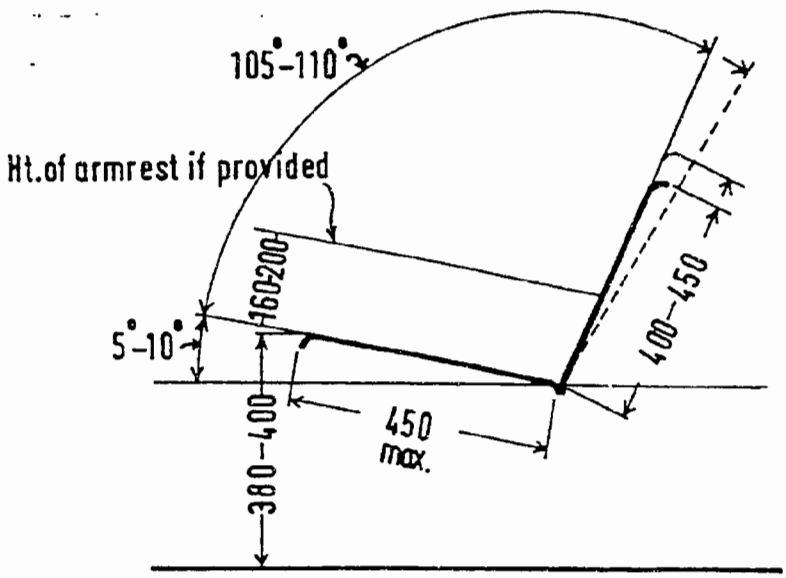
139. It is felt that there is considerable scope in the design of dining furniture to improve the uniform institutional look of many dining halls. Nevertheless the table finish should be easy to clean and have good resistance to heat and staining. Similarly, upholstered chairs should be covered with a wipeable material.

Tables and chairs should be fitted with resilient or shock absorbing feet to minimise noise at meal times.

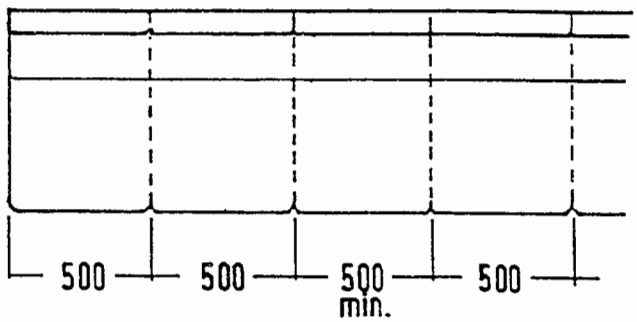
Storage of Personal Belongings

Technical Reference

140.1 Building Bulletin 58: Storage of Pupils' Personal Belongings HMSO (1980).



SECTION OF CHAIR OR SETTEE

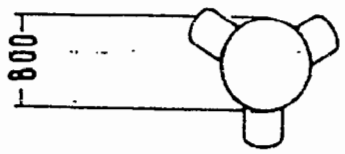


PLAN OF SETTEE

Functional Dimensions
EASY CHAIR & SETTEE

Dimensions in mm.

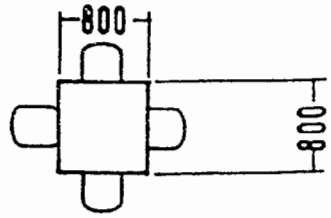
Figure 9



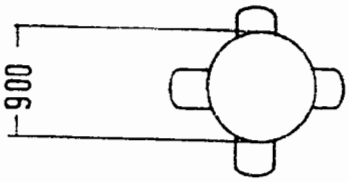
3places

Area 167,552 sq.mm/p.
Perimeter 837 mm/p.

4places



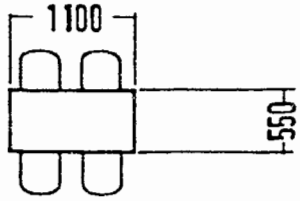
Area 160,000 sq.mm/p.
Perimeter 800 mm/p.



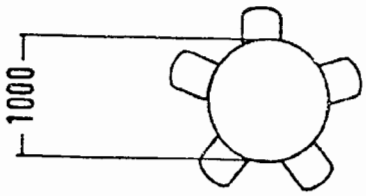
4places

Area 159,043 sq.mm/p.
Perimeter 706 mm./p.

4places



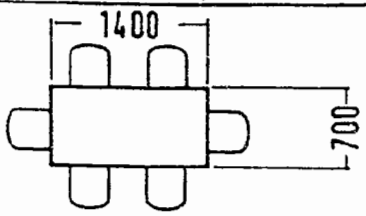
Area 151,250 sq.mm/p.
Perimeter 825 mm/p.



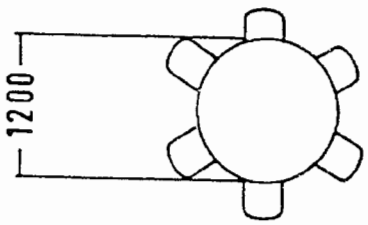
5places

Area 157,080 sq.mm/p.
Perimeter 628 mm/p.

6places



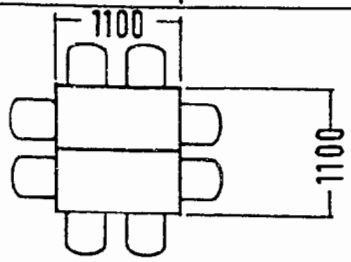
Area 163,333 sq.mm/p.
Perimeter 700 mm/p.



6places

Area 188,496 sq.mm/p.
Perimeter 628 mm/p.

8places



Area 151,250 sq.mm/p.
Perimeter 550 mm/p.

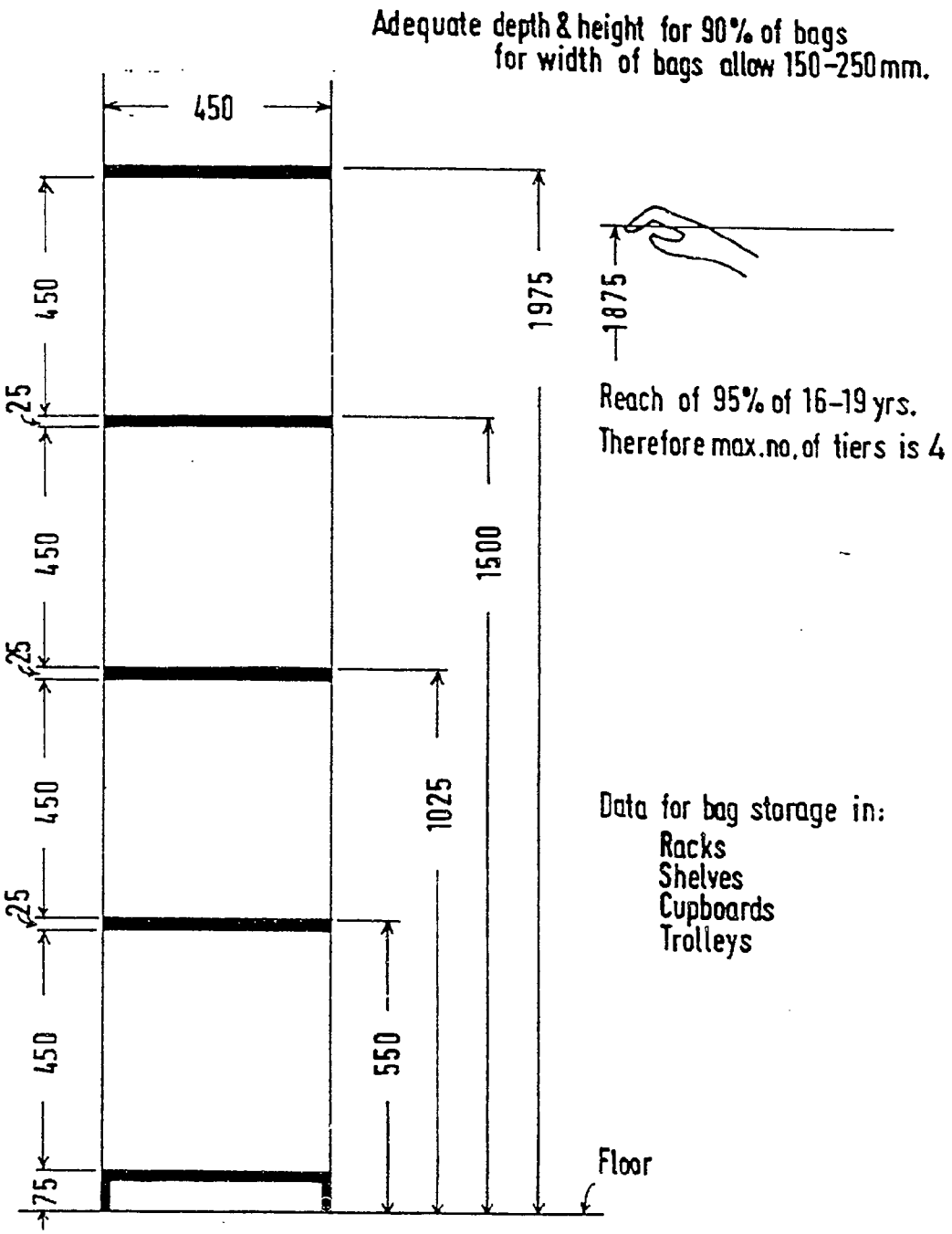
Min. criteria specified in BS.5873 Pt.1

Area 151,600 sq mm/p.
Perimeter 480 mm/p. (round)
" 550 " (rect.)

Dimensions in mm.

Plan Sizes
DINING TABLES

Figure 10



For details of bag & coat data see Building Bulletin no.58.

Dimensions in mm.

Dimensional Data

STORAGE OF STUDENTS' BAGS

Figure 11

A recent FIRA/DES Study on personal storage has been published in BB 58, 'Storage of Pupils' Personal Belongings' and much of the discussion although specifically intended for schools, is pertinent to the 16-19 age group. Many of the problems observed were the same – banks of broken lockers (unused), rooms and corridors littered with bags, coats lying around teaching areas and so on. The main difference at the post-compulsory level is the increase in certain categories of belongings and the necessity of secure overnight storage.

141. Storage requirements of the 16-19 age range vary so that the same provision for all is not necessary. Indeed, many part-time students or those on non-academic courses may require no more than a conveniently placed coat peg and space to leave a bag. At the other extreme, students on a catering course will require extensive personal storage space for complete changes of clothing.

Equipment for Work

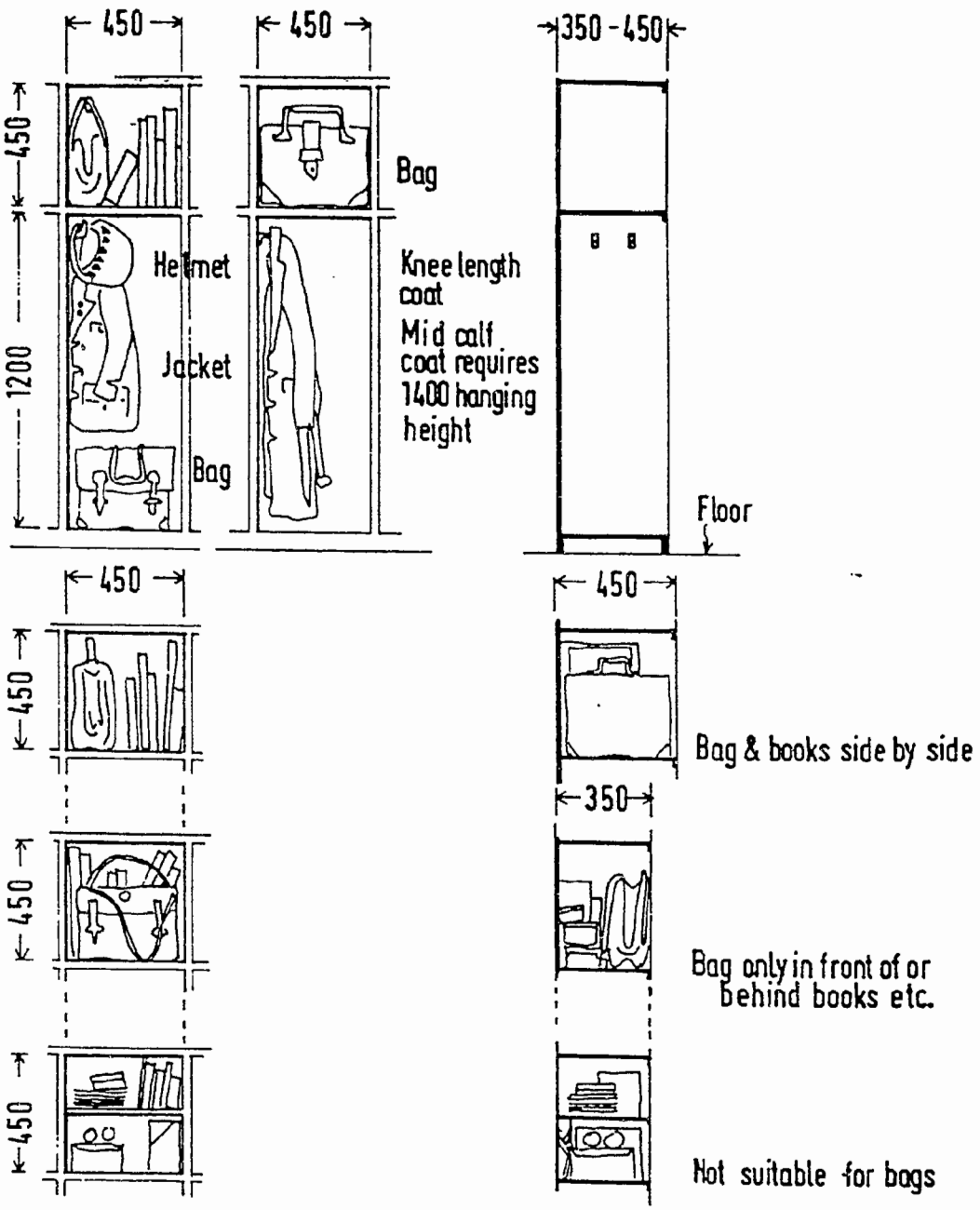
142. For the majority of students, it is the ubiquitous bag which serves as the main repository for personal belongings and many need no other storage space. The bag itself, however, will frequently require temporary storage – a fact which is rarely considered or catered for. Such storage, which need consist of no more than racks, shelving or pigeon holes, should be conveniently sited at entrances to areas such as the library, dining hall, common room and all practical areas where bags lying carelessly on the floor constitute a potential hazard (see Figure 11).

143. For pupils who require additional storage provision for books or equipment, locker space must be provided. It is emphasised that this is not essential for every student but many do require relatively secure storage provision, the amount of which varies depending on the course being taken. The two basic types as shown in Figure 12 will cover most requirements. The half locker is intended mainly for book storage while the full length locker will in addition cater for items such as clothing and sports equipment. The minimum dimensions given in Figure 12 are based on such factors as bag size and coat length.

144. There are, however, a number of other factors in addition to locker size which determine the success of locker provision, including security, key management and siting. A full discussion of these can be found in paragraphs 42 – 49 and in BB 58.

Outdoor Clothing

145. Central cloakrooms were generally unsuccessful in secondary schools and are similarly so for the 16–19 age range. Security is a major consideration so that coat hanging facilities would be more sensibly located within departments or sixth form centres. Full length lockers will accommodate outdoor clothing and need to be ventilated for this purpose. Pupils may, however, require additional hanging facilities if they need to move between buildings during the day. It may well be necessary to provide a limited number of coat pegs at key points which will provide temporary hanging space for students using each teaching area. Social refreshment and study areas may require similar facilities. The organisation of the institution will to a large extent determine whether students can leave outdoor clothing at one point for most of the day, and thus only require hanging space in one area, and whether pegs for short term hanging need to be provided throughout the building (see Reference 1).



For details of bag & coat data see Building Bulletin no. 58

Dimensions in mm.

Dimensional Data
STORAGE LOCKERS

Figure 12

C3

REFERENCES

British Standards Institution

BS 1142 Specification for Fibre Building Boards.

Part 1 (1971): Methods of Test

Part 2 (1971): Specification for Hardboard

BS 2543 1970 Woven Upholstery Fabrics. (Requirements for woven wrap-pile and non-pile primary covering fabrics for domestic upholstery).

BS 3379 1975 Flexible Urethane Foam for Load Bearing Applications.

BS 3794 1973 Specification for Decorative Laminated Plastic Sheets. (Mechanical properties and resistance to outside agencies.)

BS 3962 Methods of Test for Clear Finishes for Wooden Furniture

Part 1 (1965): Test for low angle glare

Part 2 (1971): Resistance to wet heat

Part 3 (1971): Resistance to dry heat

Part 4 (1970): Resistance to marking by liquids

Part 5 (1972): Resistance to marking by oils and fats

Part 6 (1975): Resistance to mechanical damage.

BS 4680 1971 Clothes Lockers.

BS 4723 1971 Nylon Stretch Covers for Upholstered Furniture. (Requirements and making-up recommendations: Method of Test.)

BS 4875 Strength and Stability of Domestic and Contract Furniture

Part 1 (1972): Seating

Part 2 (1977): Tables and Trolleys

Part 3 (1977): Cabinet Furniture

BS 4965 1974 Decorative Laminated Plastics Sheet Veneered Boards and Panels. (Requirements for eight types of board.)

BS 5459 Performance Requirements and Tests for Office Furniture

Part 1 (1977): Desks and Tables

Part 2 (1977): Adjustable Chairs.

BS 5669 1979 Specification for Wood Chipboard and Methods of Test for Particle Board.

BS 5790 Coated Fabrics for Upholstery

Part 1 (1979): Specification for PVC Coated Knitted Fabrics

Part 2 (1979): Specification for PVC Coated Woven Fabrics

BS 5852 Part 1 (1979): Methods of test for the ignitability by smokers' materials of upholstery composites for seating.

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BS 5873 Educational Furniture

Part 1 (1980): Specification for functional dimensions, identification and finish of chairs and tables for educational institutions

Part 2 (1980): Specification for strength and stability of chairs for educational institutions

Part 3: Strength and stability of tables (in course of preparation).

BS 5910 Part 1 (1980): Methods of Test for Surface Finishes for Furniture. Assessment of Surface Resistance to Cold Liquids.

BS 5940 Office Furniture

Part 1 (1980): Specification for office workstations, desks, tables and seating.

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38. School Furniture Dimensions: Standing and Reaching, 1967.

44. Furniture and Equipment Dimensions: Further and Higher Education, 18 to 25 Age Group, 1970.*

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