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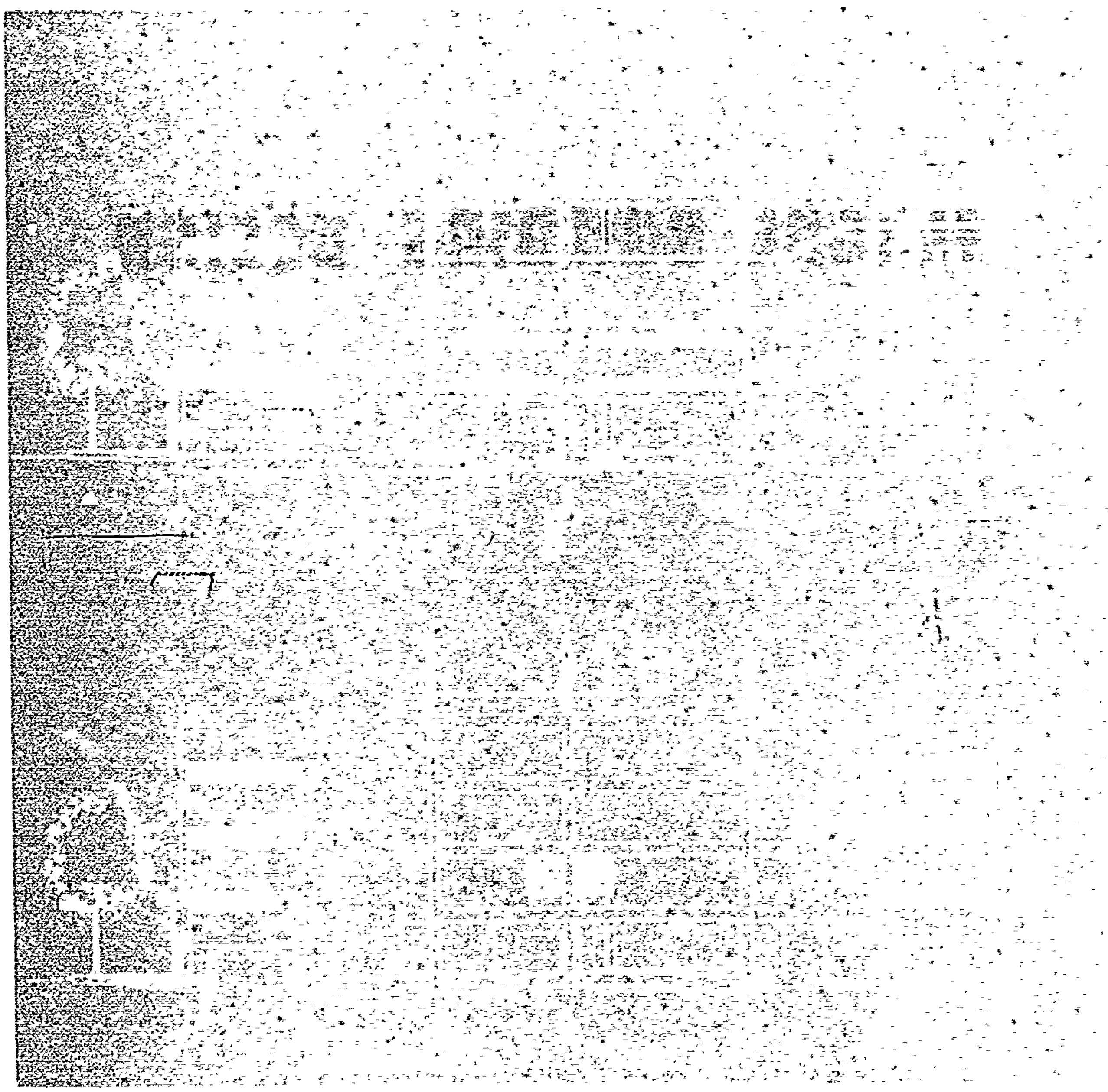
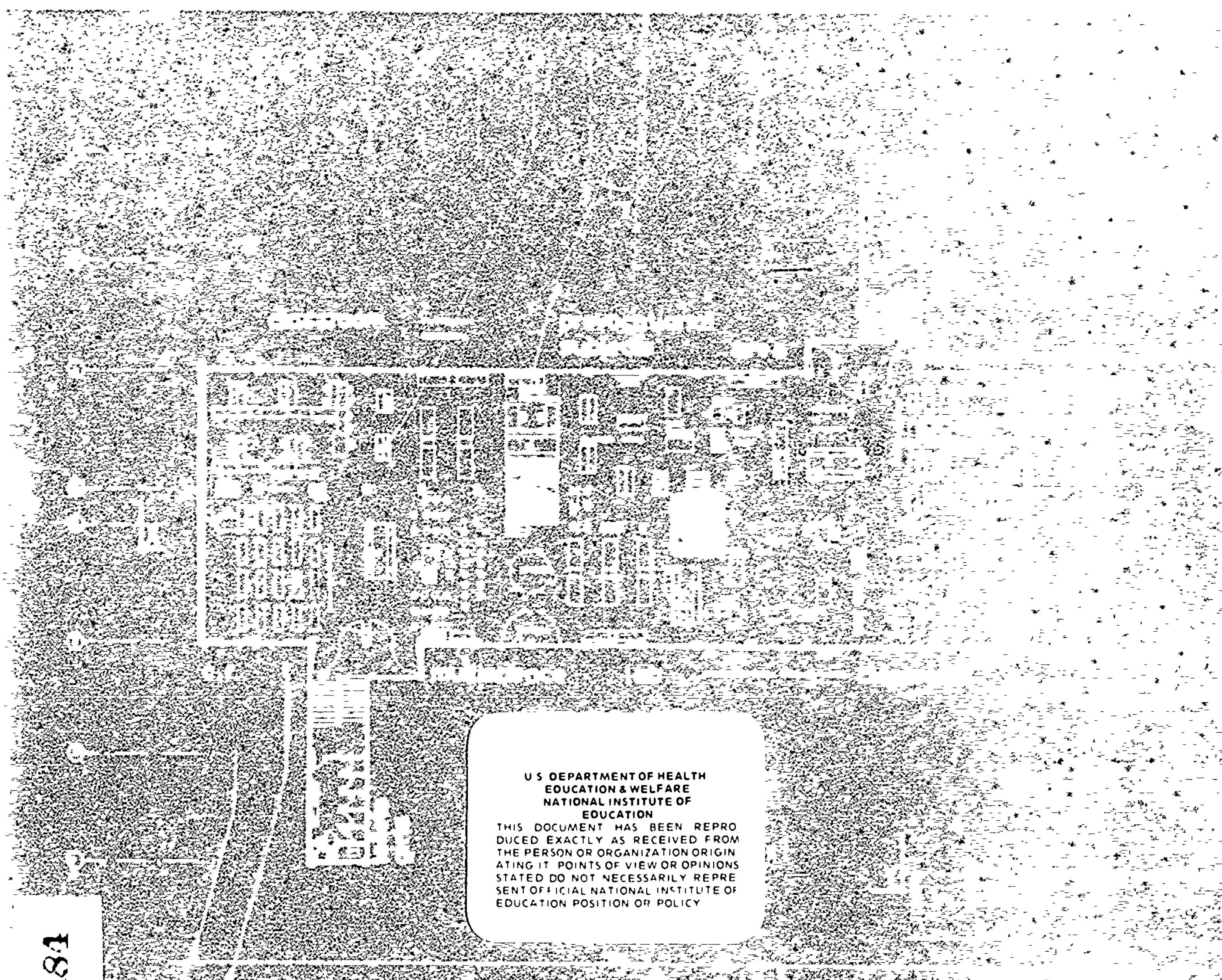
ABSTRACT

Guidelines are presented for the design, costs, and use of primary and secondary general schools in the 18 countries comprising the Asian region served by UNESCO. Because of the great diversity in climate, building design and construction skills, and resources in these countries, the generalizations about school building design and furniture should be evaluated individually by each country. The materials included are intended to be of use to planners, architects, school building designers, principals, and teachers. Those chapters dealing with the size of the school and ways of scheduling towards maximum utilization of teaching spaces will be of interest to administrators. On the other hand, those chapters devoted to the design of individual spaces will have more appeal for teachers. The book reports in great part on those developments already undertaken, with costs and evaluation included. (Photographs and the illumination grids in back cover pocket may reproduce poorly.) (Author/MLF)



SCHOOL BUILDING DESIGN ASIA



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Preface

The purpose of this book is to stimulate discussion on the main factors affecting the design costs and use of primary and secondary general schools in the specific context of the Asian region. The tasks of selection of material and of presentation have posed considerable difficulties, for the eighteen countries of the region served by Unesco show great diversity in respect of their climates, building materials, available design and costing skills, educational development and resources for educational building. The risk that we have taken is of presenting material too sophisticated for some situations, too simple for others.

Against this, we have observed that the application in other parts of the world of far greater resources than can be mustered in many Asian countries, has not always resulted in greater educational benefits. Given good teachers, relevant curricula and a modest physical environment designed to meet the educational needs, the quality of the educational output in the countries of the region will improve immensely. It is with this attempt to improve quality – a feature of Asian educational endeavour in the 1970s – that this book is concerned. In real terms this means that designers will need to approach the problems of design with somewhat greater insights into education, its structure, content and methods, than has often been the case in the past For this reason, much is said about education in the countries of the region and the chapters concerning the design of teaching spaces approach the problem through a study of the teaching and learning needs in each subject area. As the pages that follow will show, the changes suggested are not dramatic. They include, for example, the design of desks and chairs to fit the body sizes of the children so that they can learn in greater comfort; the rejection of laboratories that are stale copies of outmoded university science facilities and their replacement by cheaper and more functional furniture; the design of schools, tailored to meet the programmes and populations that they have to house in place of buildings that are wasteful of space and thus of resources.

Generalisations about design of school buildings and furniture have, of course, to be evaluated in the context of the country in which it is proposed to bring about change. Thus, some countries will find it more convenient to calculate the range of optimum sizes of schools needed using a computer; in others the problem will be, how to improve the amenities of remote schools in mountainous, seismic areas where it is not only difficult but dangerous to build a roof spanning as little as from three to four metres.

Much of the book reports developments undertaken by the Institute in the countries of the region – work that has been both tested and costed in real situations and with the ready co-operation of the Governments and organisations concerned. In this connection, special thanks have to be offered to the Government of Sri Lanka*, not only for its hospitality in providing a home and other facilities for the Institute since 1966, but also for having freely given the use of its schools for field trials of many of the ideas that are described in the chapters that follow.

Whilst much of the material that we have included is intended for educational planners, administrators and school building designers, it is hoped also that it will be of use to both principals and teachers, for it is they, in the end, who use the schools and thus remain satisfied or otherwise with what has been provided. The chapters dealing with the size of the school and with ways of scheduling accommodation to obtain maximum utilisation of teaching spaces, will be of interest to heads of schools, whilst the chapters on the design of individual spaces will give teachers some insight into the designer's approach to the problem of providing an appropriate environment for teaching and learning.

The material in this book has been contributed by the staff of the Institute and reflects their understanding of the varied situations in the countries of the region, almost all of which have been served by the Institute during the past ten years.

The drawings have been prepared by one of the Institute's draughtsman, Mr. P. J. H. Fonseka. Mrs. M. Senanayake of Messrs. Kularatne & Co. Ltd., Colombo, has been most co-operative in its printing.

D. J. Vickery

**The printing of this book was partly completed before the name of Ceylon was changed to Sri Lanka. For this reason the country is referred to as Ceylon in the body of the book.*

Chapter 1

THE EDUCATIONAL BACKGROUND

Plate 1

The purpose of this Chapter is to explain, as briefly as possible, those features of the educational systems of the Region that are relevant to the designer in his work of designing school buildings. Of importance in this context is some understanding of the structure, content and methods of education. Designers using this book will find that, somewhat reasonably, it describes things as they are and they are, in fact, from an educational view-point often far from satisfactory. However, the pace of education is set by educationists and not by building designers whose business it is to provide buildings, furniture and equipment to meet the present needs. This should not, however, prevent the designer from keeping an eye cocked to the future – innovation and change in education is very much in the air in the Asian Region and buildings which, whilst satisfying present needs, do not facilitate change when it comes, will be expensive failures.

This short explanation is given here for those who expect that a book which is the product of a school building research institute, will be wholly innovatory in character. This, it will be seen, is not the case. The main concern of the Institute since its inception in 1962, has been concentrated on the adjustment of building concepts in the region so that more functional schools can be provided to meet present needs. Getting chairs and desks of the correct size so that children can work comfortably, providing data on available daylight so that windows can be designed to give the right amount of light, showing how accommodation needs can be calculated to avoid waste, suggesting more functional ways in which laboratories and workshops can be designed – these are the "innovations" of this book and they would yet, if they were to be introduced in the schools of many countries of the region, be innovations there too.

Whatever is done by the designer requires that he understands the context of his work – that is the education system.

The main components of educational systems in the Asian Region are shown in Figure 1. They form the framework for what is known as the "structure of education".

1.01 The Structure of Education

Educational systems vary from country to country because they form part of a specific cultural, social, political and economic environment. All educational systems, moreover, are in a state of continuous adjustment in response to changing national circumstances and emerging needs.

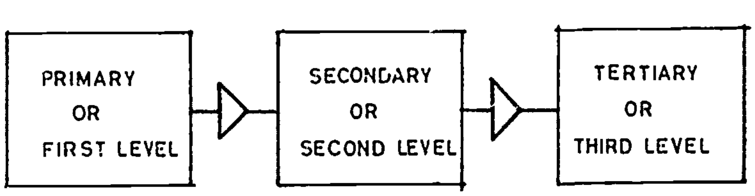


FIG. 1

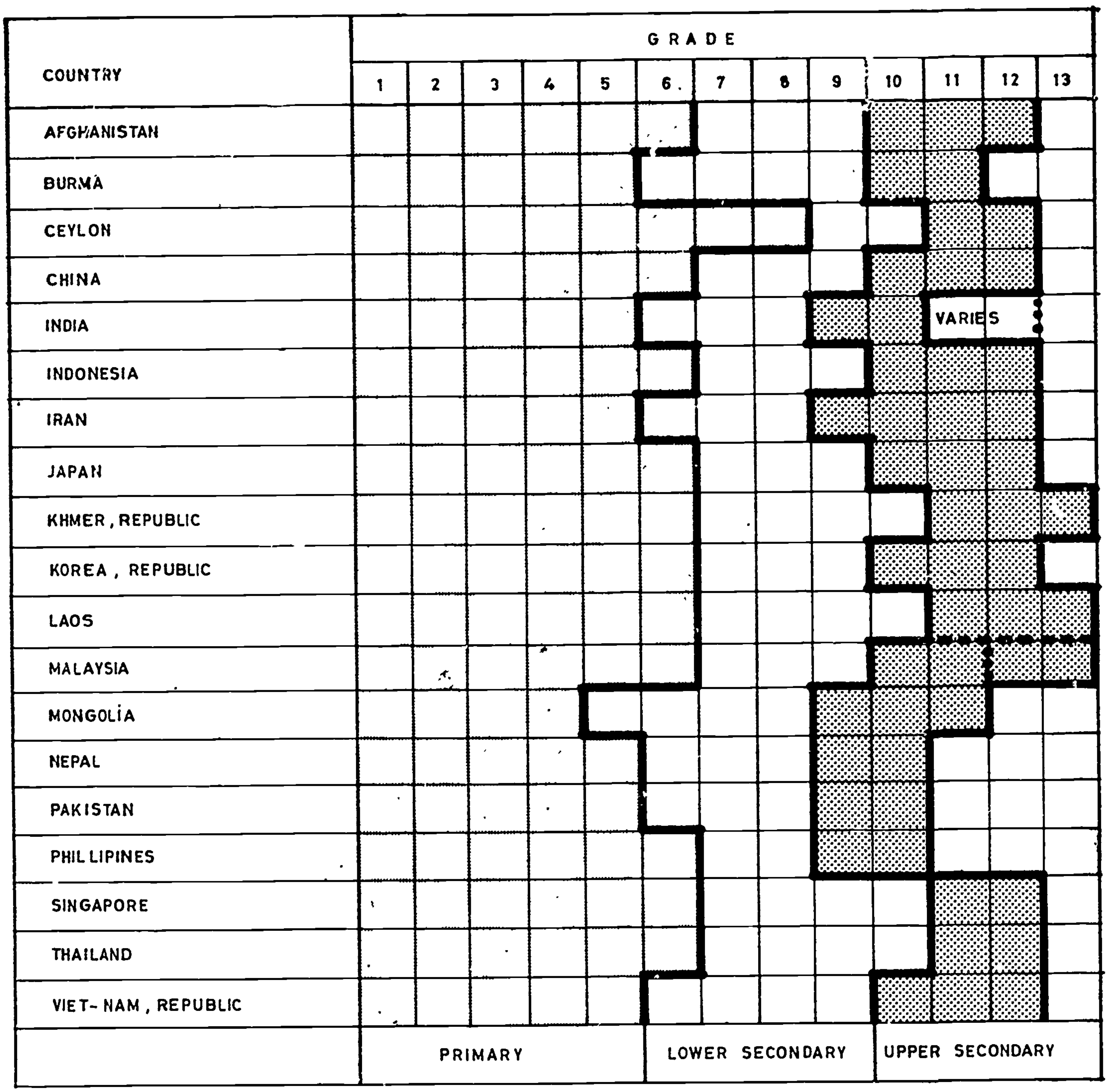

GRADE
COUNTRY
1
2
3
4
5
6
7
8
9
10
11
12
13
AFGHANISTAN
BURMA
CEYLON
CHINA
INDIA
INDONESIA
IRAN
JAPAN
KHMER, REPUBLIC
KOREA, REPUBLIC
LAOS
MALAYSIA
MONGOLIA
NEPAL
PAKISTAN
PHILLIPINES
SINGAPORE
THAILAND
VIET-NAM, REPUBLIC
VARIES
PRIMARY
LOWER SECONDARY
UPPER SECONDARY

FIG. 2

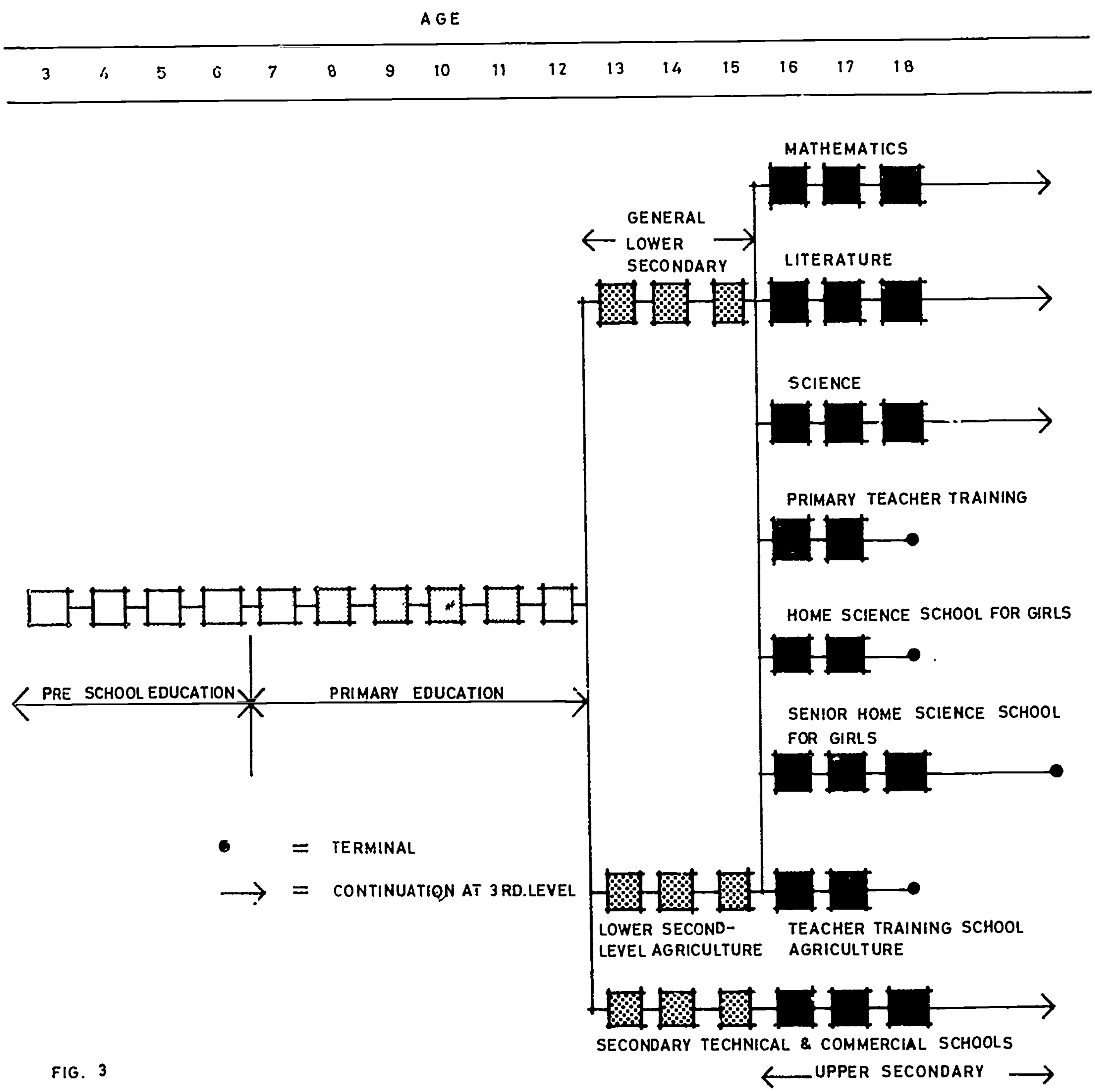


FIG. 3

Figure 2 shows, at a point in time, the variations in the *structure* of the systems at the first and second levels of education in the countries of the Asian Region. The source of the information used to compile the figure is dated March, 1969 (1.1) and the significance of the statement, made above, concerning "continuous adjustment" is well illustrated by the fact that some of the countries have already changed the structure of their educational systems during the past three years. Ceylon, for example, has now adopted a 5 – 4 – 2 structure, similar to that of Burma. That is, 5 years of primary, 4 of lower and 2 of upper secondary education. The buildings originally built for Ceylon's 8 – 2 – 2 system now have to serve a different educational purpose. The need to design with the possibility of changes such as this in mind, is at the root of much of the thinking in this book.

Of course, the structure of education in each country is usually a much more complex affair than Figure 2 might suggest. The components of a typical system are shown in detail in Figure 3.

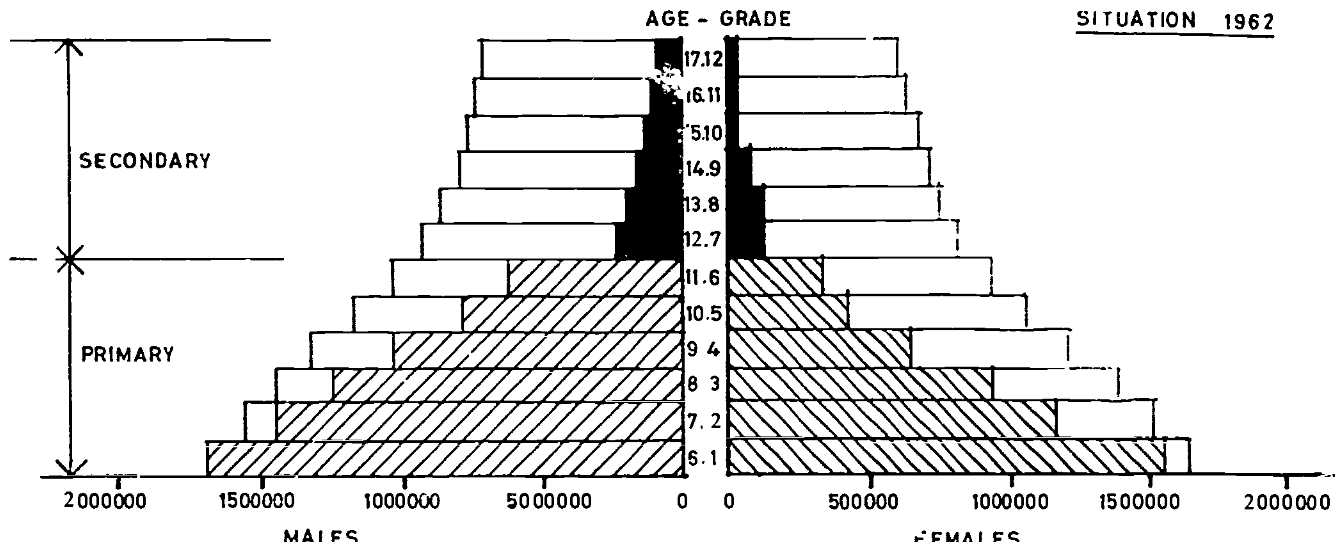


FIG. 4

But whilst each country has a system of education structured more or less like that shown in Figure 3, all children do not pass through the entire system. Indeed, one of the two main problems in most countries of the Asian Region is how to increase the number of children receiving education *within* the constraints of the limited resources of money available for teachers' salaries, equipment, land and buildings. Figure 4 shows a familiar situation in respect of the numbers of boys and girls attending school in one of the countries of the Region. It will be noted that more boys receive education than girls and that there is a sharp decline in the numbers leaving the primary sub-system to enter the lower secondary system.

One aspect of educational change which is the direct concern of the designer is that of planned increases in enrolment. Figure 5 shows the anticipated enrolment in the same country, but 20 years later. The future need to expand existing schools as well as to construct new schools, in many, though not all, countries of the Region, is very evident.

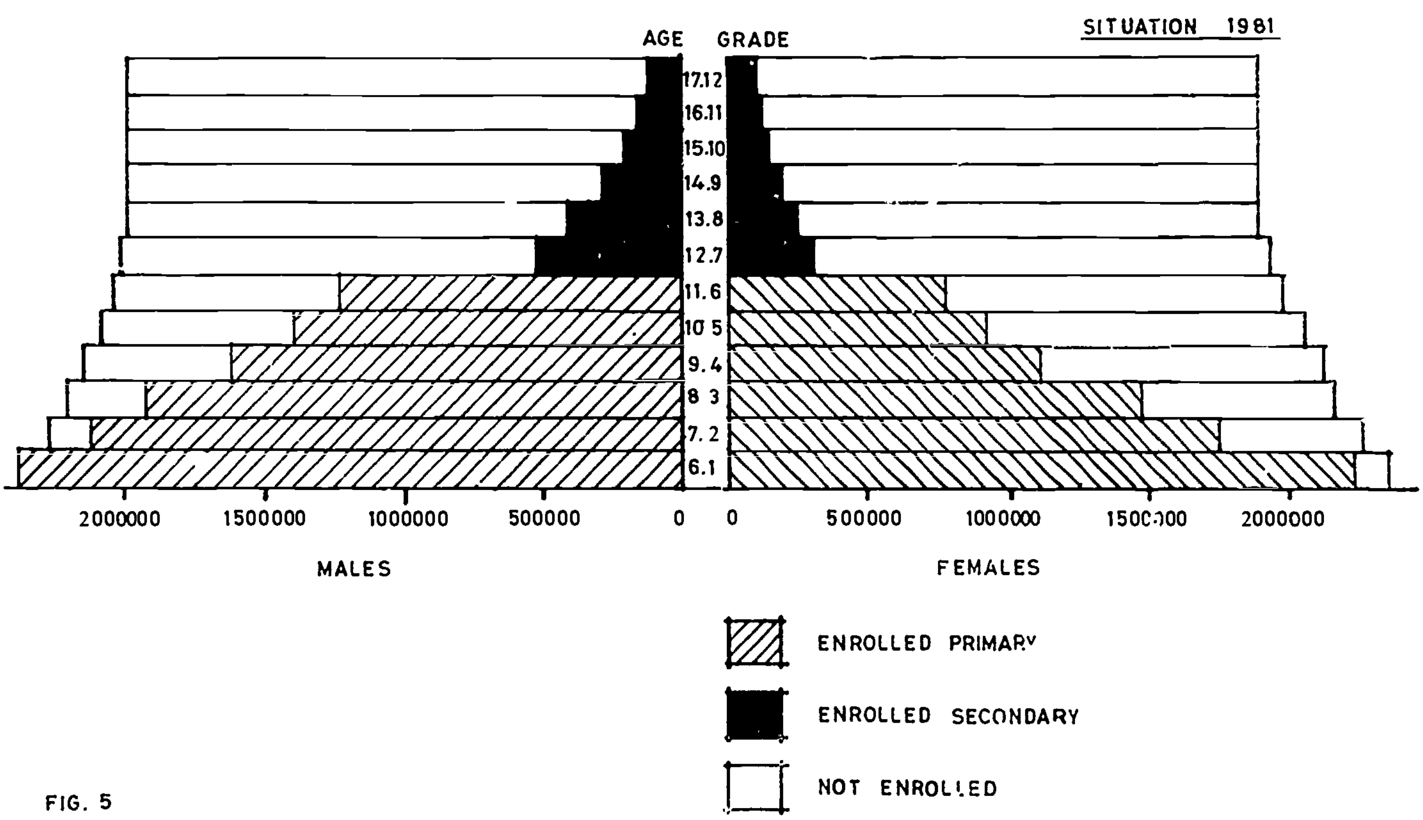


FIG. 5

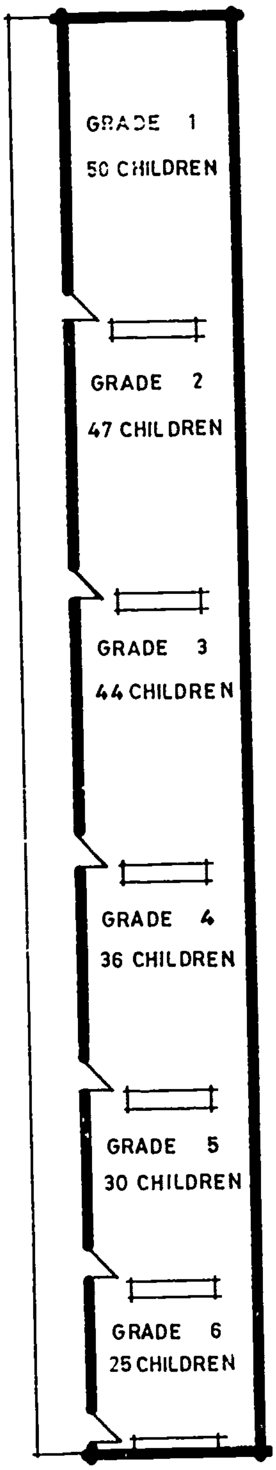


FIG. 6a

A common characteristic of both figures 4 and 5, is the reduction in numbers of children attending school, year by year. Although increasing numbers enter the system progressively as the population grows, children "drop out" of the system as they grow older. It is, in fact, quite common in some countries to find that, of 100 children entering primary school, fewer than 50 complete their primary education (1.2). On the other hand, there are a few countries where retention is high and of the original 50, some 44 will complete primary education.

Figure 6a suggests that, if classrooms were designed to be proportional in area to the numbers of children retained in the primary school system, they would all need to be of different sizes. The figure by no means, indicates the worst position in the Region where, in some countries of 50 children in Grade 1, only 8 may reach Grade 6. One of the ways of partially overcoming the (predictable) waste of space due to dropouts is to arrange *3 or 4 form entry schools.* (Figure 6b.)

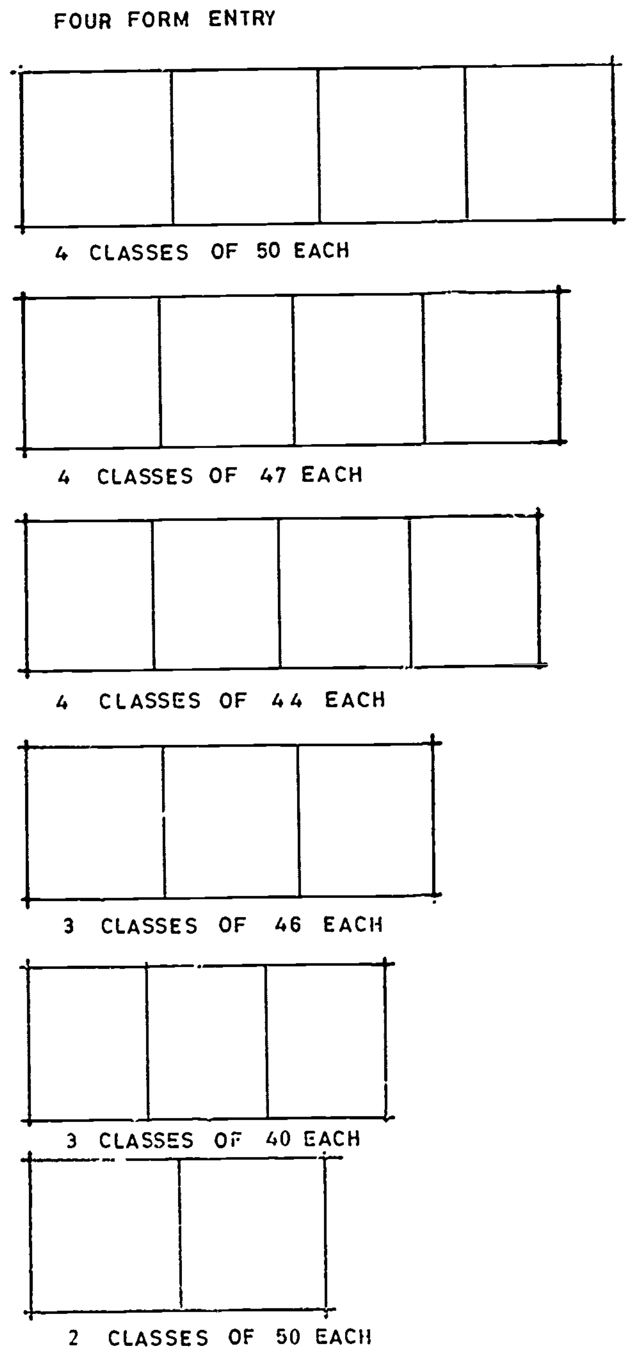


FIG 6b

The best way, however, is probably to separate one teaching group from the next by an adjustable partition that can be moved as the numbers in each class change from year to year.

The situation in respect of wastage is not, however, likely to remain static. As the quality of education improves and the socio-economic status of the parents changes for the better, it seems likely that the incidence of wastage will slowly reduce. The subject is complex, and it may be sufficient for the designer to anticipate that, whilst the number of children in Grade 1 classes will remain constant, the numbers of children in the grades above 1 will very slowly increase until all grades have classes of similar numbers of children. The rate of change is, however, likely to be slow and the case for assuming that spaces of equal size are needed for all grades, needs to be based on a careful study of the appropriate statistics of age-grade structure.

Most of the characteristics, outlined above, apply to education at the first level. Wastage at the second level is equally pronounced, as is evident from Figure 4.

Information on the structure of education is, as will be seen from the outline given above important as it determines the types of schools, the number of grades, and the age structure of the children.

1.02 The Content of Education

The education process which stems from well defined aims and objectives, comprises a series of experiences, contrived for the children, and set down in the form of a curriculum. The areas of the curriculum, such as geography, history, science etc., together with the detailed material to be studied, are usually known as the *content* of education. The ways in which the detailed material is organised by the teacher into units of learning or experiences for the children, is known as *method* and this aspect of education is dealt with in 1.03 below.

From a study of content, the designer will gain an understanding of the sort of building he is called upon to design. Industrial arts and science in the curriculum may, depending on the situation, suggest the need for laboratories for teaching and learning in these subject areas. The inclusion of agriculture, biology and physical education may suggest the needs for the design of the site to accommodate these out-of-door activities.

The content of education in the Asian Region naturally varies from country to country. Certain common trends can, however, be observed at both the first and second levels.

The aim of *primary education* is usually described as to provide for all children, boys and girls, a general education in which they are prepared to take their places in a changing society, are helped to develop habits of critical thinking and are given opportunities to gain knowledge and develop skills and abilities (1.3). The list of aims can be, and often is, extended (1.4) (1.6).

Realisation of the aims of primary and, indeed, secondary education through the curriculum, which is broadly conceived as defining "all the experiences of pupils which are planned and directed by the school", (1.4) is traditionally, if unsatisfactorily, expressed as "the list of subjects set out in greater or less detail, which are to be studied by pupils under the teacher's guidance" (1.4).

The subjects prescribed in the curricula for first level education in the countries of the Asian Region, broadly include the following:

Language arts
Elementary mathematics/arithmetic
Social studies
Moral or religious education
General science (including hygiene)
Aesthetic studies (music and art)
Practical arts (handicrafts, gardening, home science)
Physical education
Other subjects (e.g. English, French, Russian, optional subjects)

The designer would be wise, as is explained more fully in later chapters, not to regard this list as a guide to the total activities in the school. "The environment and atmosphere of the school, the so-called extra curricular activities...are important factors which contribute to the education of the child, but they are distinct from curriculum" (1.4).

The apportionment of time available to implement the primary curriculum varies very widely, from 240 to 180 days of the year, depending on the country. Similarly, the weekly hours of work vary from 32.3 to 18.4. At least 200 annual working days, if not more, and a minimum of 30 hours per week seem to be necessary, if the objectives of primary education are to be achieved. Whatever the actual occupation of primary school buildings for the purposes of primary education, it seems obvious from the data given in the previous paragraph, that they are likely to be unused for substantial periods of the year and the possibility of utilisation by the community in connection with programmes of life-long education (1.7) is already the subject of exploration and experimentation in many countries of the Region. (Plate 2).

As at the first level of education, the curriculum content at the second-level varies in detail from country to country. Certain broad trends can, however, be observed in both the lower and upper secondary curricula of the region.

The main distinction to be drawn between primary and secondary curricula is that of the increasing freedom offered to children to choose their own areas of study at the second level. In most first-level curricula, all of the children study all of the subject areas prescribed. At the second level, the curriculum usually includes a number of *core* or compulsory subjects and the pupils may *elect* to study other subjects which they feel are of special interest to them. The number of core subjects are usually greater at the lower than the upper second level and the reverse is usually the case with the elective subjects. Whilst, of course, both the teachers and equipment needed to teach core subjects have to be provided, it is quite common to find a wide range of elective subjects offered, only a few of which can be taken due, either to limitations in the availability of specialist teachers and equipment, or to the economic impossibility of providing a teacher to teach a very small group of children for a very short period each week.

Table I illustrates a fairly common curriculum for second-level schools in the Asian Region. It has been synthesised from a study of all second-level regional curricula (1.1). Obviously in designing for a particular situation, the precise curriculum of the country concerned should be consulted.

TABLE I

TYPICAL CURRICULUM FOR SECOND-LEVEL GENERAL EDUCATION IN THE REGION

LEVEL	CORE SUBJECTS	ELECTIVE SUBJECTS
Lower Secondary	Religion First language Second language History Geography General science (or physics, chemistry & biology) Mathematics Physical education Vocational subjects	Home economics Agriculture Music Fine arts
Upper Secondary	Religion First language Second language Mathematics Physical education	
	SCIENCE STREAM	
	Physics Chemistry Botany Zoology Advanced Maths	Geometric and Mechanical drawing Art/Music Manual Skill Agriculture
	ARTS STREAM	
	History Geography Literature Art/Music	Home economics Handicrafts Commerce Civics

The apportionment of time to the various subjects at the lower second-level varies, from country to country, as do the subjects selected themselves. The average time spent, however, is very roughly as follows:

Plate 2

Language	..	35%	Core subjects
Social Studies	..	13%	
Science, Maths	..	25%	
Arts, handicrafts	..	6%	
Physical education	..	7%	
Vocational studies	..	7%	
Others	..	3%	
Electives	..	4%	

From this it will be concluded that some 55% of the teaching accommodation will be needed for classrooms, some of which may be furnished as special rooms for mathematics, social studies etc., and the remaining 45% will comprise science laboratories, workshops and other similar special teaching spaces. Figure 7, a lower secondary school from Malaysia, illustrates the sort of ratios of classrooms to special teaching accommodation that are characteristics of lower second-level schools in the Region.

At the upper second-level, the quite different curriculum results in a different time allocation and different space needs. The following apportionment of time is somewhat typical for the schools of the Region.

Science Stream	Languages	27%	Common core subjects
	Social Studies	12%	
	Physical education	5%	
	Science & Maths	41%	
	Electives & others	15%	
Arts Stream	Languages	35%	Common core subjects
	Social Studies	12%	
	Physical education	6%	
	History, Geography Literature	19%	
	Electives & others	20%	

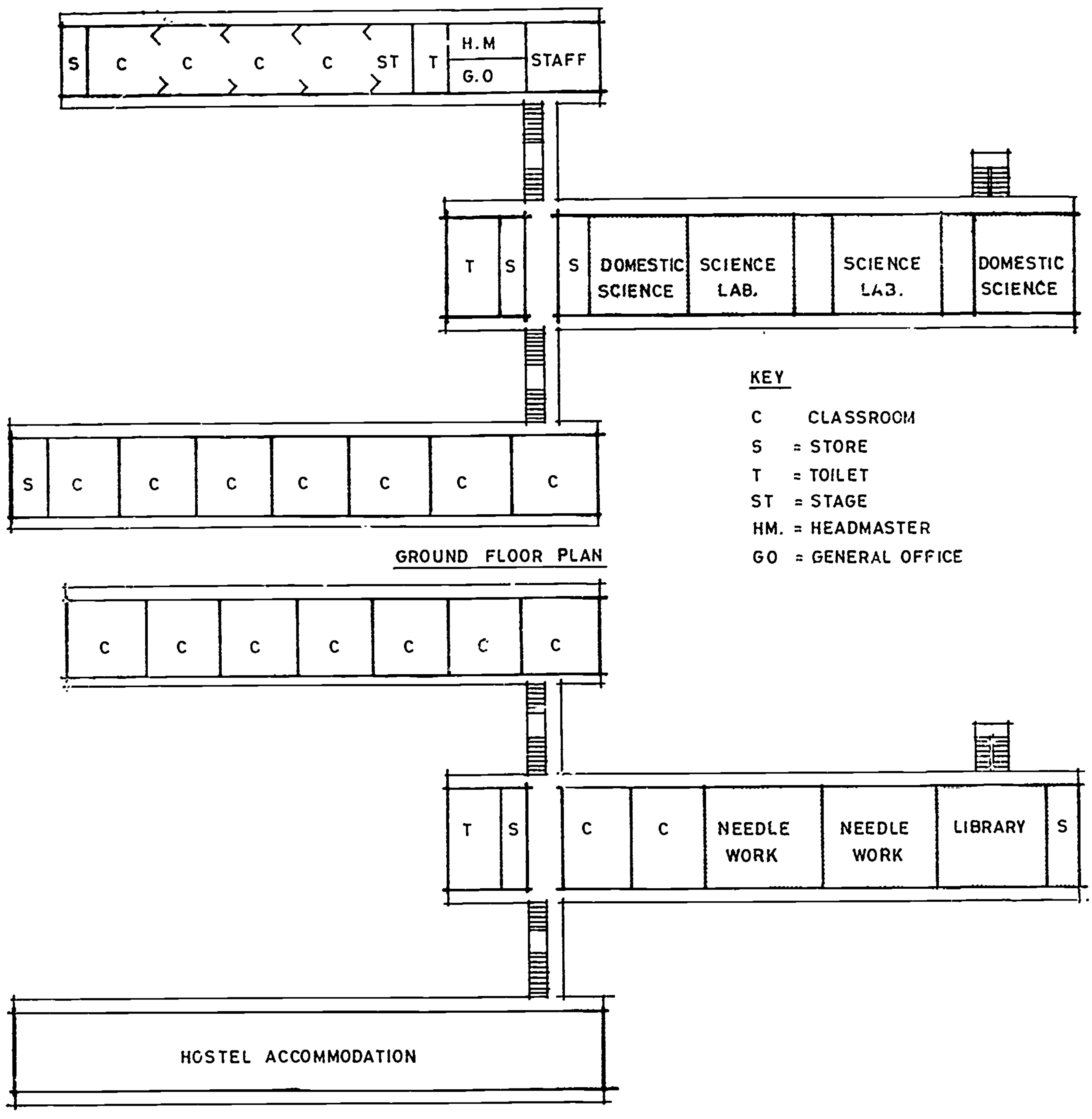


FIG. 7

Clearly, in both streams, the core subjects will occupy from 53 to 39% of the accommodation, whilst, in the science stream, some 41% will need to be in the form of laboratories and special rooms. Accommodation for the arts streams will mainly take the form of classrooms which may be specially furnished in relation to the purpose for which they are individually intended, e.g. the geography room. Clearly, as special rooms are, in general, more expensive than classrooms, upper secondary schools are likely to be more expensive, per pupil place, than lower.

So far, content has been described in terms of subject areas such as mathematics, science, history, etc. In fact, content, although described by one or other of these words, can vary considerably in its meaning as between one country and another. In order to design buildings for a particular situation, it is always necessary to examine in detail the curriculum content for which a particular space is to be used before designing it.

General science provides an excellent example of a subject area in which the content is sufficiently different in different countries to result in different sorts of laboratory design. A comparison of the outline content for lower secondary education in two countries of the region is given below:

Country A	Country B
1. Statics	1. Heat
2. Dynamics	2. Light & Lighting
3. Heat	3. The solar system
4. Light	4. Weather
5. Electricity & magnetism	5. Natural resources
6. The solar system	6. Ecology
7. Chemical & physical changes	7. Magnetism
8. Simple treatment of gymnosperms & angiosperms	8. Machines
	9. Visual instruments
9. Classification of plants	10. Communication & transport by electricity
10. Soils	
11. Simple animals	11. Science & progress, methods of discovery, industry

Apparently the general science content prescribed by country A follows a somewhat more formal or traditional approach than that of Country B, the curriculum of which suggests a more modern and possibly more exploratory approach to learning about science. The laboratory for country A could be somewhat traditional in its design, whilst that for country B might reflect the element of exploration through the provision of facilities for the children to construct models and experiment in their own way. Figure 8 provides examples of laboratory plans which respond to these different sorts of science curriculum content.

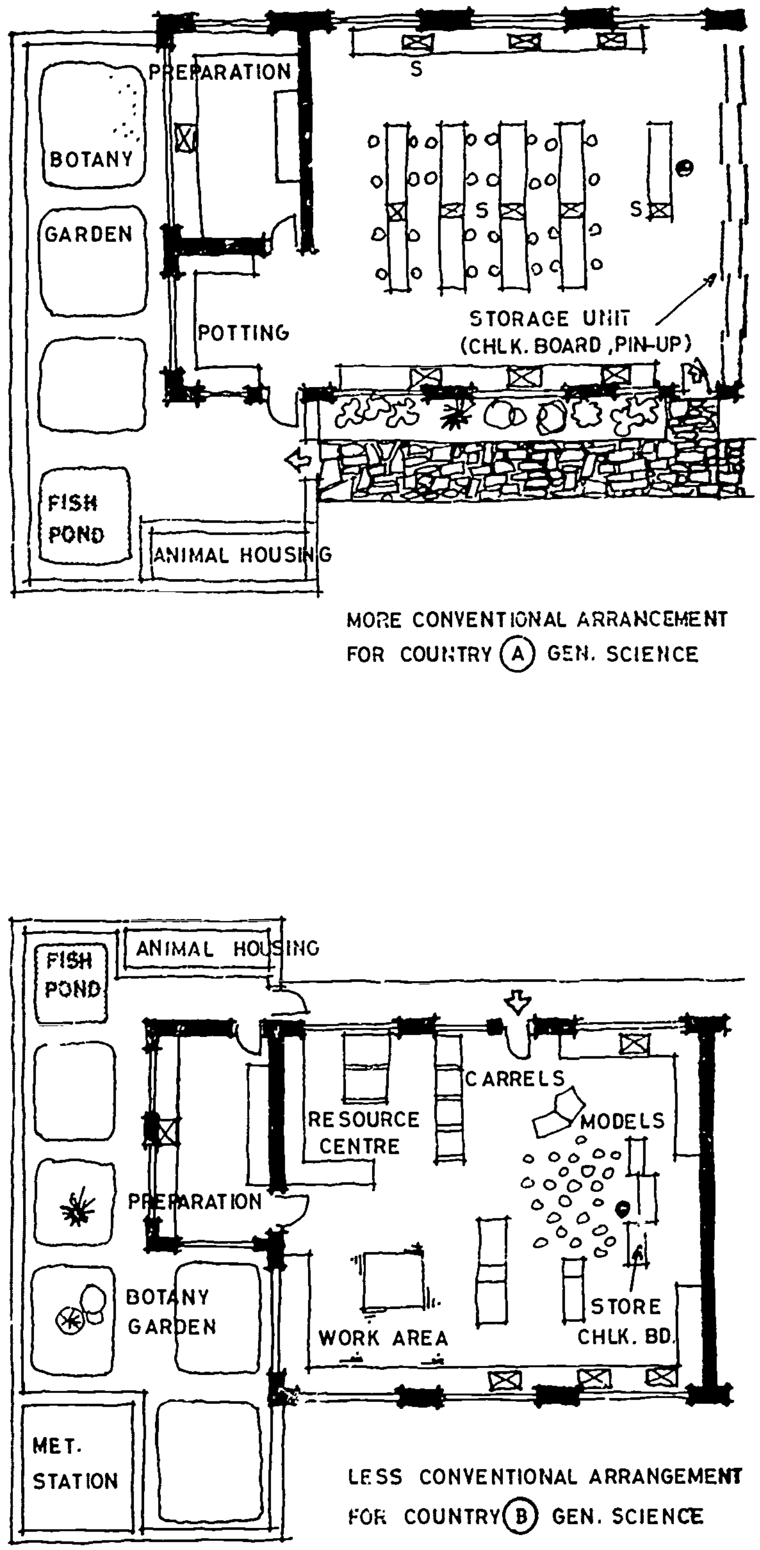
But a list of headings indicating the course content for science can give no idea *how* the subject is to be taught and learned, for this depends on the *methods* used.

1.03 Methods

The structure and content of education are the strategies designed by educational policy makers. Methods are the tactics used by the teacher in the schools to ensure effective child development through learning.

From the view-point of the designer, the structure of education affects the sort of school he is designing, its size and the age range of the children in it. The content of education, that is the curriculum, affects the organisation of the school and an understanding of it helps determine the sort of teaching and learning spaces to be provided. An understanding of *method* will enable the designer to arrange the spaces, their furniture and fittings in such a way that the teaching and learning processes can take place most effectively.

Learning may be cognitive – that is knowing or understanding; it may be affective – that is, it may result in the development of attitudes; it may be psychomotor – that is the learning of skills with the body or



MORE CONVENTIONAL ARRANGEMENT FOR COUNTRY (A) GEN. SCIENCE

LESS CONVENTIONAL ARRANGEMENT FOR COUNTRY (B) GEN. SCIENCE

FIG. 8

parts of the body such as the hands. In what ways can these apparently abstract concepts of child development be realised through teaching method and what connection, if any, has this with building design?

A well described example of method (1.5) freely adapted to illustrate the points made above, is provided by considering two separate approaches to learning through the construction of a model. The first approach is highly organised, the children sitting and watching the teacher demonstrate how each part is made and then copying each phase of the demonstration as it continues. A design for such a teaching situation is shown in Figure 9. The second approach, with another group of children, involves a brief introductory discussion with the teacher which arouses interest in model making, after which the teacher works *with* the children who are divided into sub-groups, in completing the model, each group working in its own (democratic) way. In this second approach, the teacher would move from group to group acting the role, not of a teacher, but of a co-worker. A design for such a teaching situation is shown in Figure 10.

A comparison of the outcome of these two different *methods* of approach to teaching and learning is interesting. The first group produced the best models but only worked when the teacher was present and very little spirit of group co-operation was observed. The second group showed initiative and a good co-operative spirit. Difficulties were solved in such a way as to get the model finished and moreover, not always in the manner that the teacher might have suggested. There can be little doubt that, in the cognitive and affective areas, the second group learned more than the first.

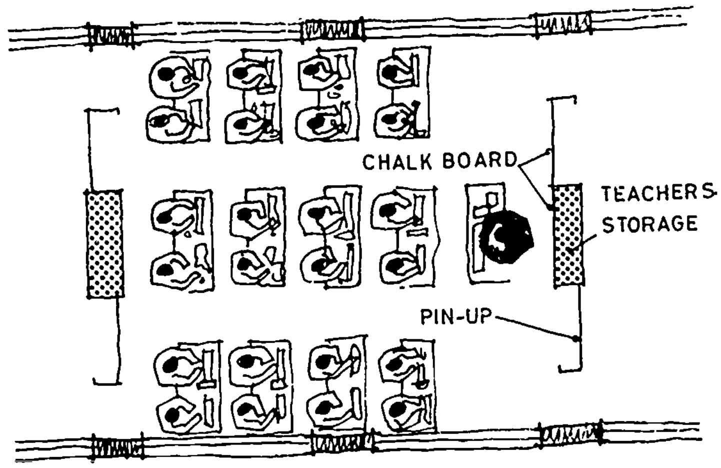
Desired psycho-motor development can also be assisted by design if the designer is well provided with data on the body sizes of children of all ages in the school, understands the principles of movement in relation to perception and the methods used for development in this domain.

The simplest examples will illustrate this point. A child of 4 to 7 years trying to construct a (straight) line on a table is less likely to succeed if working on a round table than on a table with straight edges. After 7 years the child is able to break away from the perceptual influence of the table (1.8). If the relationship between the form of the table and the perceptual problems of the child is recognized by the teacher and the designer, the right sort of table can be provided.

A more obvious example of the effect of design on the development of motor skills is illustrated in Figure 11.

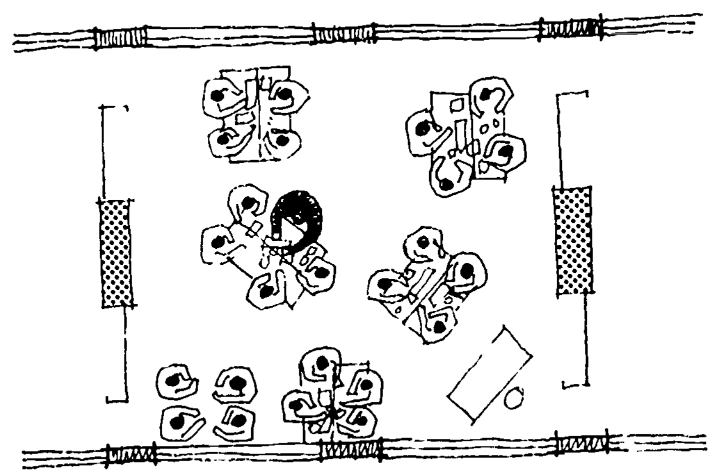
The effect of building design on perceptual development (in relation to vision, sound, texture etc.), a previously unexplored field, is now receiving increasing attention. Much that has been written by Bayes (1.9), and Larson (1.10); (1.11) and others, especially in the University of Utah, U.S.A., is relevant to this aspect of school design.

Of course, a classic approach to the methods of teaching, such as that described by Kochhar (1.12) would list two main approaches, namely the lecture or teacher-centric and the heuristic or pupil-centric method.



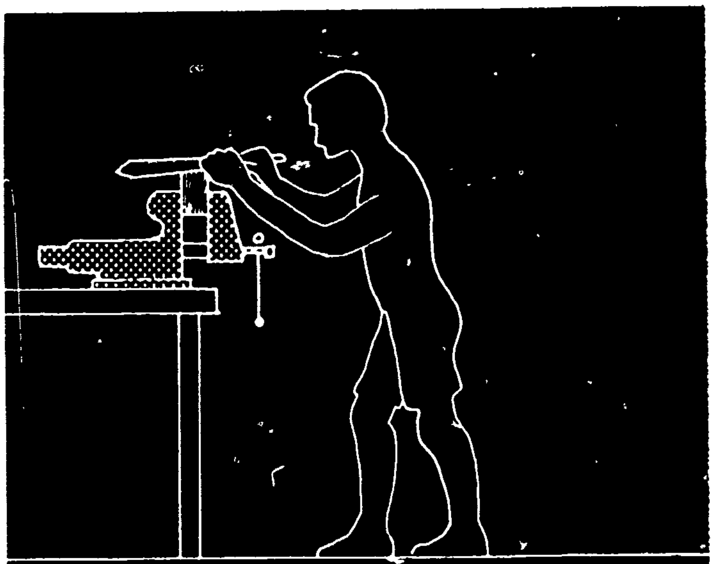
A FORMAL METHOD OF TEACHING - THE CHILDREN WATCHING & COPYING A DEMONSTRATION BY THE TEACHER.

FIG 9

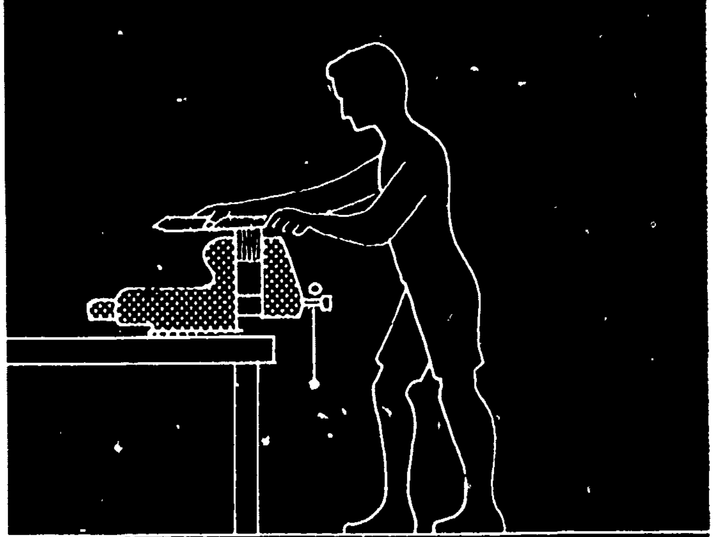


PUPIL CENTRED PROJECT WORK -
A LESS FORMAL APPROACH - THE TEACHER ACTING AS CO-WORKER

FIG. 10



TOO HIGH - DIFFICULT TO ACQUIRE DESIRED SKILL



CORRECT HEIGHT - MAKES ACQUISITION OF DESIRED SKILL EASY

FURNITURE DESIGN MAY ASSIST OR IMPEDE THE DEVELOPMENT OF SKILLS

FIG 11

The lecture method, with its built-in disadvantages is, unfortunately, widely used in the countries of the Asian Region today at both the first and second levels of education. (Plate 3). The lecture method may inhibit pupil participation in the learning process and assumes that all children learn at the same pace and have the same attitudes. Only the exceptional teacher is able to stimulate and maintain the interest of children through lectures and he or she, in so doing, will make great use of visual aids, question and answer techniques and discussions during the teaching session. In fact, the exceptional teacher will instinctively move away from the pure, one-sided lecture and try progressively to involve the children as individuals in the learning process. There is a strong connection between the examination-based systems of the countries of the region and the lecture method. The lecture is used by teachers because it enables them, in popular terminology, "to cover the ground" (prescribed in the syllabus).

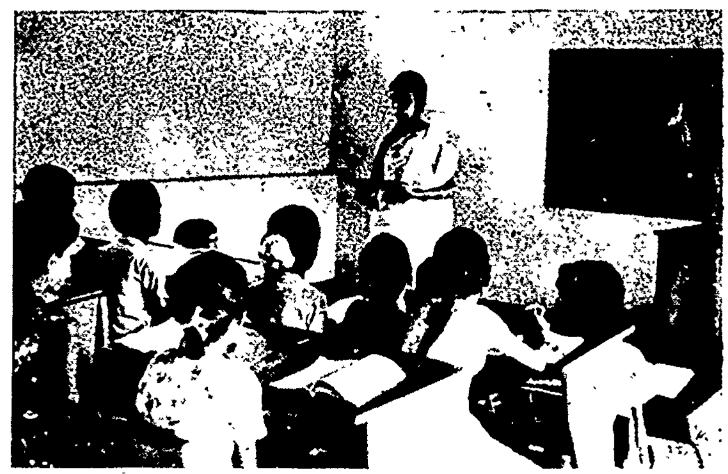


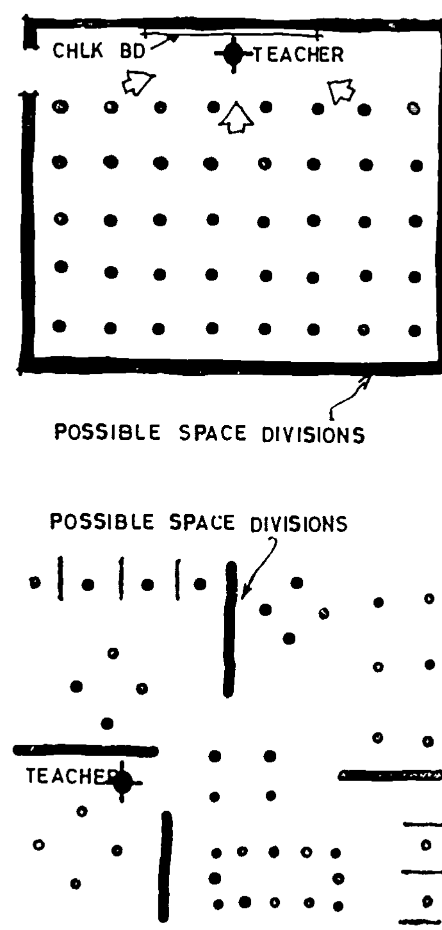
Plate 3

Most designers of schools today and for a few years to come, will have to provide facilities for teaching and "learning" by lectures. There are, however, encouraging signs of change in the methods currently in use in Asian countries (1.13). Radio and television, long used as educational media in India, Japan, the Philippines, Malaysia, Singapore and Thailand are increasingly coming to be recognised as important methods of teaching and learning. Programmed instruction has been introduced experimentally in the Republic of Korea, Philippines, Singapore, India, Pakistan and Ceylon. The main focus of these and other developments in method and educational technology, is their common characteristic of learner-centred use. The most developed methods of pupil-centric education in Asia are, however, in the areas of the sciences where for some while now, in the curricula of countries such as Ceylon, the Philippines and the Republic of Korea, problem-based methods have been tried out with success at the lower second-level of education.

The significance, for the designers of the introduction of these new ideas is in their emphasis on the learner as either an individual or as a member of a small group. This is shown dramatically in Figure 12 and suggests the need for the exercise of considerable imagination in designing to satisfy the needs of today whilst, at the same time, providing buildings that can be adapted for the newer methods of tomorrow.

THE COMMON PATTERN

ASSUME A GROUP OF 40 ARE HOMOGENEOUS, LEARN AT ONE PACE HAVE SAME ATTITUDES MAYBE SUCCESSFUL ON OCCASIONS IN THE HANDS OF A SKILLED TEACHER



THE COMING PATTERN

WORKING WITH GUIDANCE FROM TEACHER AND / OR TEACHING AID AS INDIVIDUAL OR IN SMALL GROUPS HETEROGENITY ASSUMED

FIG 12

1.04 Asian Education systems as seen by the designer

The purpose of this chapter has been to highlight some of those aspects of education, an understanding of which may, to a greater or lesser degree, help the designer. Figure 13 summarises, strictly from the designer's view point, the main features of the education of the region as they are today. Figure 14 suggests, from the same point of view, one of the possible education systems that might be found in the region, a decade or more in the future.

For the *present*, the main aim of the designer must be to provide the best possible physical facilities for *present* educational needs. This means concentration on simple things such as providing enough chalk board, and providing it at the right height and in the right position, providing desks and chairs that are of the right size and comfortable enough to make the achievement of the basic psycho-motor skills of reading and writing easier rather than difficult. If this alone can be done then a great leap forward will have been taken.

THE 3 SUB-SYSTEMS OF A TYPICAL EDUCATION SYSTEM IN ASIA – 1972

ATTRIBUTE	PRIMARY	LOWER SECONDARY	UPPER SECONDARY	ATTRIBUTE
SIZE				SIZE
DURATION OF EDUCATION IN YEARS	0 – 6	0 – 3	0 – 2	DURATION OF EDUCATION IN YEARS
NUMBER OF SUBJECTS STUDIED	MANY SUBJECTS	FEWER SUBJECTS	STILL FEWER SUBJECTS	NUMBER OF SUBJECTS STUDIED
PUPILS PER CLASS	≯ 50 & ≮ 40	≯ 45 & ≮ 35	≯ 40 & ≮ 30	PUPILS PER CLASS
CORE SUBJECTS	ALL	CORE 64 % ELECTIVE 36 %	CORE 14 % ELECTIVE 86 %	CORE SUBJECTS
MEDIUM OF INSTRUCTION	LANGUAGE A B C D	LANGUAGE A B C	LANGUAGE A B	MEDIUM OF INSTRUCTION
EXAMINATIONS	TERMINAL	TERMINAL	TERMINAL	EXAMINATIONS
PUPIL TEACHER RATIO	1.1 TO 1.2 PER CLASS	1.3 TO 1.4 PER CLASS	1.4 TO 1.5 PER CLASS	PUPIL TEACHER RATIO
INSTRUCTION	38 TO 44 PERIODS	44 PERIODS	44 PERIODS	INSTRUCTION
SIZE OF CHILDREN				SIZE OF CHILDREN

FIG. 13

A POSSIBLE ASIAN EDUCATION SYSTEM TOWARDS THE END OF THE CENTURY				
ATTRIBUTE	PRE-SCHOOL & PRIMARY	SECONDARY	FURTHER OR LIFELONG	ATTRIBUTE
SIZE				SIZE
DURATION OF EDUCATION YEARS	0 PRE-SCHOOL 8 PRIMARY	0 6 NO GRADES - INDIVIDUAL OR SMALL GROUP PROGRAMMES	0 FORMAL 4 0 FURTHER 60	DURATION OF EDUCATION YEARS
NUMBER OF SUBJECTS	FEWER THAN PREVIOSLY BUT BETTER CO-RELATED IN CONTENT	VERY MANY MORE THAN PREVIOUSLY & OF GREATER RELEVANCE	UNLIMITED	NUMBER OF SUBJECTS
PUPILS PER CLASS	GROUPS OF 20 30 0 30	INDIVIDUAL COURSES FOR INDIVIDUALS; TEACHING IN TEAMS; GREATER USE OF KNOWLEDGE OF GROUP DYNAMICS		PUPILS PER CLASS
SUBJECTS	COMMON SUBJECTS FOR MOST STUDENTS	MULTI-MEDIA PACKAGES WITH VARIED CONTENT FOR INDIVIDUALS & GROUPS		SUBJECTS
PUPIL - TEACHER RATIO	PROBABLY NOT MUCH CHANGED BUT TEACHERS DIFFERENTLY ORGANISED AND SUPPORTED BY MEDIA			PUPIL - TEACHER RATIO
INSTRUCTION PER WEEK	PROBABLY SLIGHTLY MORE		VARIABLE BUT WILL ENSURE COMPLETE USE OF ACCOMMODATION	INSTRUCTION PER WEEK
SIZE OF PUPILS				SIZE OF PUPILS

FIG. 14

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Chapter 2

THE EDUCATIONAL BRIEF

2.01 General

Brief writing depends on how the matter is viewed. The *Educational Brief* or *Educational Specification*, as the document is sometimes called, is the educationist's description of the school required. In most cases, the designer, on reading the brief, may decide that he has a number of questions to ask to supplement the information given. From the designer's view-point, this gives rise to the idea of a *User Requirement Study*. Ideally, of course, both documents would be identical. This chapter will discuss methods of communication between the educationist and the designer, from both points of view and, in so doing, stress that, without adequate communication, it is most unlikely that the end product, that is the school, will be wholly suitable for the purpose for which it is intended.

The scale of school building operations in most countries of the Asian region is so large and the technicians available for design so small in number, that the use of standard designs for primary and secondary schools is the only practical way of ensuring that building programmes can be effectively implemented. Even so, many instances could be cited where, despite the standardisation of designs, working drawings and building specifications, it has proved impossible to spend the sums allocated for school building during the financial year.

Significantly enough, in the few countries where there are substantial numbers of private schools, the architectural professions are well developed and it is still the practice to design the individual school building.

Whatever the situation – and it may be thought more critical where there are hundreds of units to be built – there is a need, at some stage or other, for the educationist to communicate his requirements for a new school, or schools, to the designer.

The first, and perhaps the most vital judgement that has to be made in connection with the preparation of the Educational Brief or User Requirement Study, concerns the amount of information that is to be either provided by the educationist or acquired by the designer. Obviously it is optimally desirable for the communication to contain everything necessary for the design of the school.

The list in Appendix I indicates, by way of subheadings, the sort of information that might be communicated in a comprehensive Educational Brief. (2.1) Appendix II shows one of the charts from a comprehensive User Requirement Study. (2.2)

Where there are educationists able and willing to participate in the preparation of such documents and designers with the time and skill to assimilate and use the material, then the writing of a comprehensive brief should obviously be undertaken. Smith (2.3), however, raises a very pertinent issue in relation to the outcome of using documents of such complexity in another, not dissimilar context. "the procedural charts devised by the author intimidate the designer and lead him to abandon his own common sense and judgement for the complexities of the author's discipline. In this way, the systematic method defeats the end it was originally intended to serve – the production of good design".

Some examples of Educational Briefs that have, as far as is known, not intimidated the designer, are given in the list of references at the end of the chapter, (2.5; 2.6; 2.7; 2.8). The documents are respectively, 384, 177, 208 and 254, printed pages long.

O'Reilly (2.4) raises another related issue in a case study of briefing and design where a large design agency, probably as large and as well staffed as many Public Works' architects departments in the countries of the Asian Region, was commissioned to design for a large local authority. Despite the preparation of an elaborate brief by the authority and subsequent further study of the user's requirements by the designer, "... there existed:

(a) Important and extensive client (the local authority) uncertainties and disagreements about objectives...;

(b) No clear line of effective client authority;

(c) Considerable pressure from sections of the client to rush briefing and design work, despite a lack of resources and client preparation.

...Although it is realised that this study represents only one case, there are indications from a variety of other sources, that the kind of problems and impasse experienced in this case may be fairly widespread."

There are thus two problems that might arise in connection with an Educational Brief, the first resulting from excessive complexity and the second from possible unreliability as a document which truly represents the client's requirements. The second point is of considerable relevance in the school building field for a school has many different users (or clients) – principals, students and teachers of geography, languages, biology, metalwork, woodwork, ceramics, agriculture – to name but a few. It seems unlikely that any single individual could write an Educational Brief which adequately reflects the requirements of such a wide variety of teaching interests.

Whilst the interests of educationists should be mutually compatible, experience shows that there are often quite sharp differences of understanding at the various levels of the education hierarchy as to the physical facilities required.

At the directorate level the need for new schools will have arisen as a result of the preparation of an educational plan. The locations of the new schools may be decided using demographic data, information on the location of existing schools and in response to political pressures. Resources budgeted for new buildings will also affect decisions at this level.

The communication from the Education Ministry to the Public Works or other Ministry responsible for design may say little more than, "please design a new school on a site acquired at Y (site drawing enclosed) for 560 children from grades 6 to 10. Enclosed please find the curriculum for these grades and notes on pupil-teacher ratios. The maximum cost is to be Z. Requests for any further information should be addressed to the undersigned".

A preliminary calculation of the accommodation schedule (using the methods shown in chapter 3) may show that for 560 children, the utilisation of the science laboratory workshop and home science room may be very low – perhaps only 40%. By increasing the population of the school to 720, the utilisation of these spaces can be raised to 70%. Alternatively a multi-purpose room can be provided for these subject areas with high percentage utilisation if the population remains, as originally specified, at 560.

If, at Directorate level, it is decided to build the school for 560 children, the designer is faced, at the lower level, with the subject inspectors or education officers who may be opposed to the provision of multi-purpose facilities for teaching special subjects such as science, woodwork and home science.

At the level of the Principal, other problems may arise. With a population of 560 children, grade 10 may be very weak due to drop-outs. The Principal may argue that as he has a new school with facilities for grade 10 teaching not available in nearby schools, his grade 10 should be strengthened by drawing off children from other schools in the vicinity. He may be supported in this by the Inspectorate and, perhaps opposed by the officials at Directorate level. The Principal may also want a canteen, kitchen and room for extra-curricular activities – none of which can be afforded within the limits of cost, prescribed by the Directorate.

The teachers will, of course, be mainly concerned with the detailed arrangements of facilities within the teaching spaces and some may have such unique and even eccentric views that reference to the Inspectorate may become necessary. A common complaint at this level is that of the specialists (geography, music and art teachers) who urge, reasonably, that special rooms be provided in which to teach their subjects.

The designer thus faces a variety of educationists at different levels and with different interests in the end product that he is called upon to design. (Figure 15)

Experience shows also that certainty as to the needs decreases progressively up the hierarchical table. A teacher of home science is usually very much more certain that she needs a cooker for classes in foods and nutrition than is a Director of Education that he needs a school for a precise population of 560 in an area where the demographic data are unreliable and the political pressures to provide a school are strong.

Figure 16 shows the interests of the various officials who will usually be involved in the preparation of the Educational Brief.

Both the Educational Brief and the User Requirement Study are nothing more than a communication between educationists and the designer.

The communication may be verbal or written. It has already been suggested above that in most countries of the region there is neither the time nor, often, the expertise to prepare a comprehensive document.

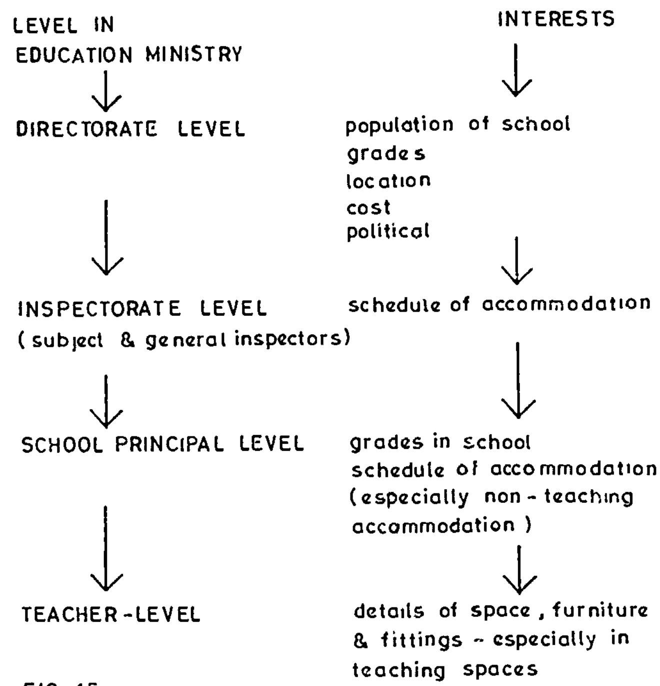

FIG 15

If the brief is to be anything other than comprehensive, and if it is accepted that comprehensive brief writing is unlikely to become a common practice associated with all school building in the Asian Region in the foreseeable future, then some decision has to be taken on which of the elements of the brief are to be communicated in writing and which are to be communicated verbally.

It would seem logical to write down the user requirements that are less easily agreed. These include the items listed in Figure 16. The more easily agreed items in this list will be seen to be matters of detail – none the less important – which depend on the matters of principle at the head of the list. Thus the size, cost, and location of the school are matters of primary importance and should be included in the written brief, together with schedules of accommodation. All other matters can be agreed verbally as design work continues.

The importance of communicating matters of principle in writing is underlined by the fact that, in some Asian countries, there is a high rate of turnover of senior officials at the decision making level and, if matters of principle are incorporated in the brief as they are agreed, then at least a starting point for discussion with the most recently appointed official will have been established.

The whole question, it should be reiterated, is not one of alternatives in respect of the material to be communicated, but rather of selecting the appropriate *mode* of communication.

The elements of the brief that might be communicated in writing and verbally, are shown in outline in Table II.

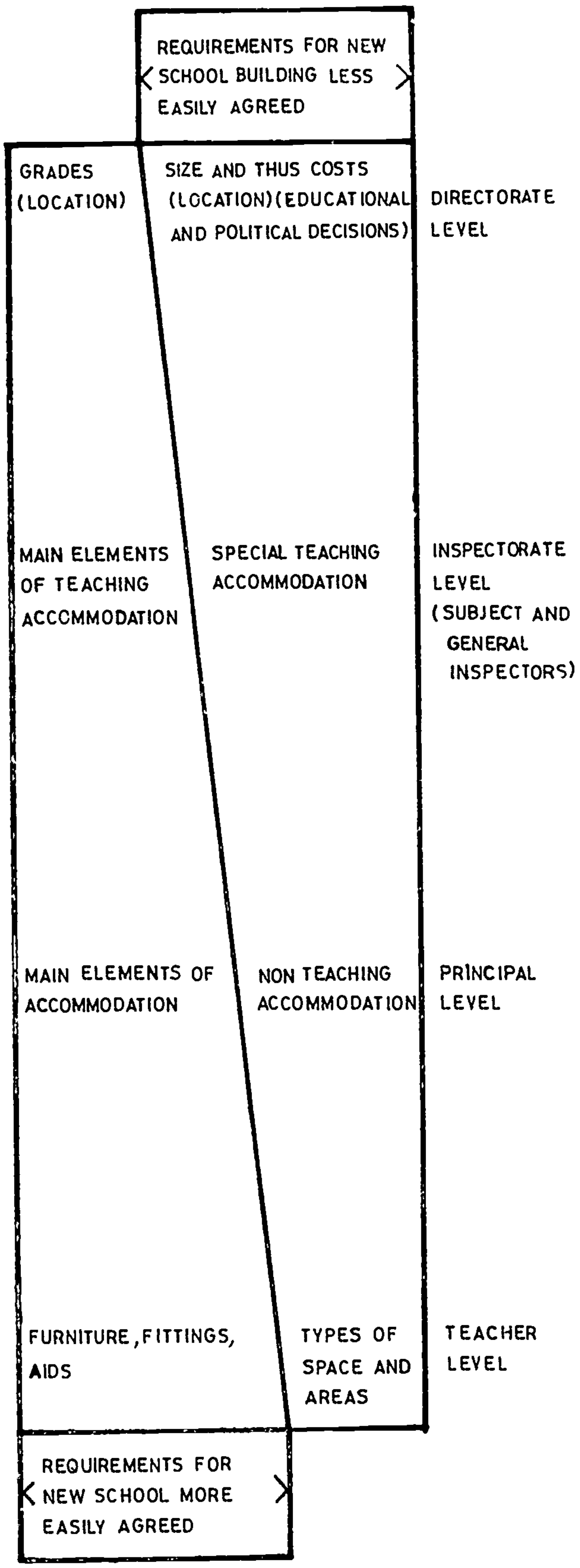

FIG. 16

TABLE II

THE BRIEF - ELEMENTS TO BE COMMUNICATED IN WRITING AND VERBALLY

	Communicated in a Document
1. LOCATION	(a) Location of site with catchment area (b) Site plan (c) Site sections
2. ESTIMATED POPULATION OF SCHOOL BY AGE AND GRADE	(a) Calculated using census or other data (b) Using data provided by the client (The two should agree – they often don't.)
3. THE EDUCATIONAL PROGRAMME OF THE SCHOOL	For primary schools this is easily obtained. For Secondary schools offering elective subjects a decision may be more difficult to elicit.
4. SCHEDULE OF ACCOMMODATION	(a) For teaching areas (b) For non-teaching areas
5. COST PER PLACE OR COST PER UNIT AREA OR TOTAL COST	(a) Should be stated by the Ministry, but (b) is more often than not told to the Ministry by the designer.
6. AREA PER PLACE	ditto (5)

Communicated Verbally

All other matters (the designer may take notes – the sketch drawings providing a supplementary means of communication).

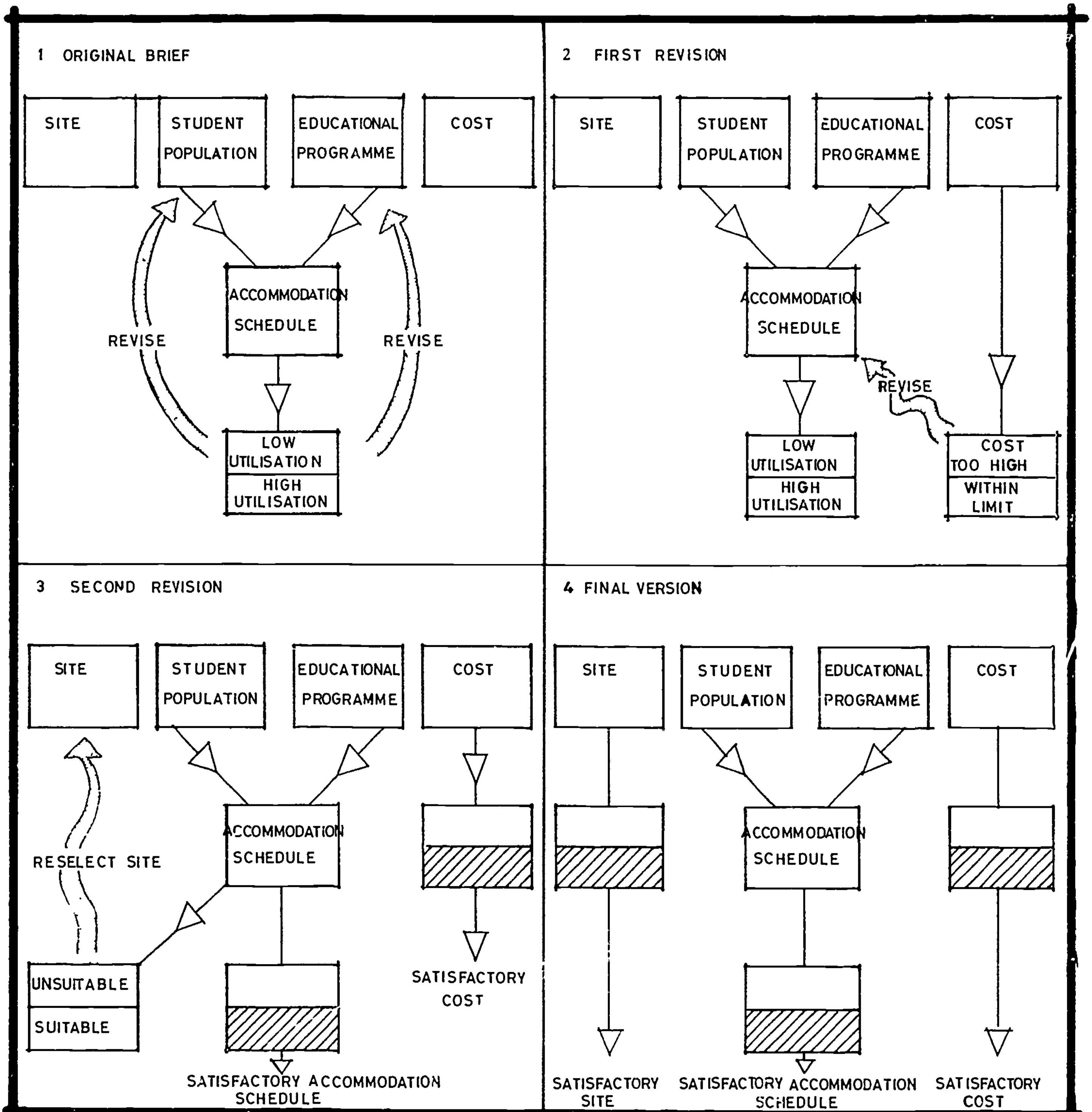

FIG. 17

The Educational Brief document, which need not exceed from 10 to 15 pages in length, will almost certainly be revised two or three times before both educationists and the designer are satisfied with the final version. The process leading to this version is shown diagrammatically in figure 17. The chances of being able to proceed with design on the basis of the original brief are usually remote, as the figure suggests. A final brief for a school in one of the countries of the region is shown in Appendix III. All other information required in connection with the design of the school to working drawing stage can be successfully communicated verbally.

2.02 The Brief and Standard School designs

The discussion in the first part of this chapter relates to the design requirements for an individual school. Most countries of the region, however, use standard designs for school buildings as this is the easiest way of handling a large volume of work with a very small staff.

The idea of *standardisation* of design suggests two possibilities for raising the inherent quality of the standard building solution. First, because only one design is sought, it should be possible to devote much more time to it than would be the case where many different designs are required. A design staff, however small, should be able to work intensively on what in many situations will be the *only* design work in an office in which, for most of the time, the main concern is with locating standard buildings on sites and organisation of building contracts.

The second possible virtue of standardisation in respect of the quality and the costs of building is the in-built opportunity for continued *evaluation* of what is built, paid for and used.

Standardisation of design (which, of course, is *not* to be confused in any way with industrialisation of buildings, prefabrication, modular co-ordination etc.,) results, not only in the repeated construction of whole buildings, identical in pattern, but also in the repeated construction of every single element and repeated use of every single component of the elements. The implication of this is well illustrated by an example from part of a standard school building, the design for which has been used hundreds of times in one country of the region. Figure 18 shows three of the many ways in which a timber roof truss can be designed to span, in this case, a 6 m wide classroom. For years, the truss actually used was the King Post which requires the greatest quantity of timber to construct. Lately, a cost evaluation has shown the obvious economies of the light-weight truss which also, of course, meets the strength and other criteria. Considerable savings could be made as a result of the evaluation as long as the standard design, of which the truss forms a part, continues to be used.

Sometimes, of course, change resulting from evaluation is more difficult to bring about. The Building Regulations of a Municipality in a country of the region require corridors in all public buildings, including schools, to be not less than 2.44 m wide, whereas from a design view-point the width of corridor required at most points in the schools is 1.83 metres.

This represents, for all the new schools that are being built, a considerable waste of space and money.

The familiarity of the design technician with building costs frequently results in this aspect of evaluation receiving most attention. Educational evaluation is less frequently undertaken, if for no other reason than that of the lack of communication between designer and educationists mentioned earlier in this chapter. The most common ways of effecting changes in design to achieve improvements in educational amenity are, at best, informal contacts between the Inspectorate and the designers in the Ministry. As yet there is little evidence in the Asian Region of educationists applying the discipline of evaluation, used for teaching and learning material, to the buildings designed to house the resulting teaching and learning activities.

In fairness, it should be said that the concept of building evaluation is of recent origin and that the work of the Building Performance Research Unit of Strathclyde University, Scotland (the basis of the evaluation methods of which is briefly explained in 2.9) a unique organisation in this field, first began to be published in the late 1960's. This activity, it will be noted involves a special unit, set up for the purpose, in a University, as well as the use of a computer. (2.10, 2.11).

More appropriate in the Asian regional context would, perhaps, be the institution of annual or bi-annual building design review committees, the members of which would include representatives of all those concerned with school building from designers to users.

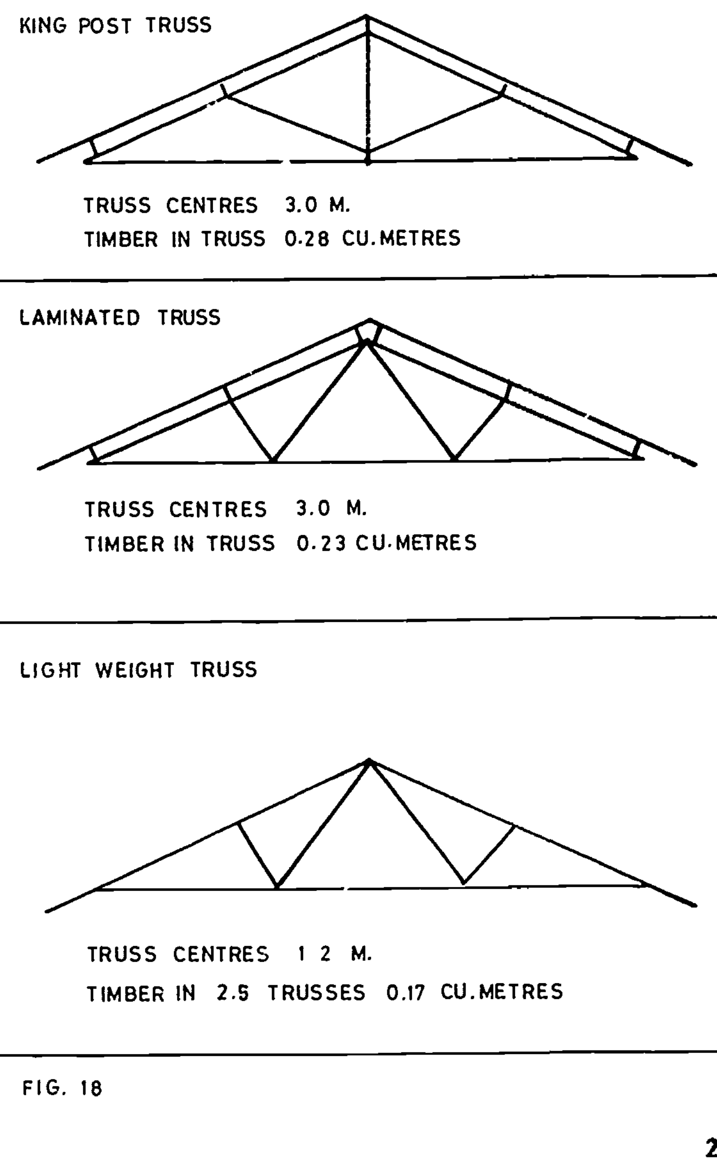

FIG. 18

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Chapter 3

ACCOMMODATION SCHEDULES AND THE SIZE OF THE SCHOOLS

3.01 Some General Considerations

The factors affecting the size of a school are many and complex. They involve consideration of school organisation, economic use of accommodation and teachers, the numbers of children in the school catchment area, economic use of equipment and the somewhat more nebulous, though no less important, concept of the school as a social unit.

These somewhat functional aspects need, moreover, to be considered in the social and political context of the country, province or locality in which the school is built. For example, where the catchment area is very strictly defined and the residential qualifications of the children can be verified as genuine, then a good school designed for, say, 800 children will have an enrolment of that number. When control is less positive, then a school designed for 800, which has achieved a reputation for the quality of the education it offers, may be found to be occupied by perhaps upwards of 1,600 children, many of them registered at addresses of convenience in the catchment area but, in fact, residing outside it. Political pressures may also be brought to bear on the heads, particularly of good urban schools, to admit children resident outside the catchment area. "Education, it should be remembered,... is largely within the realm of administrative politics." (3.1) also (3.2). As, slowly, the enrolment of the school increases far above its designed capacity, the quality of education offered in such conditions seems likely to drop.

This is rarely understood by parents. "... families will not take no for an answer when they are convinced that children need at least a (secondary) education to rise in the present world." (3.3).

The business of educationists and architects is to foresee the social and political contingencies and to recognise them as having, often, at least as important a bearing on the size and the design of the school as the more easily appreciated factors outlined in the first paragraph of this chapter.

An example of the application of the understanding of such a contingency is illustrated in figure 19 which shows an appreciation of the fact that the population of the school is likely to expand, necessitating the use of the buildings for two sessions or shifts each day. The disturbance to the children of the first shift, likely to be caused by the early arrival of the children of the second, has been anticipated by the provision of a quarantine area in which the second shift can wait until their session commences. The design also shows an understanding of social conditions, for some of the children of both shifts who live in houses where conditions are not conducive to study outside school hours, are able to remain in the quarantine area to read and do their "homework".

3.02 The Schedule of Accommodation - General

The accommodation of most schools comprises spaces for which a use is programmed and others for which no special programme is arranged. Thus a classroom, laboratory, workshop or library are spaces for which a use is programmed and toilets, corridors, staircases and canteens are spaces which are not usually programmed for use at special times. Sometimes a distinction is made between "teaching" and "non-teaching" spaces. As a child may learn health habits as part of the health education programme in the toilet or the canteen, the distinction may not always be valid and thus the terms "programmed" and "non-programmed" are preferred.

The other advantage of the concept of programming arises from the possibilities of economic utilisation. Programming can be arranged for *maximum* utilisation of spaces and waste of capital expenditure on spaces with low utilisation can be avoided.

Two of the many important qualities of spaces programmed for education are, *capacity* and *time*. A space may have a *capacity* of 20 children for some particular activity, some activities, however, require more space per child than others; for example teaching and learning history may need 1.2m² per pupil place; teaching and learning biology may need 2.5m² per place.

Thus, a space for history for 20 children would be 24m² a space for biology for 20 children would be 50m².

The concept of capacity is illustrated in figure 20.

If there are 40 periods in a week, then there are 40 separate periods of time for which *one* teaching space (e.g. a classroom) can be used. Each of these periods of time is called a *space period*. One space can be used for 40 separate periods in a week. Figure 21 shows the availability of the *same* space for each of the 40 periods.

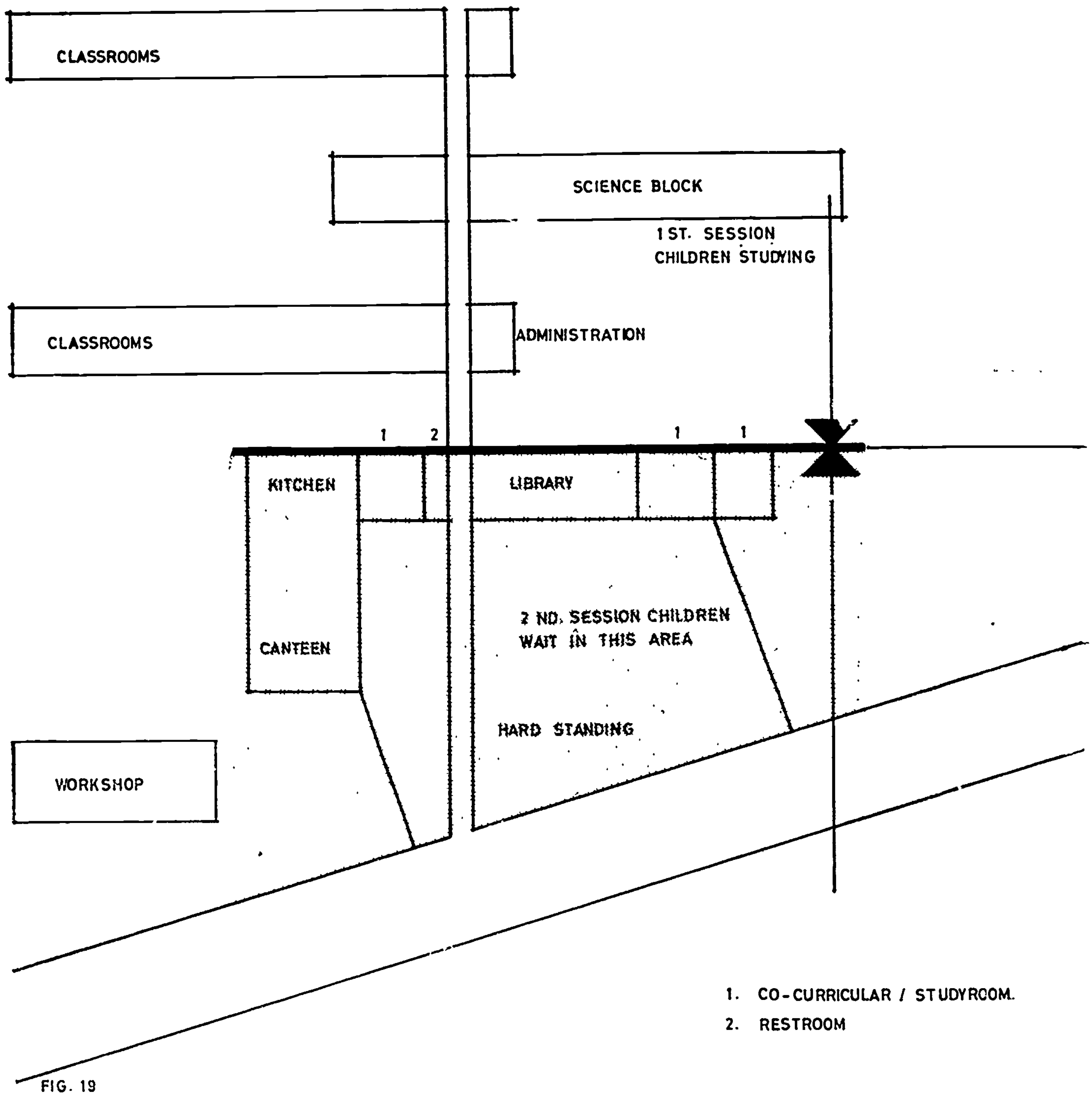
In a medium or large sized school, it is impossible (without the assistance of a computer) for the headmaster to programme or time-table the use of all the spaces for all of the time.

Experience shows that, at most, 90% of the classroom space periods can be utilised.

Thus of the 40 periods for which a classroom is available, $\frac{90}{100} \times 40 = 36$ space periods are utilisable.

Experience also suggests that special rooms such as workshops and laboratories where equipment has to be prepared, put out and cleared away, have an optimum utilisation of 75%.

Thus of the 40 space periods for which a special room is available, $\frac{75}{100} \times 40 = 30$ space periods are utilisable.


CLASSROOMS
SCIENCE BLOCK
1 ST. SESSION
CHILDREN STUDYING
CLASSROOMS
ADMINISTRATION
1
2
1
1
KITCHEN
LIBRARY
2 ND. SESSION CHILDREN
WAIT IN THIS AREA
CANTEEN
HARD STANDING
WORKSHOP
1. CO-CURRICULAR / STUDYROOM.
2. RESTROOM
FIG. 19

The way in which the needs for programmed spaces can be calculated is illustrated by reference to a specific situation. Consider a school having grades 6,7,8 and 9. Each grade has only one "class", "section" or "teaching group" and the school has thus four "classes". The curriculum for all grades is the same, as follows:

		Periods per week
1. Religion*	..	2
2. First language*	..	6
3. Second language*	..	6
4. History*	..	4
5. Geography*	..	4
6. General Science	..	5
7. Mathematics*	..	5
8. Physical Education	..	2
9. Vocational subjects	..	6
Total	..	40 periods per week

The subjects marked with an asterisk(*) will be taught in classrooms, general science in a laboratory, vocational subjects in a workshop and physical education on the site.

The spaces needed can be calculated as shown below:

(a) Classrooms

Subject taught in (a) Classrooms	*Periods per Week (b)*	*Number of Groups (c)*	*Space Periods Needed (b x c)*
Religion	2	4	8
First language	6	4	24
Second language	6	4	24
History	4	4	16
Geography	4	4	16
Mathematics	5	4	20
	Total space periods		108

One *classroom* has 36 *utilisable* periods per week (see above). Thus the number of classrooms (or spaces) needed is:

$$\frac{108 \text{ space periods}}{36 \text{ periods}} = 3 \text{ spaces (or classrooms)}$$

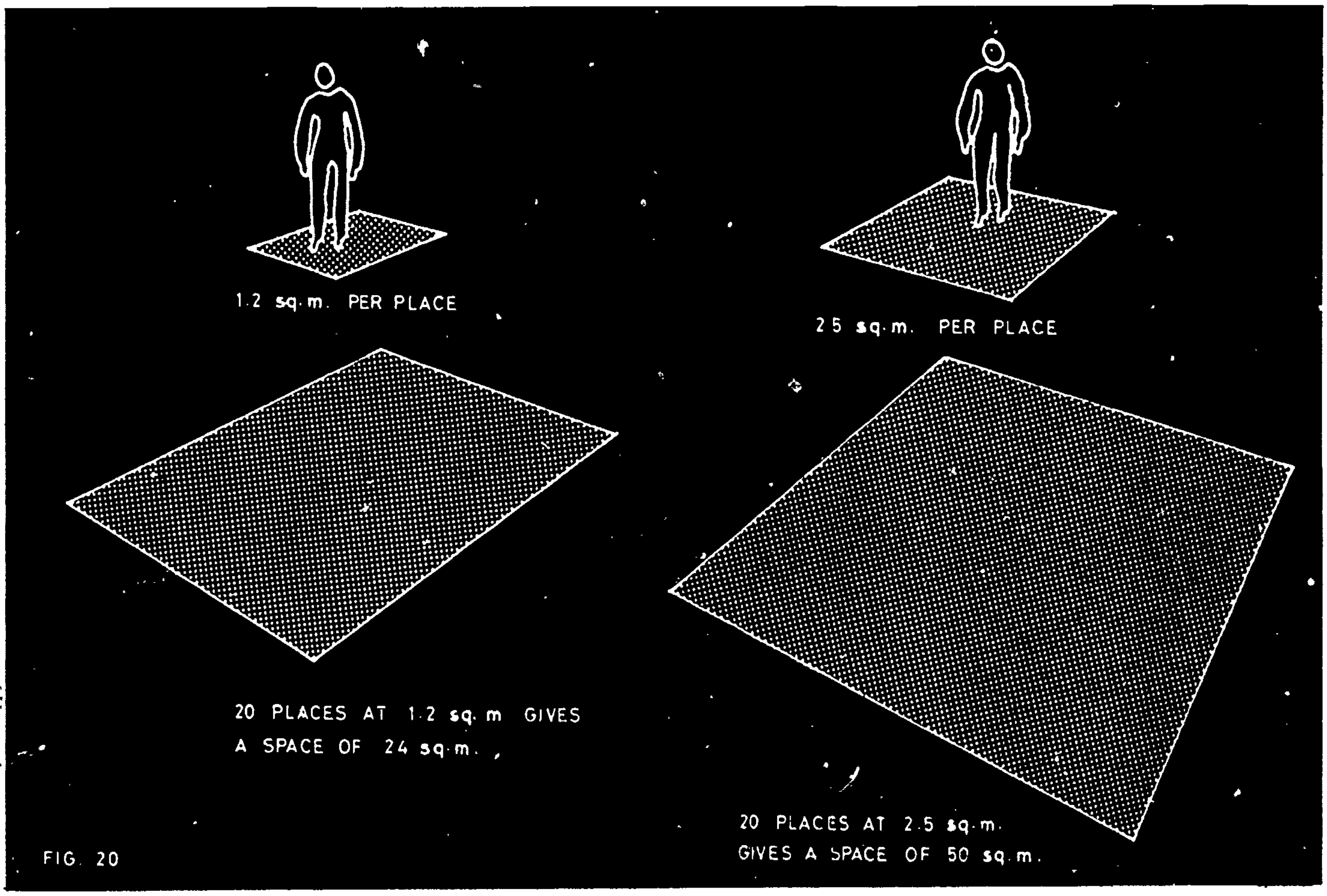


FIG. 20

(b) General Science Laboratory

Science: 5 periods per week x 4 teaching groups
= 20 space periods

30 utilisable periods are available in one week in one science laboratory. (see above – 75% utilisation is the most that can be achieved)

Thus the number of general science laboratories needed is

$$\frac{20 \text{ space periods}}{30 \text{ periods}} = 0.66 \text{ spaces.}$$

Clearly it is not possible to provide *less than one* space (unless general science is coupled with some other activity) and, thus, one general science laboratory will have to be provided. Its utilisation will be

$$\frac{20}{30} \times 100 = 66\%$$

of that possible.

(c) Workshops (Vocational subjects)

Vocational subjects 6 periods per week x 4 groups
= 24 space periods.

Number of workshops needed is given by

$$\frac{24 \text{ space periods}}{30 \text{ periods}} = 0.80 \text{ spaces}$$

One workshop will be provided having a utilisation of 80% of that possible (i.e. 80% of 30 periods).

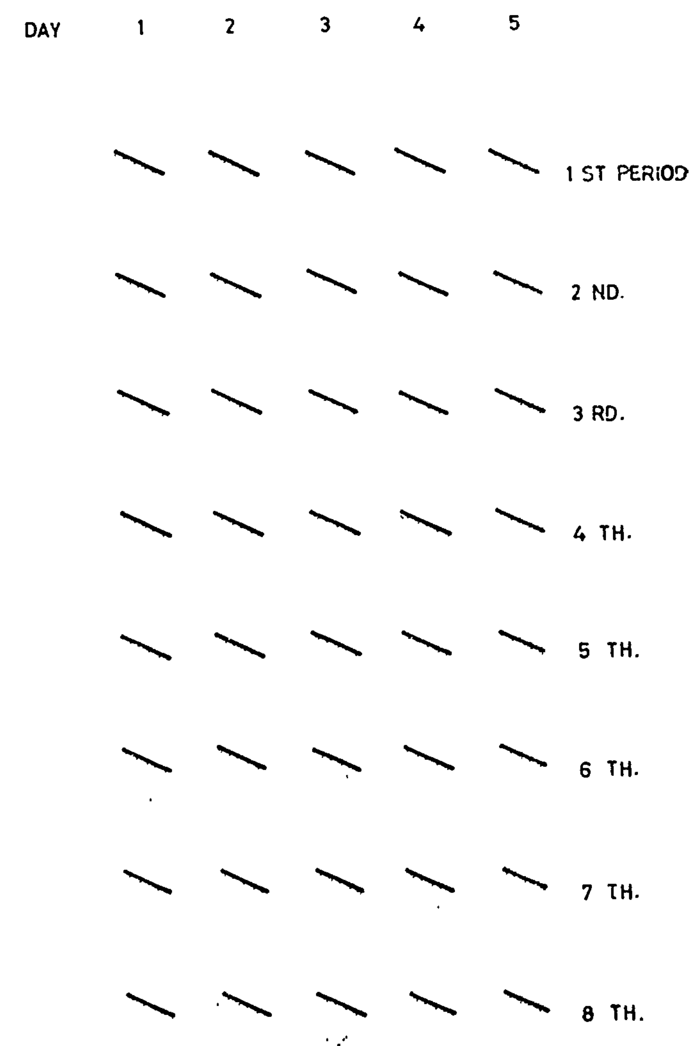
The total accommodation, the use of which can be programmed, is shown in figure 22. As there are only four teaching groups – grades 6,7,8 and 9, and there are 5 spaces, it is evident that, at any one time, only 4 spaces will be utilised. When one group has physical education, only 3 of the spaces will be in use.

A traditional type of accommodation schedule for such a four class school would include a classroom for each class, a laboratory and a workshop. This would result in two spaces *always* being empty (figure 23).

But utilisation of teaching spaces is not always the same as that of the four grade school, the accommodation requirements for which have been calculated above.

Consider the same curriculum but a different class structure which reflects the wastage discussed in chapter 1 (see figure 5).

Grade		*Groups in grade*
6	..	6 a 6 b 6 c 6 d
7	..	7 a 7 b 7 c
8	..	8 a 8 b
9	..	9 a 9 b
Total	..	11 Teaching Groups



THE AVAILABILITY OF A SINGLE SPACE DURING <u>ONE</u> WEEK OF 40 PERIODS

FIG. 21

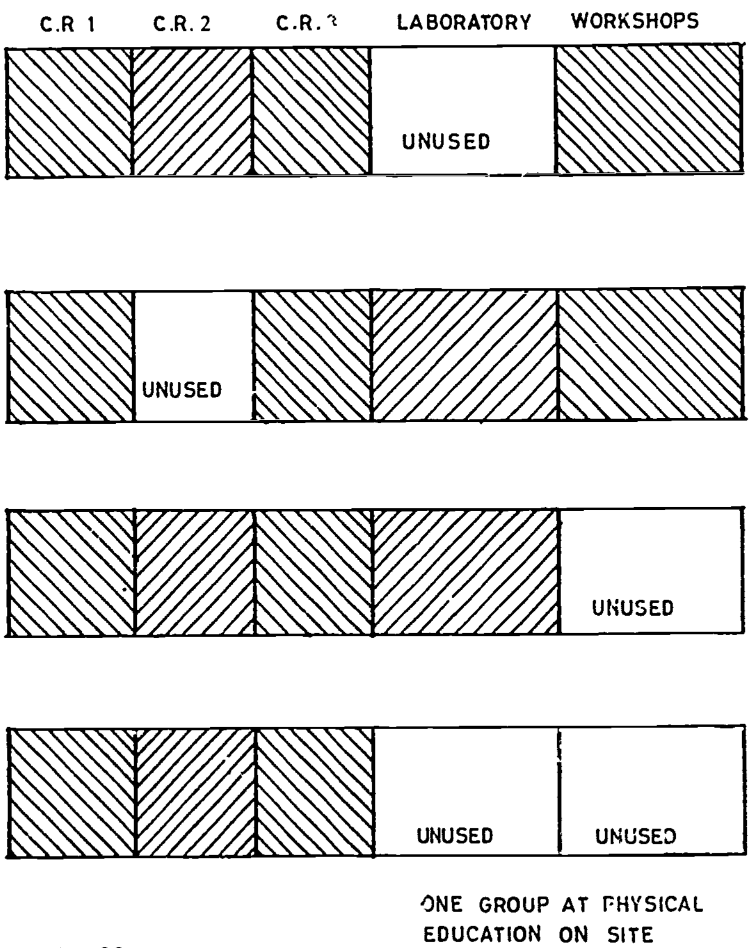


FIG. 22

The calculation for classrooms is as follows:

TABLE III

Subject (a)	*Periods per Week (b)*	*Number of Groups (c)*	*Space Periods needed (b x c)*
Religion	2	11	22
First Language	6	11	22
Second Language	6	11	66
History	4	11	44
Geography	4	11	44
Mathematics	5	11	55
Total space periods			297

One *classroom* has 36 utilisable periods per week. Thus the number of classrooms (or spaces) needed is:

$$\frac{297 \text{ space periods}}{36 \text{ periods}} = 8.3$$

9 spaces (or classrooms) would be provided.

The requirements for *general science* are calculated as follows:

$$\frac{5 \text{ periods per week}}{11 \text{ teaching groups}} = 55 \text{ space periods}$$

30 *utilisable* periods are available in one week in one science laboratory. Thus the number of laboratories needed is:

$$\frac{55 \text{ space periods}}{30 \text{ periods}} = 1.83 \text{ spaces}$$

Two laboratories, if provided, will have a utilisation of:

$$\frac{66 \times 100}{60} = 91\%$$

The number of *workshops* needed is given by:
6 periods per week x 11 groups = 66 periods. 30 utilisable periods are available, per week in one workshop. The number of workshops needed is thus:

$$\frac{66 \text{ space periods}}{30 \text{ periods}} = 2.2$$

Three workshops, if provided, will have a utilisation of:

$$\frac{66 \times 100}{90} = 73\%$$

which is rather low.

It will be seen from the above calculations of accommodation needs, that the utilisation, percent, fluctuates as the number of teaching groups in a school increases.

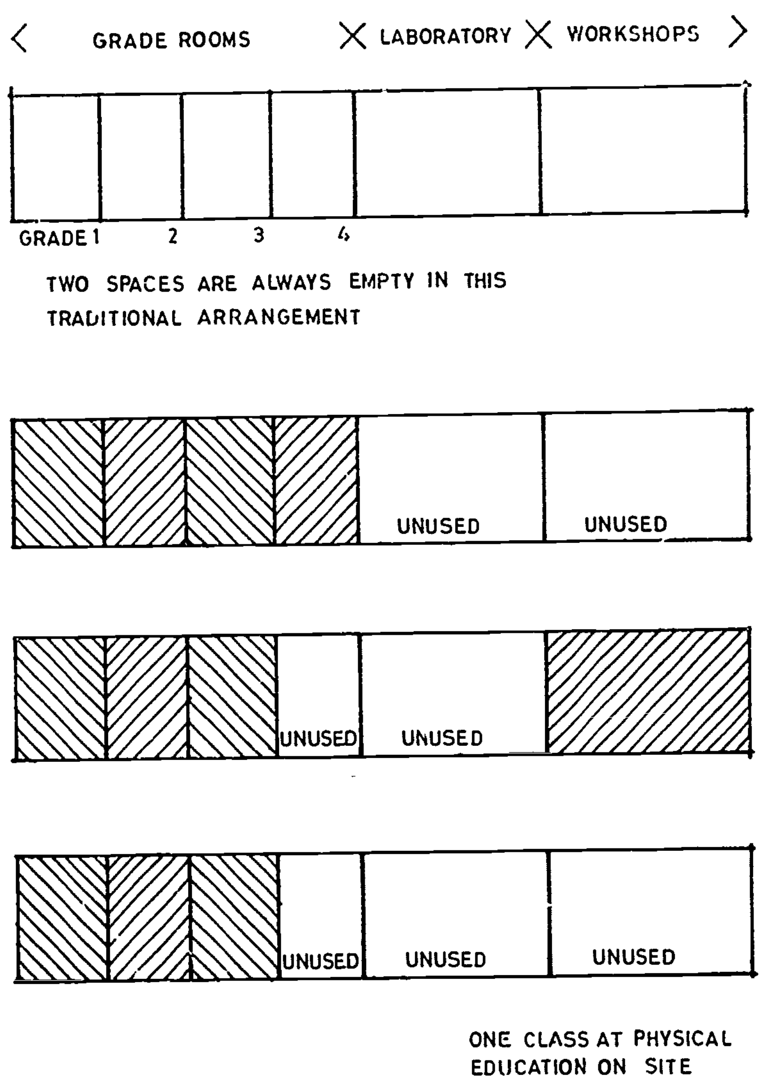


FIG 23

Sometimes, the utilisation is very low indeed, as is suggested in the schedule of accommodation at the end of Appendix III – a real example from a country of the region.

The fluctuation of utilisation with the number of teaching groups for the example used in this chapter is shown in graphical form in figure 24. It will be noted that the allocation of one classroom to every separate teaching group gives a consistently lower utilisation per cent than is the case when the needs for classrooms are exactly calculated using the method shown in the previous pages. The comparison for the grade 6 to 9 school is tabulated below for greater clarity. It should be noted that it is doubtful whether such savings could be achieved for a school, grades 1 to 5, except in very dry areas where much outside teaching is possible.

TABLE IV

Population of School at 40 Children per class	*Number of Teaching Groups in School*	*Traditional Allocation of Classrooms*	*Calculated need for Classrooms*	*Saving of Classrooms resulting from calculation*
160	4	4	3	1
200	5	5	4	1
240	6	6	5	1
280	7	7	6	1
320	8	8	6	2
360	9	9	7	2
400	10	10	8	2
440	11	11	9	2
480	12	12	9	3
520	13	13	10	3
560	14	14	11	3
600	15	15	12	3
640	16	16	12	4
680	17	17	13	4
720	18	18	14	4

In itself, the saving of from 1 to 4 classrooms may not seem significant. Seen, however, against an estimated need (3.4) in 1970 for 407,160 primary school classrooms for five of the smaller countries of the region and an estimated (3.5) 157.3 million new places (or 40 million new classrooms) between 1964 and 1980 for the region as a whole, the saving resulting from the *calculation* of classroom needs instead of the traditional method of allocation of these spaces, is very considerable.

If all schools had a population of only 160 children, then using the calculation methods shown above, 10 million classrooms at an estimated (3.5) cost of 10,800 million need not be built in the period 1964 to 1980.

The figures seem astronomical, but the situation is very real. Figure 25 shows the plan of a recently built, standard, 720 place secondary school in one of the countries of the region in which 24 classrooms have been provided for 18 teaching groups when a calculation shows that only 17 classrooms are needed. In this case there are 7 classrooms in excess of the requirements. Figure 26 shows a plan for a 640 place school with 17 classrooms where only 15 are needed. This situation is very common in many other countries too. Two reasons are commonly advanced for this waste of space. First, educational administrators argue that enrolment is growing fast and provision must be made for expansion. This, no doubt, is true, but the provision for expansion made by allocating an excess of classrooms is rarely, if ever, matched by the provision of an excess of laboratories, libraries, workshops, toilets etc., which are at least as, if not more, important than classrooms in respect of space needs. Secondly, headmasters who, it should be said, are often overworked, find the provision of one classroom space to each class the easiest solution to the problems of timetabling – problems which are already complex enough in respect of timetabling teachers, subjects and teaching groups. There must be some sympathy with this difficulty. It takes about one week to construct the two timetables needed for a 6 group, 3 grade 240 place middle school namely, room/subject/group timetable and group/subject/teacher timetable for a school in which the accommodation schedule has been precisely calculated. The cost of a headmaster or senior teacher for one week varies. An average figure might be of the order of US $ 35. A classroom (3.5) will cost about $ 1080. On the basis of this calculation, it would take 31 years before the cost of timetabling exceeds the cost of one classroom. It will be seen that, as long as salaries do not increase sharply, it is, in the short term more economical to let the headmaster face the problem of slightly more complicated programming brought about by calculated accommodation scheduling, than to allocate a classroom to each group, simply in order to ease the headmaster's timetabling difficulties.

The size of the school as indicated in figure 24 is not, however, entirely connected with the provision of classrooms to achieve maximum utilisation. Both science laboratories and workshops are more expensive to construct, per unit area, than classrooms because of the special fittings that are required. What has to be sought is thus a school size in which the highest possible utilisation of all these types of space is achieved.

For the particular example used to illustrated this text and from figure 24, it will be seen that 400, 480, 600 and 720 place schools give higher overall utilisation than do other enrolments.

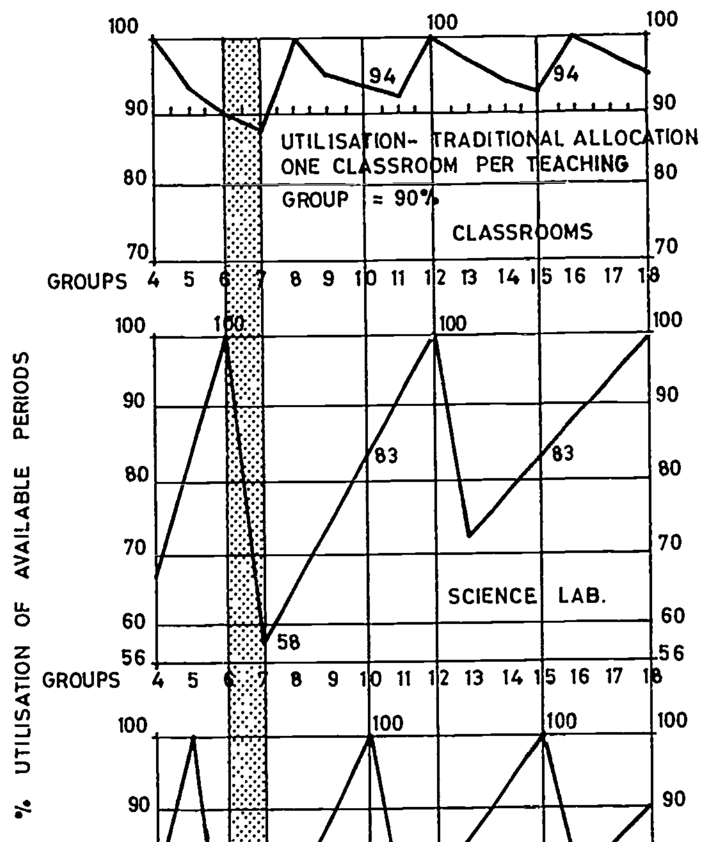


FIG. 24

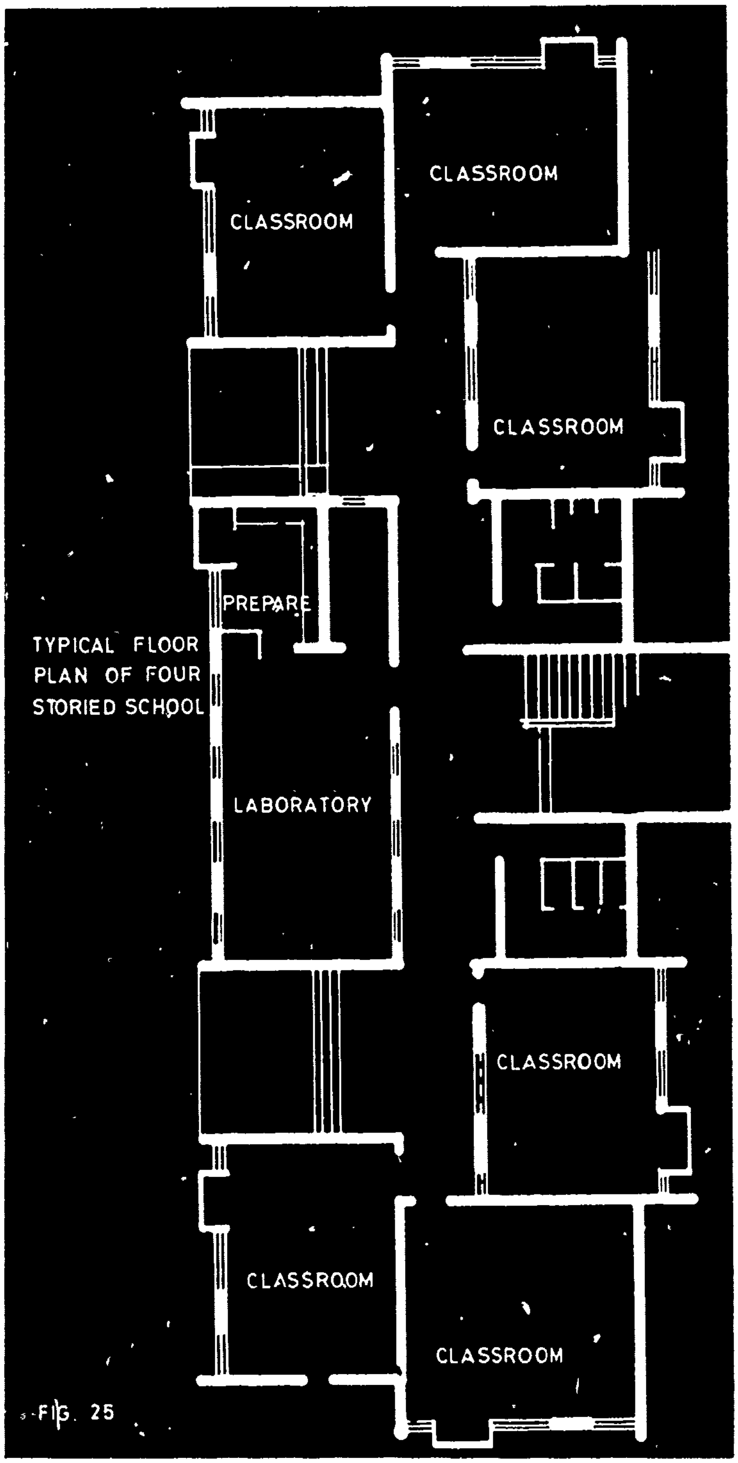
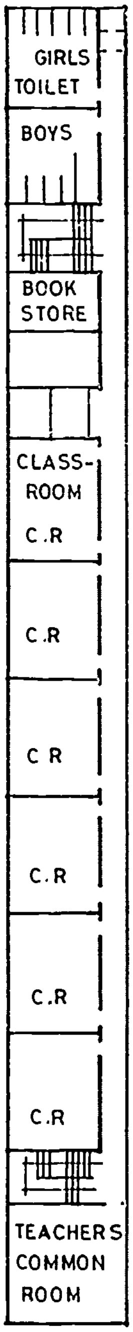


FIG. 25



TYPICAL UPPER FLOOR PLAN

FIG 26

3.03 Accommodation Schedules for Upper Second Level Schools

The techniques of accommodation scheduling, outlined above, are, however, only suitable for primary and some secondary schools where classes remain undivided throughout the week. In small upper second level schools where elective subjects are often offered, a class of 40 children will study perhaps two or three core subjects in a group of 40, and thereafter will divide up into smaller groups of 10 or 20 to study their elective subjects. There will therefore, be a need for a variety of spaces to accommodate groups of 40, 20, and 10 children at this level of education.

The figure 27 (case A) illustrates such a situation in diagrammatic form, for a small school having only one class in grade 10. If, however, there are four classes in grade 10, each of 40 students, then the situation in relation to their distribution in the two streams would be as in figure 28 which shows that, where the number of groups per grade equals the number of elective subjects the group remains undivided and rooms, all with the same number of student stations, (40 in this case) can be provided. This will result in fewer timetabling problems and also in higher utilisation. It also suggests that the greater the number of grades in the school, the greater is the chance of efficient use of space.

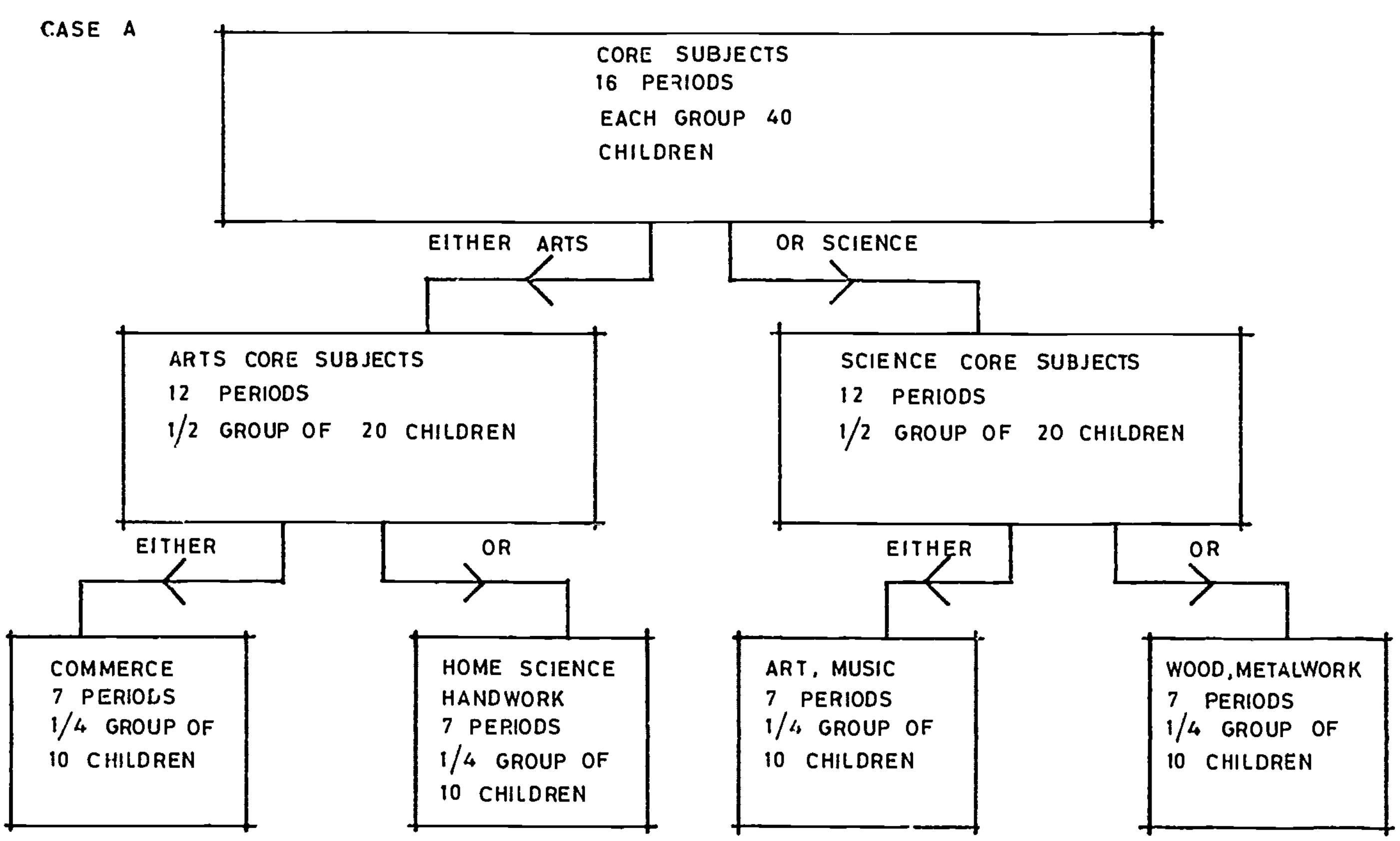


FIG. 27

Thus, in order to find the optimum size of school, it is wise to concentrate on case B (Fig. 28).

When is a school fully utilized?

It seems fairly clear that very small schools at the second level of education can very rarely hope to be fully utilised. It is, therefore, only worthwhile considering the case of larger schools of say 30 classes and above. The two bar charts show the sort of accommodation required for a particular curriculum and also suggest that it is extremely difficult, even with a large school, to get optimum utilisation of all types of teaching space. However, it is clear, if one looks at the bar chart for the smaller school of 1,680 places, that the waste of space which is indicated by hatching is, per cent, much greater than the waste, per cent, shown in the second bar chart for a school of 3,840 places. In this large school it will be noted from the bar chart that there is optimum utilisation of all spaces except the physics laboratory. The percentage waste in these laboratories is 4.5. This compares with a waste in the physics laboratory for the 1,680 place school of 15 per cent.

The conclusions that can be drawn from these bar charts are, first, that there is likely to be more chance of achieving optimum utilisation in larger schools than in smaller schools and, secondly, following from this, that the per place costs of larger schools are likely to be smaller than those of smaller schools. This point is illustrated in figure 29. It will also be noted from this figure that for example, the per place cost of a 1,500 place school is less than that of a 1,800 place school, and the reason for this will be made clear by placing a ruler vertically on the bar charts and trying to find points of coincidence between the utilisation of the various spaces. Methods of calculating these points of optimum utilisation have been described (3.12).

CASE B

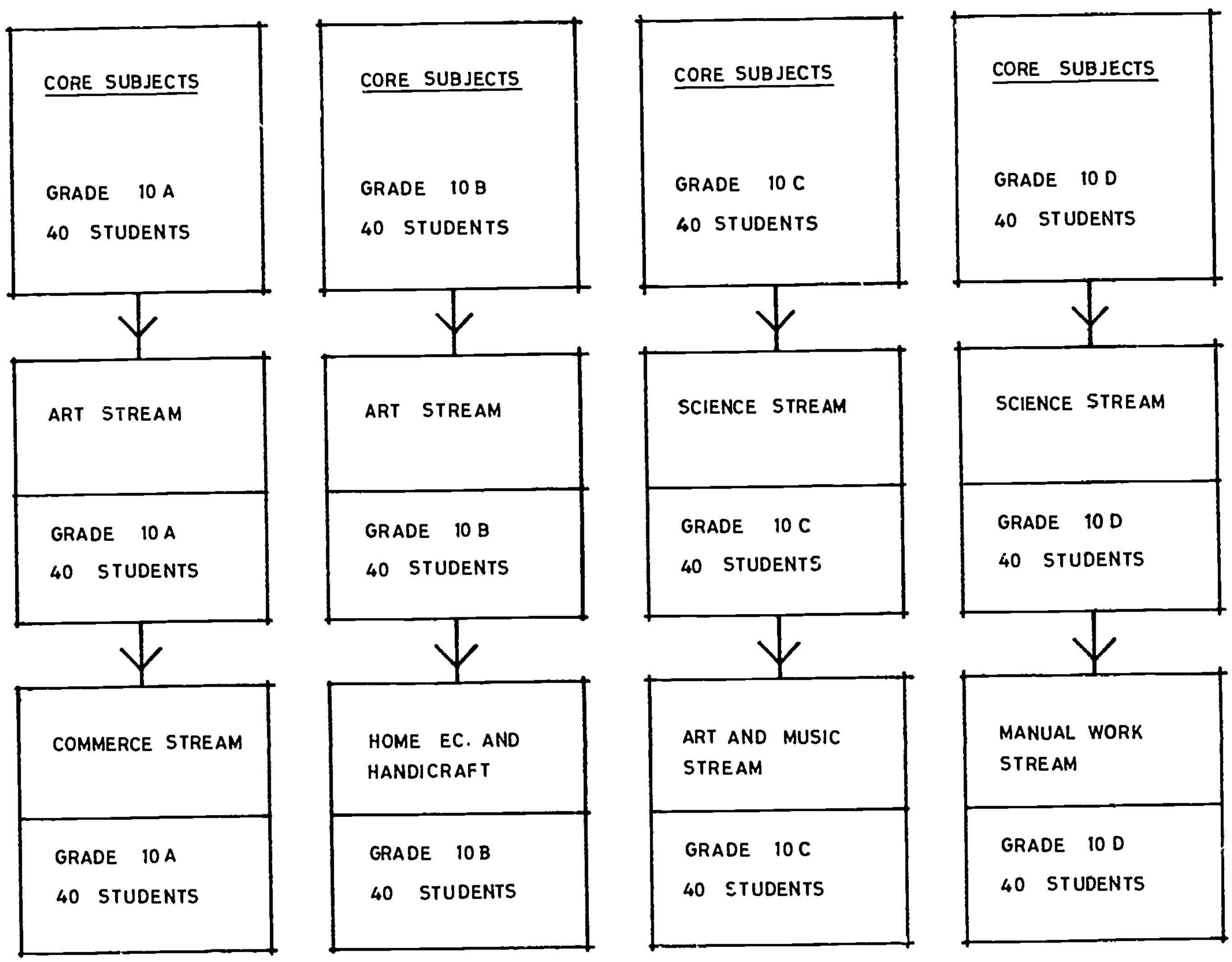
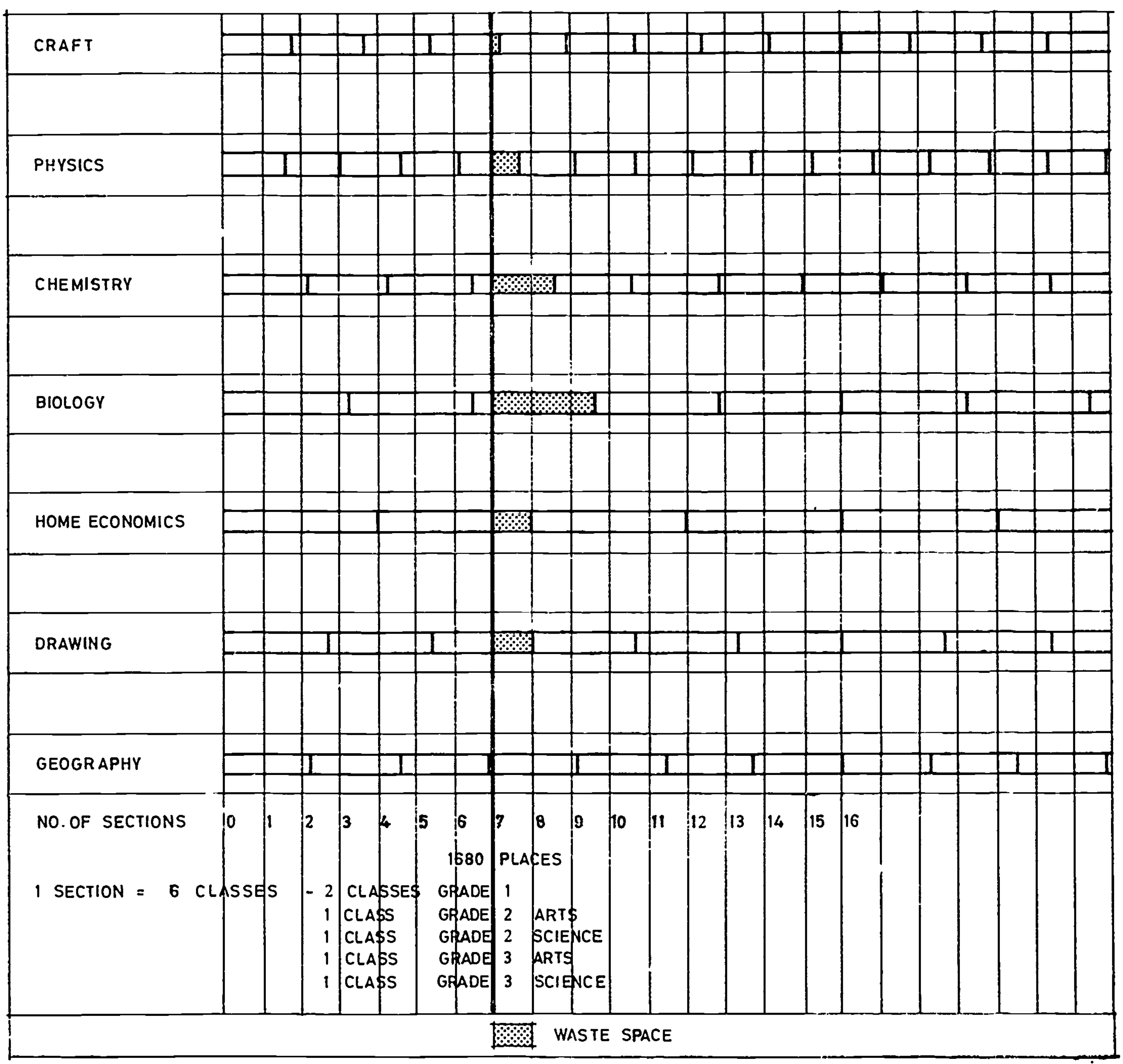


FIG 28

BARCHART 1 OPTIMAL UTILISATION OF SPECIALISED TEACHING SPACES

SENIOR HIGH SCHOOL 1 ART STREAM 1 SCIENCE STREAM



BARCHART 2 OPTIMAL UTILISATION OF SPECIALISED TEACHING SPACES
SENIOR HIGH SCHOOL 1 ART STREAM 1 SCIENCE STREAM

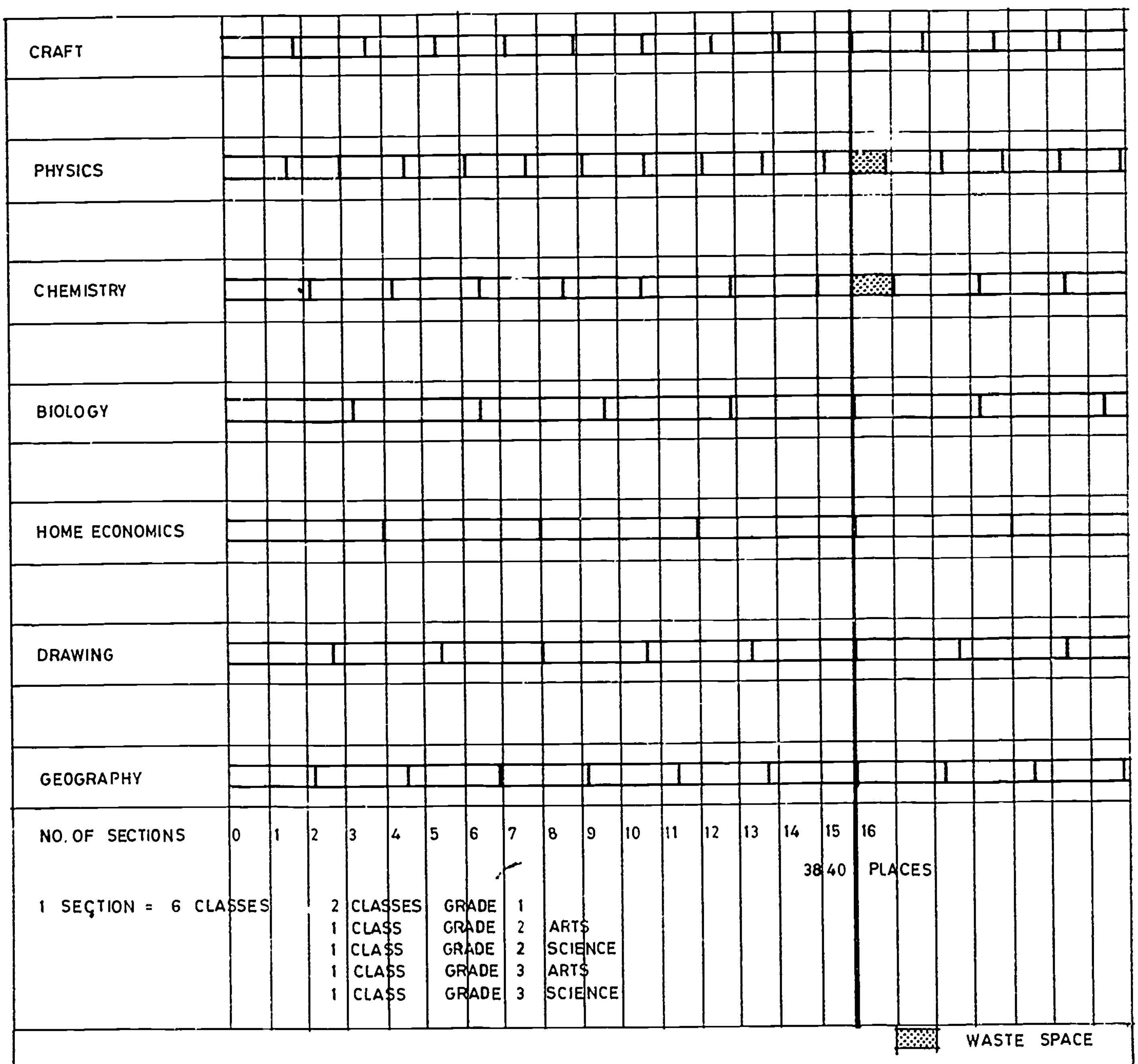


TABLE V

DISTRIBUTION OF STUDENTS BY GRADE AND ELECTIVE SUBJECT – KHMER REPUBLIC

Elective	*Humanities*						*Tech. Science*				*Agricult. Science*				
GRADE	VII	VIII	IX	X	XI	XII	IX	X	XI	XII	IX	X	XI	XII	
% of Total Enrolment in Grade ..	18.9	18.9	8.2	10.8	5.4	5.4	5.4	5.4	2.7	2.7	5.4	5.4	2 7	2.7	100%
Number of Students in Each Grade ..	280	280	120	160	80	80	80	80	40	40	80	80	40	40	1480
Teaching Groups of 40 Students ..	7	7	3	4	2	2	2	2	1	1	2	2	1	1	37

From Table V it will be seen that grades XI and XII in the science electives are just full. The next largest population which would have full groups of 40 in these grades would be 2,960 students giving 2 groups in grades XI and XII of the science electives. There is, however, a considerable difference between these enrolments and it seems most probable that, in a real situation, the enrolment may be either less than 1480 or between 1480 and 2960.

However, implicit in the method of calculation for optimum enrolment given at some length above, was the assumption that all classrooms or teaching spaces are fully occupied, in the example, by 40 students. Obviously if a room designed for 40 is used for the maximum possible 32 periods by say 15 students, its utilisation in terms of space periods is not a true measure of its actual utilisation.

Where teaching groups do not match the size of rooms, then some other method of determining the optimum size of a school has to be sought. A reliable measure of utilisation is, of course, the cost per pupil place. The optimum school, using this measure, will be that having the lowest per pupil place cost and area.

The example of Khmer Republic, second-level schools has been used for a variety of enrolments in which many of the teaching groups have less than 40 students and the per place areas and costs calculated and shown in Table VI.

TABLE VI

PER PLACE AREAS AND COSTS FOR VARIOUS ENROLMENTS - SECOND LEVEL SCHOOLS; KHMER REPUBLIC

Teaching groups of from 1 to 40 students

Enrolment	*Area per place sq. m.*	*Cost per place U.S. $*
480	4.41	205.5
720	3.01	136.6
960	3.13	142.4
1200	2.7	121.2
1440	2.45	111.2
1680	2.86	128.9
1920	2.62	118.5
2160	2.51	112.3
2400	2.49	113.4
2640	2.47	110.6
2880	2.33	104.6
3120	2.42	107.7
3360	2.47	110.8

The next question to be examined is the difference in per place costs and areas between the schools of the enrolments in Table VI which include many teaching groups of *less than* forty students and schools having the *same number* of teaching groups each of 40 students.

What, for example, is the per place area cost difference between a 1680 place school of 51 groups and a school of 51 groups each of forty and having, thus, an enrolment of 2040 students? Table VII sets out the result of this new calculation.

TABLE VII

PER PLACE AREAS AND COSTS FOR VARIOUS ENROLMENTS – SECOND LEVEL SCHOOLS; KHMER REPUBLIC

Teaching groups of 40 students

Enrolment	*Area per place, sq. m.*	*Cost per place U.S.$*
760	2.78	128.3
880	2.42	112.3
1200	2.55	115.6
1400	2.32	104.0
1480	2.40	108.1
2040	2.36	106.3
2240	2.25	101.7
2360	2.32	103.4
2760	2.16	96.3
2880	2.26	101.0
2960	2.26	101.4
3520	2.15	95.8
3640	2.28	102.3

The situation is summarised in Figure 29 which is of considerable significance for educational planners and administrators responsible for investment decisions in respect of school buildings. From the figure, it will be seen that schools of about 1400 places are *very* much cheaper in terms of plant and facilities than those of about 1700 places, whether or not the classes are in groups of 40 students. Similarly, schools of over 2,700 places are cheaper still. It will also be noted that quite small differences in planned enrolment, as for example, between 1600 and 1700 places, can lead to per place cost increases of over 8%. The significance of the graph is perhaps as much in the enrolments to avoid as in the enrolments to plan for. It should also be noted here that the data used for purposes of illustration relate specifically to the second level schools in the Khmer Republic. The study of the different educational situations in other countries will result in different quantitave answers to the question "what are optimum sizes of secondary schools?" All that is suggested here is a method of examining the problem.

The large schools, which this section suggests are most economical to build and to utilise (a well used space usually means a well used teacher), are probably only viable in urban areas. Rural areas will continue to require smaller secondary schools due to the relative sparcity of population. The danger of waste of money arises from the tendency to build rural schools with all rooms having a capacity of 40 places when in fact, many of the teaching groups are bound to be small. In such situations, whilst the usual space calculations are valuable in determining the accommodation schedule, it is also important to check this with a sample teaching timetable to determine the *capacity* as well as the number of spaces needed.

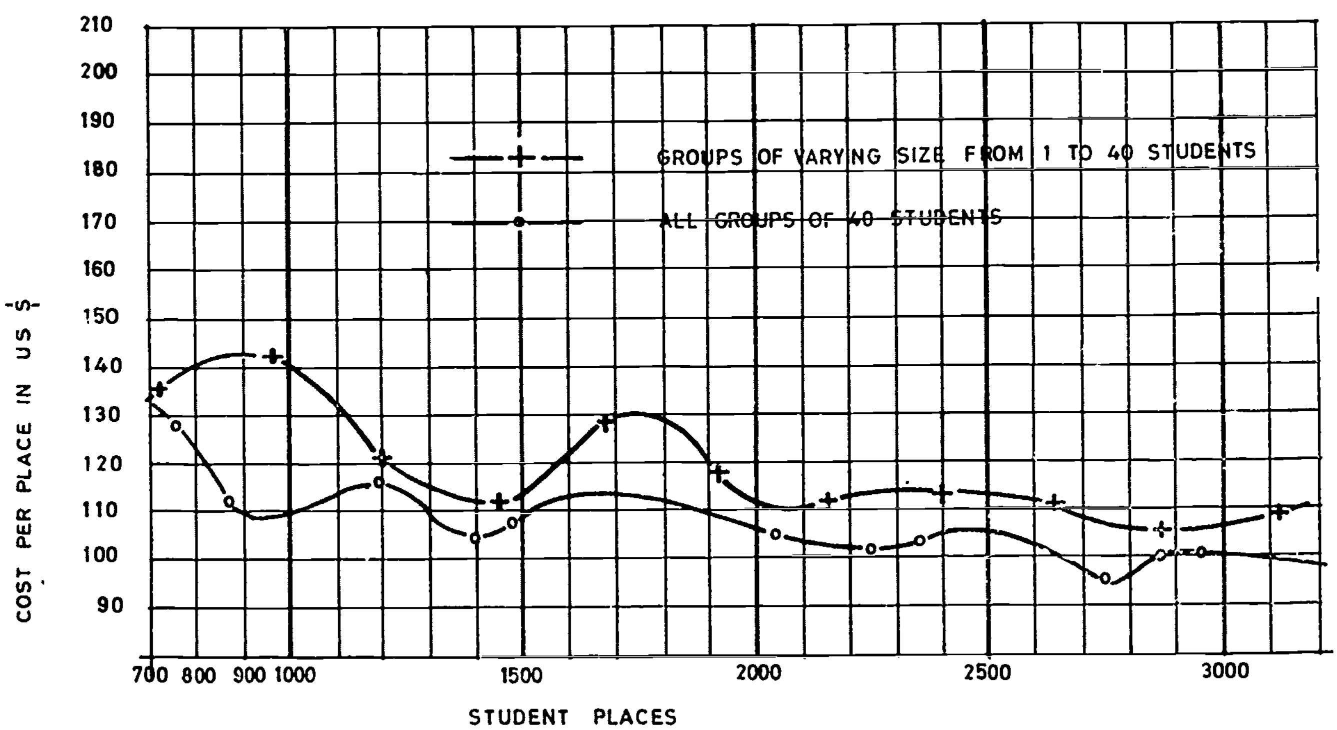


FIG. 29

VARIATION OF COSTS WITH ENROLMENT – SECOND LEVEL SCHOOLS; KHMER REPUBLIC (ESTIMATED)

3.04 The Size of the School based on the Catchment Area

The catchment area of a school is the area in which the children who attend the school normally live. The physical size of this area will usually be determined in rural areas by the maximum distance that a child can be expected to travel between home and school and school and home. In urban areas, the optimum size of the school is more likely to be based on economic utilisation or other criteria, rather than on the home to school distance.

From a theoretical view-point, the catchment areas of a number of contiguous schools can be regarded as of honeycomb pattern (figure 30) and the population of the school calculated from $P = AD$,

where P is the population to be enrolled;
A = the catchment area
$A = 2.598 R^2$
where R is the radius of the hexagon forming part of the honeycomb
D = density of population of appropriate school age.

The radius of the hexagon in rural areas is usually the maximum distance the child can travel to school. For a child of primary school age, this distance is often prescribed by the education authority. A consensus of opinion (3.7) seems to suggest that 2.5 km. is a reasonable maximum.

The honeycomb concept is, however, more likely to be of use in general planning for education rather in connection with the very practical problems of locating buildings on the land. In the great delta areas of the Ganges, Meghna and Brahmaputra rivers, where the distribution of population is virtually uniform, the honeycomb sometimes provides a logical basis for locating schools at all levels of education. In terrain such as that of Nepal, the sides of the valleys will often form the catchment areas, bounded at the valley bottom by swift flowing rivers and at the upper limits by virtually unclimable ridges. In Indonesia and the Philippines, many of the thousands of small islands are themselves each a complete catchment area whilst, in the desert areas of Pakistan and Iran, the school going population is nearly always in or close to the villages.

It is thus, in the urban areas of Asia that concepts of catchment areas are of the greatest significance at the present time and the second paragraph of this chapter indicates that the problem is connected more with

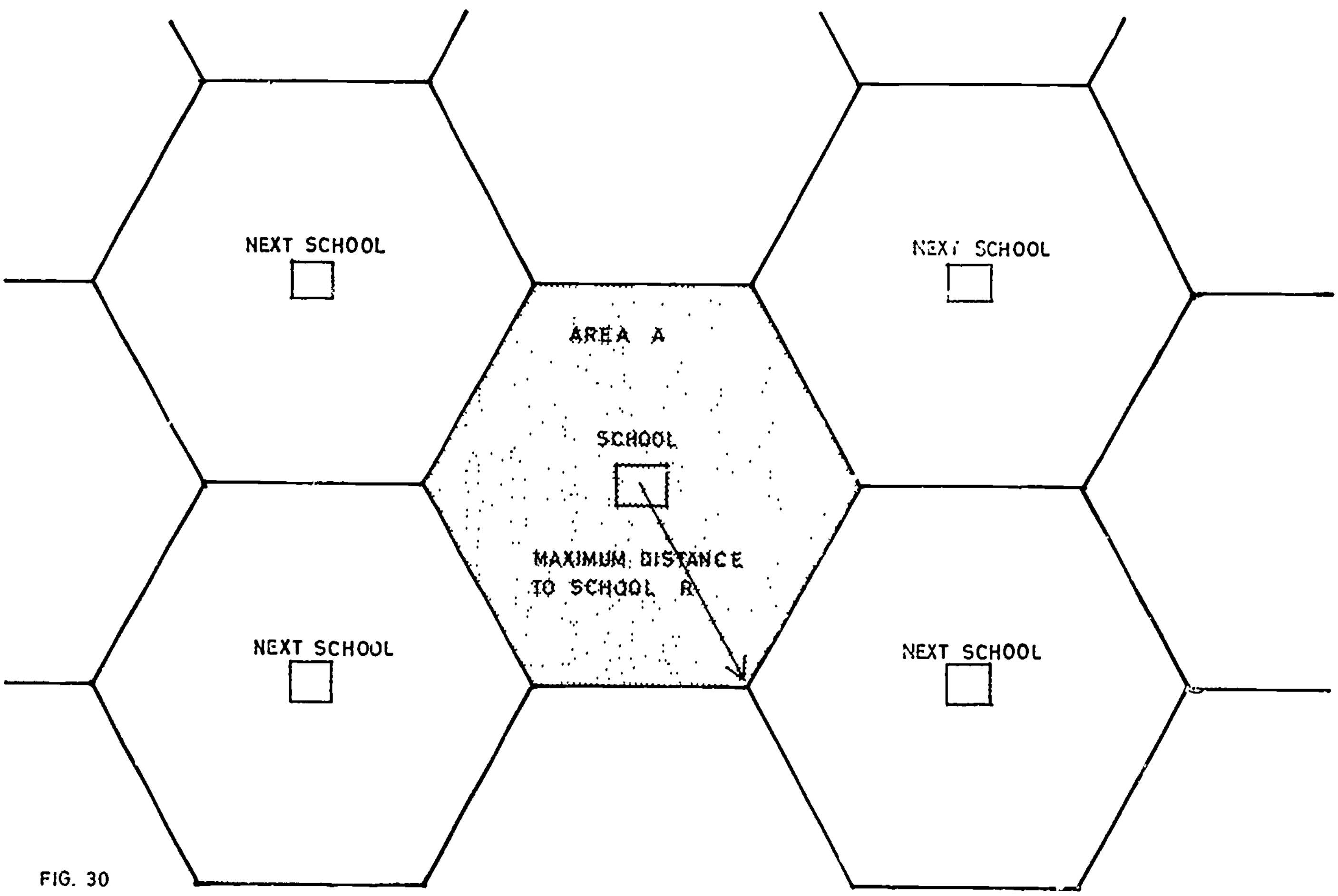


FIG. 30

the quality of education than with population distribution. Zoning regulations – that is the requirement that children *must* attend the school in the defined zone in which they are resident – seem likely to be enforceable *only* is situations in which the educational quality of all schools accessible to the children is similar. This, in many urban areas of the region, is regrettably, not the case. The result is that children often travel great distances every day to the schools which, to their parents, seem to offer the best educational opportunities. Those that have attempted to drive near schools in some of the cities in the region where this movement of children takes place, will remember the confusion of private cars, buses, cycles and tricycles assembled to take the children back to their distant homes at the end of the school day.

The realities of this common situation should find some reflection in the design of the approaches to such schools. There should be areas in which the vehicles used to transport the children can wait, without obstructing the flow of normal traffic and designed to allow the children to reach vehicles without crossing busy roads.

3.05 School Organisation

A great deal of material has been published on school organisation in countries outside the Asian Region. Some of this material is, no doubt, relevant to some of the situations in the region. In general, however, the most common setting in which school organisation needs to be considered is that well described in (3.8) "Many schools are located in congested and crowded localities, particularly in urban areas. Teachers and pupils have to work amidst the din and bustle of bazaars, cinema houses, motor stands, workshops etc... at times there is hardly room for normal movement". The mean percentage of schools needing minor or major repairs, the study (3.8), reports as 65% "...in many rural primary schools there is no furniture. Pupils have to squat on mats... 40.2% of the schools had no mats for pupils to sit upon, 42.6% had no equipment for the teaching of crafts and over 90% had no raw materials for crafts. It is under such conditions of inadequate accommodation, furniture, equipment and teaching aids that thousands of teachers teach hundreds of thousands of children year after year".

What of the organisation of the school and the concept of the school as a social unit in this context? In what ways, if at all, can the designer assist through the design of a school, in its organisation in such circumstances?

Wiseman, in a slightly different context, (3.9) reminds us that, "...standards that are accurate and truly representative of a particular region (of England) in 1950 may be completely false in 1960. Schools do not stand still; the educational system is not static".

The studies on the school environment are few but Kemp (3.10) identifies 42 variables effecting educational attainment including school atmosphere and organisation, size of school and size of classes. Kemp's correlations generally show that "...the physical factors of school and class size, and quality of building, have small effects on attainment level, and are quite negligible in comparison with the effect of intelligence". (3.9)

These findings from a study of 50 junior mixed schools in London might be thought to have little relevance to the Asian situation were it not for the observed fact that, in so many countries and despite the condition of schools described above, the education systems continue to provide useful citizens. It may also be observed that, where the school is designed to be "manageable", it frequently has a high reputation locally for its quality.

Manageability may have implications for design in respect of the location of spaces in relation to each other, circulation patterns and the like "where there are no buildings to give an outward sense to it, the house system can be a meaningless concept,..." (3.11) These aspects of design in relation to organisation are dealt with in subsequent chapters.

To end this chapter, a final comment is needed, on teachers and equipment.

Expenditure on education, in most countries of the region, is disbursed, very approximately as follows:

Teachers' salaries ..	80%
Equipment and supplies ..	10%
School buildings (including new buildings, extensions and repair) ..	10%

The greatest input is thus teachers' salaries and it is clear that greater economic significance attaches to the optimum utilisation of the teacher, rather than of the building in which the teacher works. Buildings – especially for small schools – are often a useful indicator of teacher utilisation. In the last example given in this chapter, that of the Khmer school, the optimum utilisation of the accommodation suggests similar utilisation of the specialist teacher. The best way to ensure economic use of teachers is to build schools in which high utilisation of accommodation can be shown by either of the calculation methods mentioned in this chapter.

Equipment especially at the upper level of secondary education represents an important element of expenditure in some countries because it has to be imported. Paradoxically, the countries that have to import equipment are usually, though not always, those with a shortage of foreign exchange.

The solution to this problem, which is often coupled with that of a shortage of specialist, trained teachers, is the design and construction in urban areas of common teaching facilities. Thus a workshop or science laboratory complex may be built on its own site, conveniently located in the middle of a number of local schools the children from which visit the complex and use its special equipment under the guidance of a few specially trained and very fully occupied teachers for, perhaps, half a day every week, each.

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Chapter 4

SCHOOL BUILDING COSTS

4.01 General

The cost of a school building is directly affected by a series of decisions made by :-

(a) Educationists on (i) The type of curriculum;
(ii) The numbers of children in each teaching group;
(iii) The numbers of children in the school.

(b) Administrators on (i) The location of schools and selection and acquisition of site;
(ii) School building regulations such as scale of sanitary fittings, widths of corridors and heights of rooms;
(iii) Contracting procedures.

(c) Designer on (i) Arrangement of spaces;
(ii) Selection of materials;
(iii) Form of construction.

(see Figure 31)

Reference to these various aspects is made throughout the book. For example, from chapter 3, Figure 29, it is very evident that the enrolment has a direct bearing on per place costs: Sites (chapter 5) unless carefully selected can increase the costs of foundations. Regulations such as those affecting ceiling heights (chapter 7) can, if they are unreasonably based on outmoded ideas on methods of achieving thermal comfort, add unnecessarily to per place costs. The provision by the designer of more space than is strictly necessary having regard to the functional requirements of each space in the building is another common cause of high building costs.

Building costs are also affected by fluctuations in the market prices of labour and materials. In countries with expanding economies and consequent heavy demands on the building industry, market prices usually continue to rise. Figure 32 shows a typical example of this common phenomenon.

The most important factor affecting cost is *space* Figure 33 shows how costs increase proportionately with the amount of space provided. Thus, if costs are to be kept as low as possible, it is essential that only the minimum space required in relation to the curriculum and the numbers of children in the school be provided.

It is equally essential that the space provided is fully utilised. (see chapter 3).

There is a considerable variation in the cost of school buildings for the various levels of education. (Figure 34). This is brought about by the need for more space in the general teaching areas through smaller teaching groups (see chapter 7) and by the need for a greater number of specialised teaching spaces. such as laboratories, workshops etc., required by the curricula at the lower and upper second levels of education.

There is an even greater variation in the cost of equipment and furniture. (Figure 35).

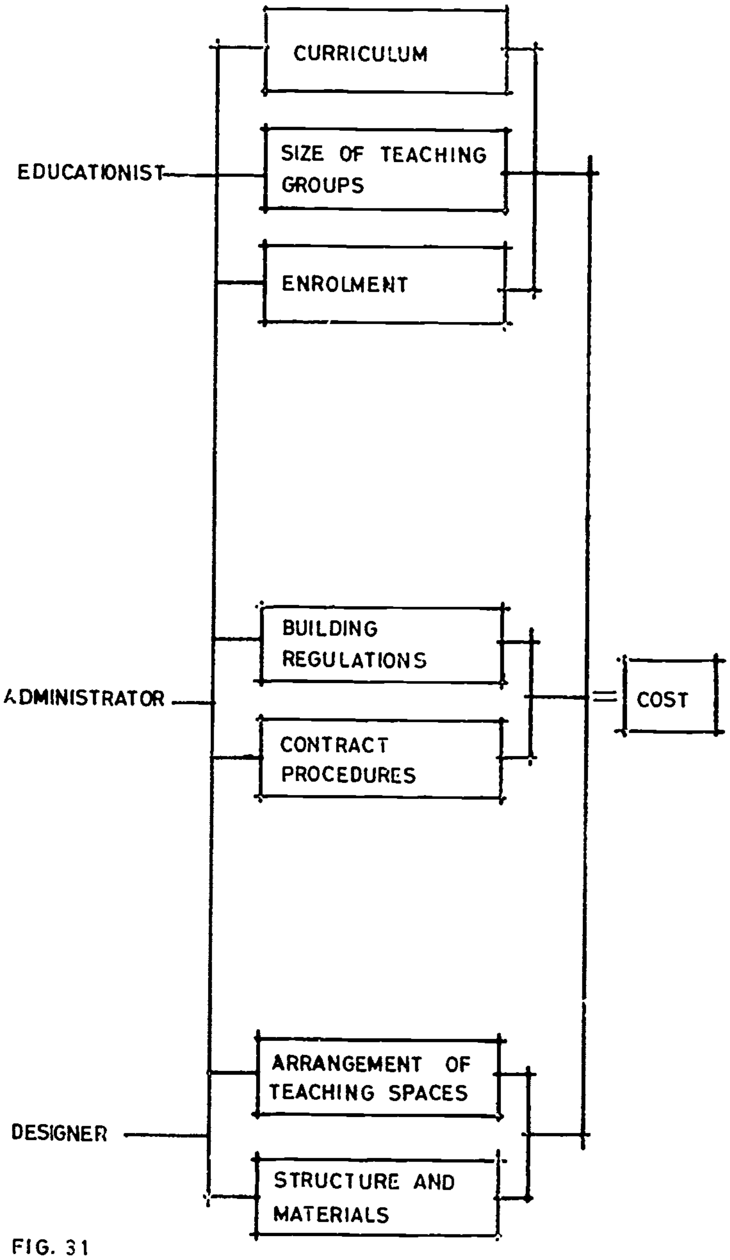


FIG. 31

The nature of the site may also have a marked effect on capital costs. If more land is acquired than can be used for the buildings and the outdoor activities of the curriculum, there may be not only excessive initial expenditure on acquisition, but also continuing recurrent expenditure on maintenance. (Figure 36). The configuration as well as the sub-soil conditions may affect the costs of the building. If the site is steeply sloping, expensive cutting and filling may be required as well as additional paths, steps and link units. (Figure 37).

If the ground has a poor load-bearing capacity, special foundations will be required. Building costs can be increased by as much as 15% if piling is required to support the super-structure. (Figure 38).

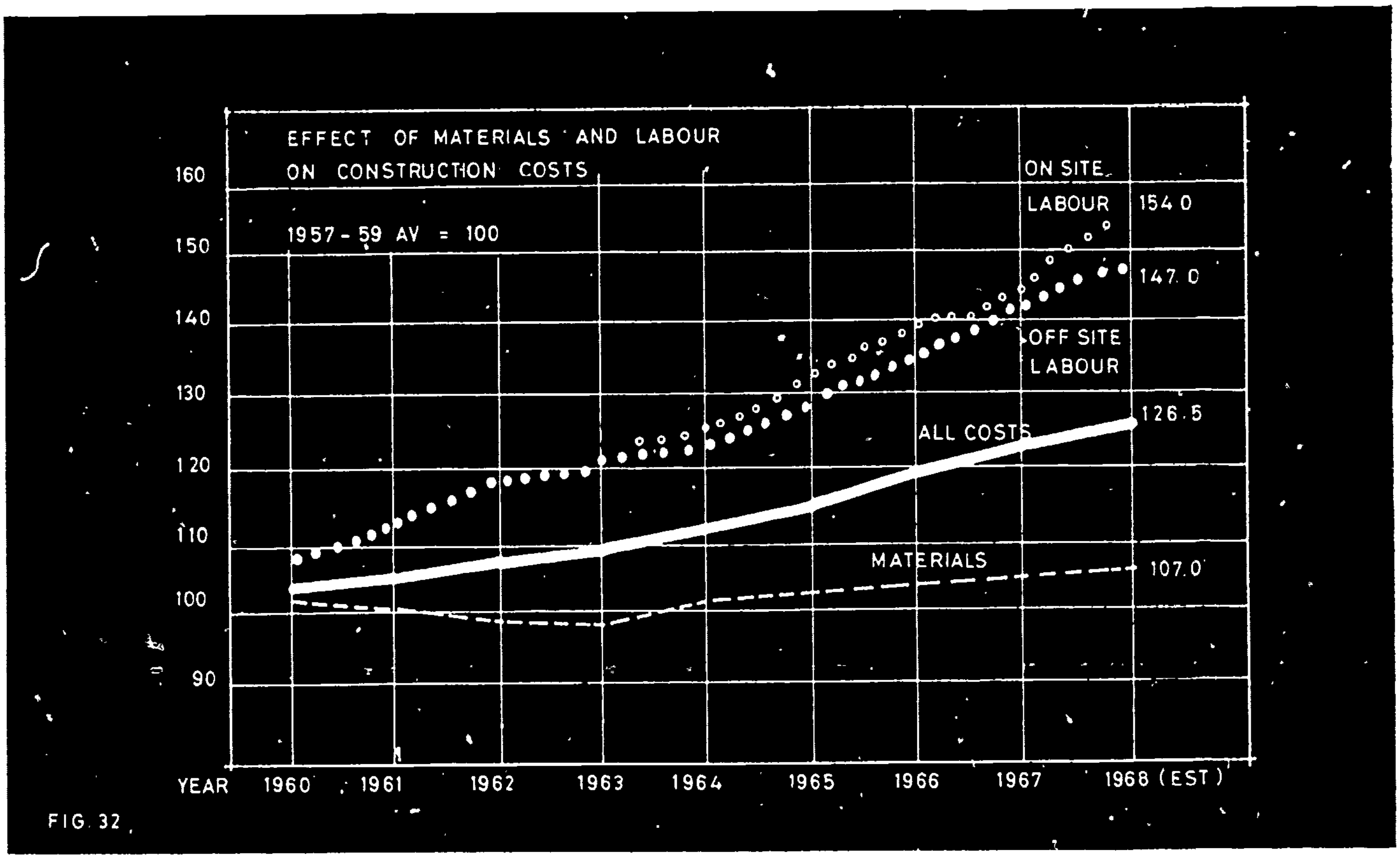


FIG. 32

In urban areas, where land costs are high due, often, to scarcity of land, high rise school buildings will be required (Plate 5) which, at present prices and in most places, cost more than low, single or double storied schools. (Figure 39). A reduction in the area of the site where land costs are high, will often offset the higher cost of a high rise building.

4.02 Space per pupil place

As the amount of space provided has the greatest effect on the costs of school buildings and as, in most countries, it is desired to keep building costs to the absolute minimum commensurate with the provision of the desired facilities for education, there must be strict control over the total space provided.

Not only must classrooms be controlled, but also all other spaces, whether programmed for teaching or spaces such as corridors, toilets, canteens and the like.

By careful arrangement of the teaching spaces, and by reducing the circulation to a minimum (in length as well as width) it will usually be possible to allocate 70% of the total floor area of the building to programmed teaching activities. Figure 40 suggests targets for allocation of floor areas for schools at various levels of education in the region.

It is not at all uncommon to find schools in Asia with not more than 50% of the total floor area allocated to programmed teaching activities.

4.03 Cost Limitations

If the costs of school building are to be kept down, then in addition to the need for regulations to control space, there is also the need to regulate for minimum standards of construction and finish.

If these dual constraints of minimum standards for space and construction can be established, then a very tight control over building costs can be obtained and it will be an easy matter, eventually, to move to the establishment of a maximum cost per place or per unit of accommodation.

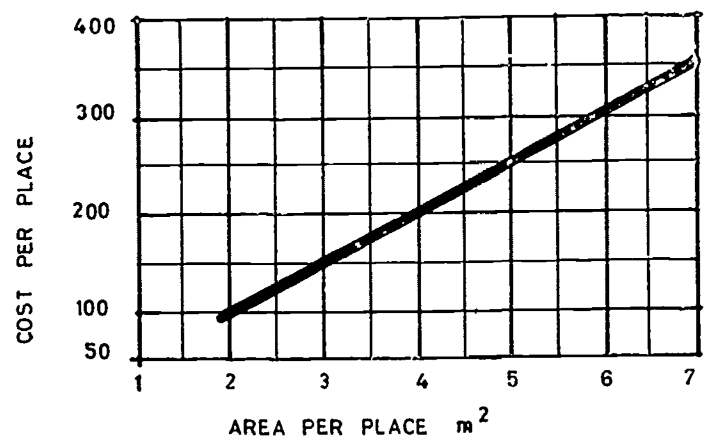
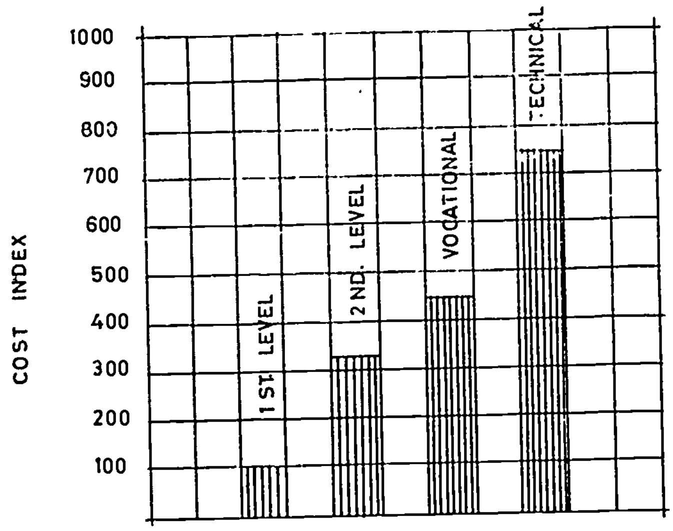
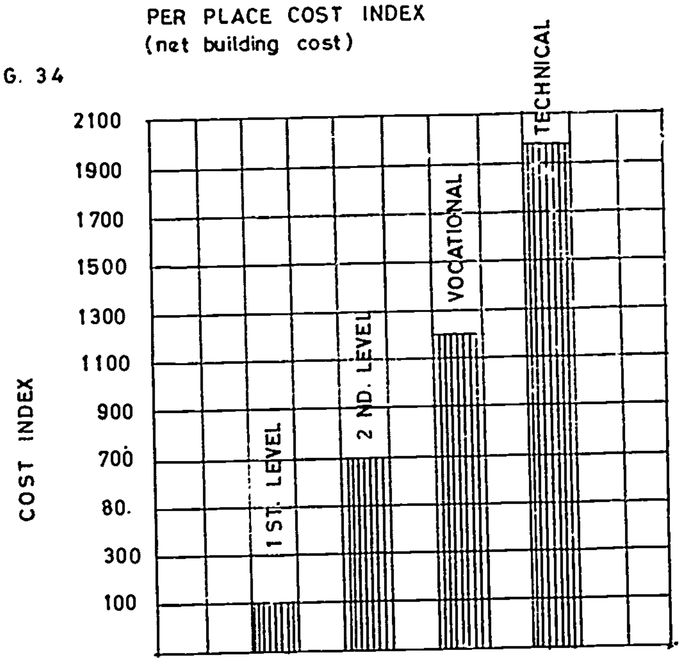


FIG. 33



PER PLACE COST INDEX
(net building cost)

FIG. 34



PER PLACE COST INDEX
(furniture & equipment)

FIG. 35

In some countries there may be problems in fixing a uniform cost throughout the country, due to variations in costs of labour, material. transportation of, or availability of materials.

In such cases it may be desirable to establish a building cost index, which could for example be based on the costs in the capital city and adjustments made to the best cost, in the various regions, by a plus or minus addition, determined by the building costs in that region.

Some countries may experience difficulty in setting up such a building cost index, but as in most countries of the region, the school buildings follow a standard pattern, a start could be made by feeding back, from the various districts, the construction costs of these "standard" buildings, to the central authority who could then compare these costs against the yardstick of the estimated cost of the building at the centre.

Example

Cost of 1st level classroom estimated at

Centre	4500 cost units	Base Index	100
Construction cost from:			
North Province			
District A	5 100	Cost Index	114
District B	4 850		108
District C	4 640		103
South Province			
District A	4 550	Cost Index	101
District B	4 400		98
District C	4 600		102

In this way, a fairly reliable building cost index could be set up within a year or so, which will provide the basis for a more equitable distribution of funds.

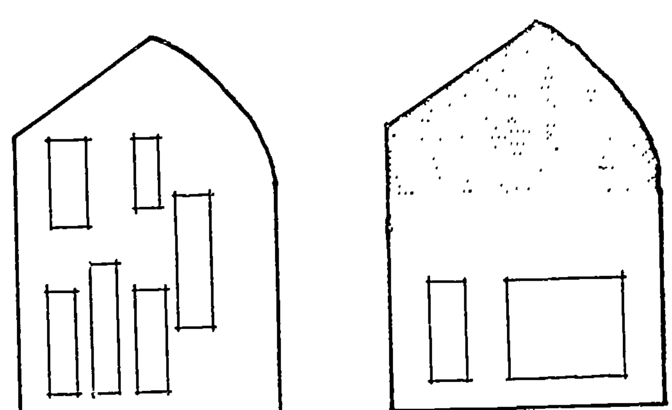


FIG. 36 NOT THIS BUT THIS

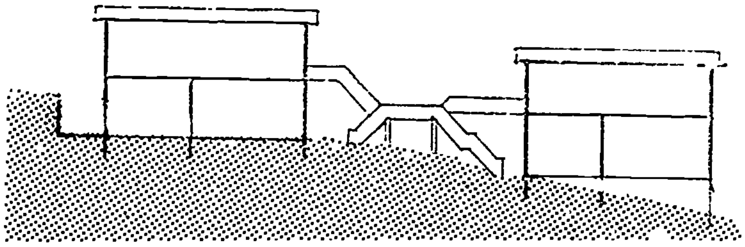


FIG. 37

Table VIII gives an example of a space distribution of a lower secondary school, a layout plan of which is shown in Figure 41. The school is located in a rural area on a steeply sloping site and the need to provide as large a playing field as possible, coupled with the nature of the site, has obviously influenced the layout of the buildings. As the land development costs were high, (see Table XI) one may first question the need for such a large playing field and secondly, why two storey buildings were not provided as this would have resulted in a more compact and manageable school. A comparative cost estimate of providing single or two storey buildings would have shown which of the two solutions is the more economical.

4.04 Cost Control

There is a general tendency when considering ways of controlling or reducing the cost of school building, to cut out arbitrarily some parts of the building which are thought to be unimportant (a library, staff rooms, canteen, for example) to substitute cheaper materials, or to cut down on the standard of finish of the structure. This approach to cost control is not reasonable, nor will it produce real savings. More often than not this form of economy leads to dissatisfaction all round. Where, for example, the staff rooms have been eliminated, the teachers will invariably take over classrooms, which, in turn, may lead to serious overcrowding of children attending the school and for whom, it must be remembered, the building was first constructed.

This form of cost control does not get to the root of the problem nor does it begin to isolate some of the causes of high building costs. Questions need to be asked about the provision and utilisation of space – Is the area per place in the teaching spaces too large in some rooms and too small in others? Has one sector of the school been allocated too high a percentage of space? Are the teaching spaces being used as much as they could be? Questions need also to be asked about the structure. Is the design staff making the best use of up-to-date construction techniques and technology? Are the building regulations based on out-of-date concepts with regard to wall thicknesses or ceiling heights, etc? Are departmental regulations so framed to include specifications for materials and construction which are no longer economical? And so on.

Cost control should be based on a critical study of the present situation and this points to the need for two broad types of analysis; first, of the distribution and utilisation of space within the building and, secondly, of the distribution of costs throughout the various parts, or elements of the building. It will be on the basis of these space and cost analyses that a joint decision by the educationist and the designer can be reached as to the best way to control or to reduce costs. Emphasis is laid on the need for a joint decision to be reached as there will undoubtedly be some compromise to be reached. If the decision is left to only one of the two main interests concerned, the results may be achieved at the expense of the other's needs.

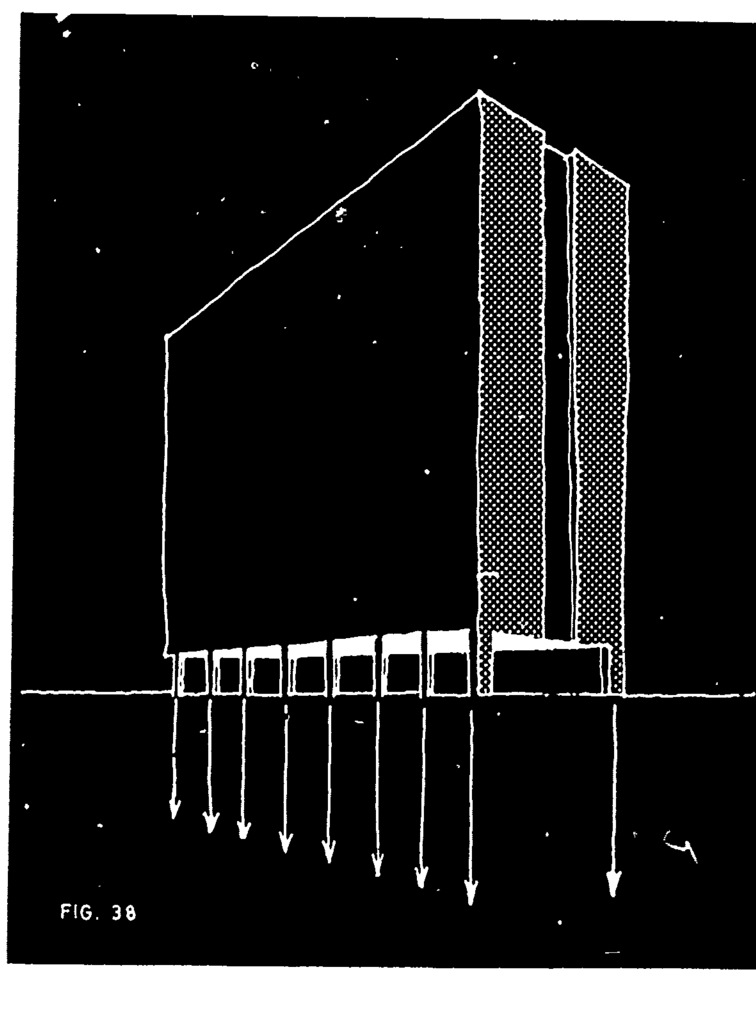


FIG. 38

TABLE VIII	SCHEDULE OF ACCOMMODATION AND AREA ANALYSIS	Ref: SG 001 R/107 Date: 1.10.69

ENROLMENTS: Designed 480. Actual Registered 395. Average Daily Attendance 362.

KEY	TYPE OF ROOM SPACE	No. of Rms.	Area of one unit	Net area Area m²	unit %	Net area Sector m³	% Total	m² per pupil Dsgn.	Actual Regd.	Av. Daily Attdce.
	Classrooms General	12	63 46	761.42	49.3		26.9	1 58	1 93	2 10
	„ Special	—	—	—	—		—	—	—	—
	Science Room	—	—	—	—		—	—	—	—
	Laboratories	3	109.54	328.62	21.2		11.6	0 68	0.83	0.91
	Home Science	3	—	211.74	13.5		7.5	0.44	0 54	0 58
	Commerce	-	—	—	—		—	—	—	—
	Art/Music	2	84 62	169.24	10.7		5 8	0.35	0 43	0.46
	Workshops	—	—	—	—		—	—	—	—
	Agricultural	—	—	—	—		—	—	—	—
	Geography	1	84.62	84.62	5.4		2.9	0.17	0 22	0.23
	Educational space for individual classes				100 0	1545.74	54.6	3 22	3.91	4.28
	Library	1	63.46	63.46	100.0		2.2	0.14	0.16	0 17
	Assembly Hall		—	—	—			—	—	—
	Gymnasium	—	—	—	—			—	—	—
	Communual educational space				100.0	63.46	2 2	0.14	0.16	0.17
	Offices	—	—	50.64	50.0		1.8	0 11	0.12	0.14
	Staff Rooms	—	—	50.64	50.0		1.8	0.11	0.12	0 14
	Administrative space				100.0	101.28	3.6	0.22	0.24	0.28
	Storage/Cleaners	-	—	40.29	16 4		1.4	0.09	0.10	0.12
	Canteen/Kitchen	—	—	205.79	83.6		7.2	0.43	0 52	0.57
	Service space				100.0	246.08	8.6	0 52	0.62	0 69
	Toilets Pupils	—	—	80.82	81 0		2.8	0.16	0.20	0.22
	„ Staff	—	—	18.95	19.0		0 7	0.04	0.05	0.05
	Toilets Change room space				100.0	99.77	3.5	0.20	0.25	0.27
	Verandah	-	—	588.05	75.6		20.7	1.25	1.49	1.62
	Linking Unit	—	—	191.20	24.4		6.8	0.35	0.48	0.53
	Circulation space				100.0	779.25	27 5	1.60	1.97	2.15
	TOTAL NET AREA					2835.58	100.0	5.90	7.16	7.84

This particular school was designed for an anticipated enrolment of 480 students (the designed enrolment) but the actual registered enrolment was only 395, at the time the school was visited and the average daily attendance was only 362 students. The difference between the designed enrolment and the actual enrolment was due to small classes in grades 9 and 10 and the difference between the two enrolments will no doubt become less as the students in the lower grades pass through the school, but one cannot be so sure that the average daily attendance will improve. Even if the designed enrolment and the registered enrolment should, one day, be the same, the average daily attendance will still represent an "in-built form of space wastage" which is very difficult to control and would seem to underline the need for the utmost care to be taken in the setting up of minimum per place areas, and, if the cost of building is a primary concern, the need to save space wherever possible.

Table VIII shows that the total net area per place for the designed enrolment is 5,90m² which is considerably higher than the per place area of 3m² suggested in the Asian Model (4.1). A closer examination shows

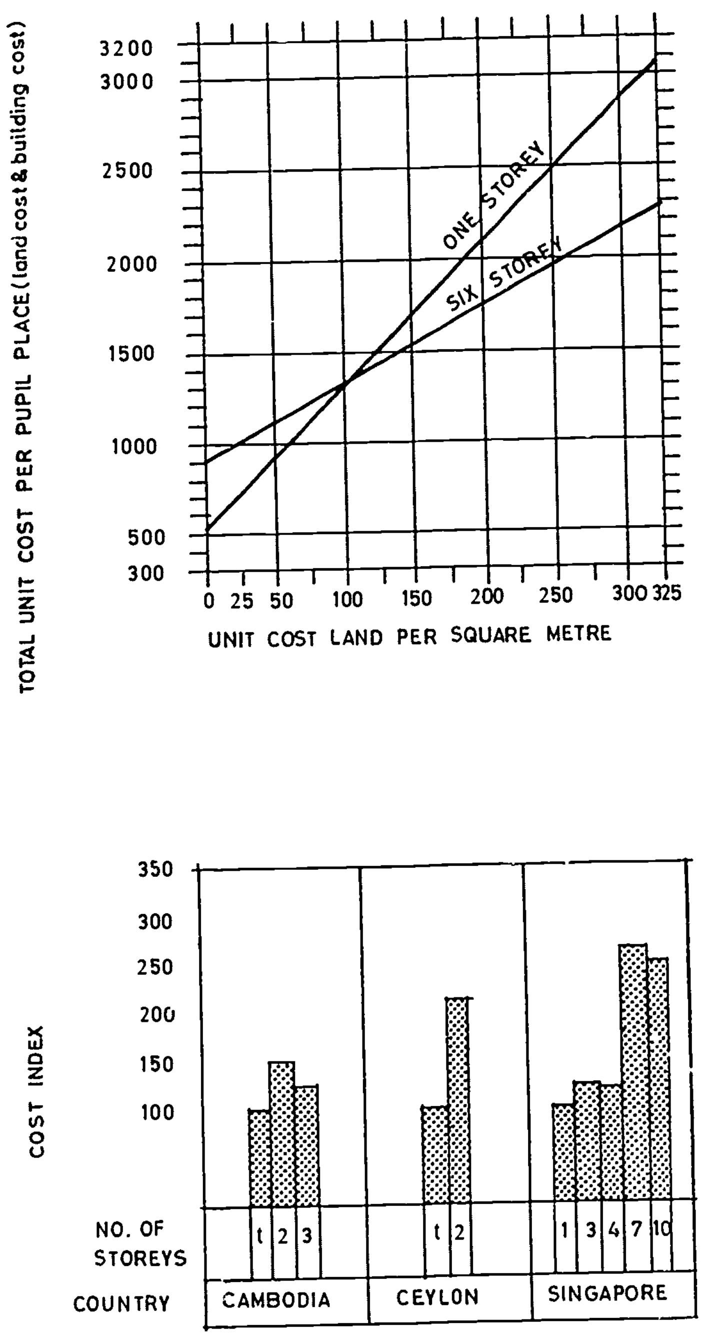


FIG 39

that, at least by ARISBR standards, savings in space could be achieved in the following types:

Type of space	*Saving in area m^2*
General classrooms – reduce from 1.58m^2 to 1.40m^2 ..	86.00
Home science – one multi-purpose laboratory would suffice for this small school ..	141.00
Office and staff room ..	25.00
Circulation space – with this type of layout it is not easy to reduce the length of verandahs. But a redesign of the classrooms to make them more square on plan would result in a saving of approx. ..	65.00
Total possible saving ..	317.00

which is approximately 11% *of the total net area.*

This saving in space may not appear very important but this is the first step in controlling costs. The second step will be to consider how the teaching spaces are being utilised.

Table IX gives a summary of the teaching spaces required for a school of this type, with its present organisation and curriculum. A comparison of the teaching spaces provided and those required is given below:

Unit	*Provided*	*Required*
General classrooms ..	12	9
Geography room ..	1	1
Art room ..	1	1
Science rooms .	3	3
Home Science rooms .	3	1
Music ..	1	-
ETV ..		

An analysis of the teaching space requirements summarised above shows that a saving of 3 general teaching spaces could be effected; that the need for domestic science laboratories is very low, and, since this subject is customarily taken by girls only and as this school is co-educational, the group size will not normally exceed 20, one multipurpose laboratory, wherein the three activities (needlework, cooking and home-craft) can be carried out, will be sufficient; that there is no timetabled instruction in music and therefore this room is not required. It was in fact, being used for ETV classes. Thus, even with the reduced scale of accommodation shown above, the teaching spaces will not be used to their maximum potential.

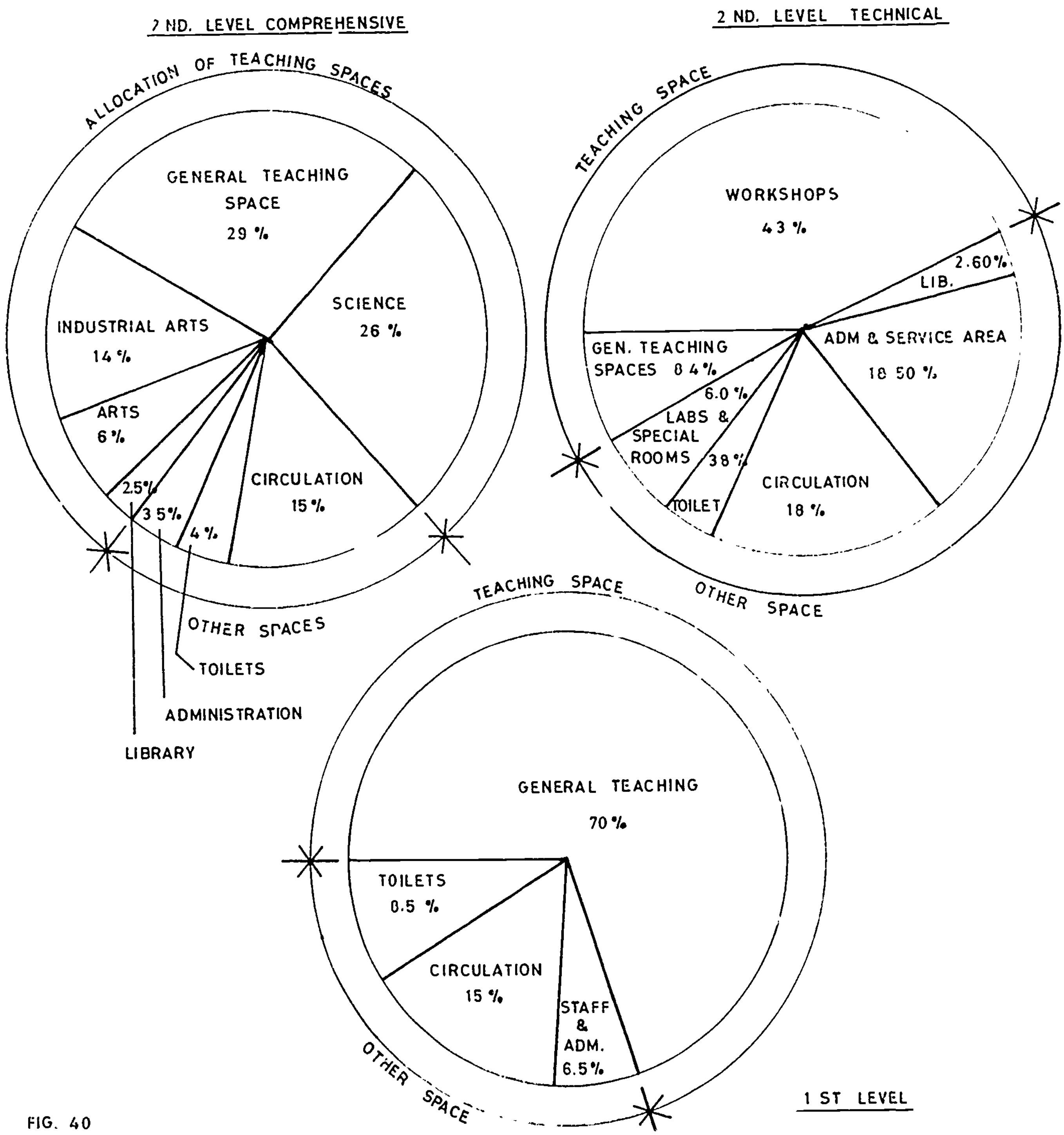

2 ND. LEVEL COMPREHENSIVE
ALLOCATION OF TEACHING SPACES
GENERAL TEACHING SPACE 29 %
SCIENCE 26 %
INDUSTRIAL ARTS 14 %
ARTS 6 %
2.5%
3 5%
4 %
CIRCULATION 15 %
OTHER SPACES
TOILETS
ADMINISTRATION
LIBRARY
2 ND. LEVEL TECHNICAL
TEACHING SPACE
WORKSHOPS 43 %
2.60%
LIB.
ADM & SERVICE AREA 18 50 %
GEN. TEACHING SPACES 8 4 %
6.0 %
LABS & SPECIAL ROOMS
3 8 %
TOILET
CIRCULATION 18 %
OTHER SPACE
TEACHING SPACE
GENERAL TEACHING 70 %
TOILETS 8.5 %
CIRCULATION 15 %
STAFF & ADM. 6.5 %
OTHER SPACE
1 ST LEVEL

FIG. 40

TABLE IX	Summary of Teaching Space Requirements	Ref. no. SG 001,R 107

Type Sec Gen Lower		Total no. of Classes	12			Designed Enrolment	480					
Possible no. of Periods	40	% Factor of	C.R	LAB.	W.S.	S.R.	Assumed no.	C.R.	LAB.	W.S.	S.R.	
Length of Period	40 minutes	Utilization	90	75	--	75	of Periods	36	30	30	30	

Grade	VII	VII	VIII	IX	X	Total no. of space periods	No. of Teaching Spaces Required		Type
Stream	—		—		-				
No of Classes	4		4	2	2				
Subject No. of Periods	- -		—	—	- -				
First Language	28		28	12	12	80	2.22		General Classrooms
Second Language	24		24	12	12	72	2.00		General Classrooms
Literature	12		12	6	6	36	1.00		General Classrooms
Mathematics	16		20	15	15	66	1 84		General Classrooms
Civics	4		4	2	2	12	0.33		General Classrooms
History	10		10	5	5	30	0.84		General Classrooms
Additional Maths	—		—		3	3	0.08		General Classrooms
						299	8.31	= 9 Spaces	General Classrooms
Geography	12		12	6	6	36	1.20	= 1 Space	Special Rooms
Arts	10		10	3	3	26	0 87	= 1 Space	Special Rooms
Science	20		24	15	15	74	2.47	= 3 Spaces	Laboratories
Health Science	2		2	3	—	7	0.19		Laboratories
Domestic Science	12		12	- -	- -	24	0.80	= 1 Space	Laboratories
ETV Language	4		4	—	-	8			ETV
Science	4		—			4	0.53	= 1 Space	ETV
Maths	4		-		—	4			ETV
Physical Education	12		12	4	4	32			Exterior

If the results of the two analyses are combined it would be possible to reduce the total net area of the school by:

		Savings m²
3 classrooms not required 3 x 63.46m²	..	190.00
Reduced area of classrooms 9 x 7.6m²	..	67.00
Reduced area domestic science	..	140.00
Reduced area staff rooms	..	25.00
Reduced area verandahs	..	225.00
Total savings	..	647.00

which represents approximately a 23% saving in space, giving a revised area per place of 4.50m².

Based on the cost analysis given in Table XI, this saving in space represents a reduction in cost of:

			Cost units
Classrooms	..	..	16 600
Home science	..	..	11 900
Staff rooms	..	..	1 900
Circulation	..	..	5 300
Total	..	..	35 700

This represents a cost reduction of *approximately* 16% *per place.*

Thus it can be seen that a critical analysis of the space needs in terms of per place area and teaching space requirements may well indicate that considerable savings in cost can be effected. It will also indicate how essential it is to exercise very strict control over the provision of space.

By extending the analysis in Table IX it could be shown that the existing accommodation would be sufficient for an additional 4 classes (160 students) which would bring the designed enrolment up to 640 students and thus reduce the cost per place, in this case by 25%.

4.05 Cost Analysis

The constant pressures of the need for new buildings to accommodate an ever increasing enrolment, to clear the backlog of school building, and to satisfy the continued demands for improved building facilities in the face of increasing rises in the prices of labour and materials make control over building costs more important than in the past. If costs are to be controlled, then the technicians given this responsibility must know where and how the money is being spent in the buildings.

There is, then, the need for a careful analysis to be made of the distribution of costs of the various parts or elements of the buildings and there is the need to know how these costs are related to the functional requirements of the building. An elemental cost analysis will give an appreciation of the cost consequences of design solutions in relation to the requirements of the building and the function of an element. For example, such an analysis will show the cost of the windows and, thus, how much it costs to provide daylighting within the buildings. In this way the analysis may point to an element which has a disproportionate cost in relation to its function. The cost analysis will also be very useful in the preparation of estimates and cost plans for future projects.

Systems of elemental cost analysis were first used by the Ministry of Education in the United Kingdom in 1950 (4.2) and have proved to be a powerful instrument for the control of school building costs in that country. So successful has the system become that it is now a matter of routine for most offices, whether public or private, to prepare cost analyses for all types of building. These analyses allow a cost comparison to be made of a great variety of design solutions for elements common to different types of buildings. Several clearing houses have been set up for the dissemination of the cost information obtained through the analyses and a standard form for the presentation of the cost analyses (4.3) has now been accepted by all U.K. Government and Local Authorities.

It has been argued by some that a cost analysis is of little value where the choice of building materials is limited and where standard plans are used. In point of fact the opposite is the case. There are many different ways in which traditional materials can be used and there is a need for constant development to improve the techniques in construction using these so-called traditional materials. Reference is made in Chapter 2 to the continued use of a cumbersome roof truss in a very simple type of building. A cost analysis

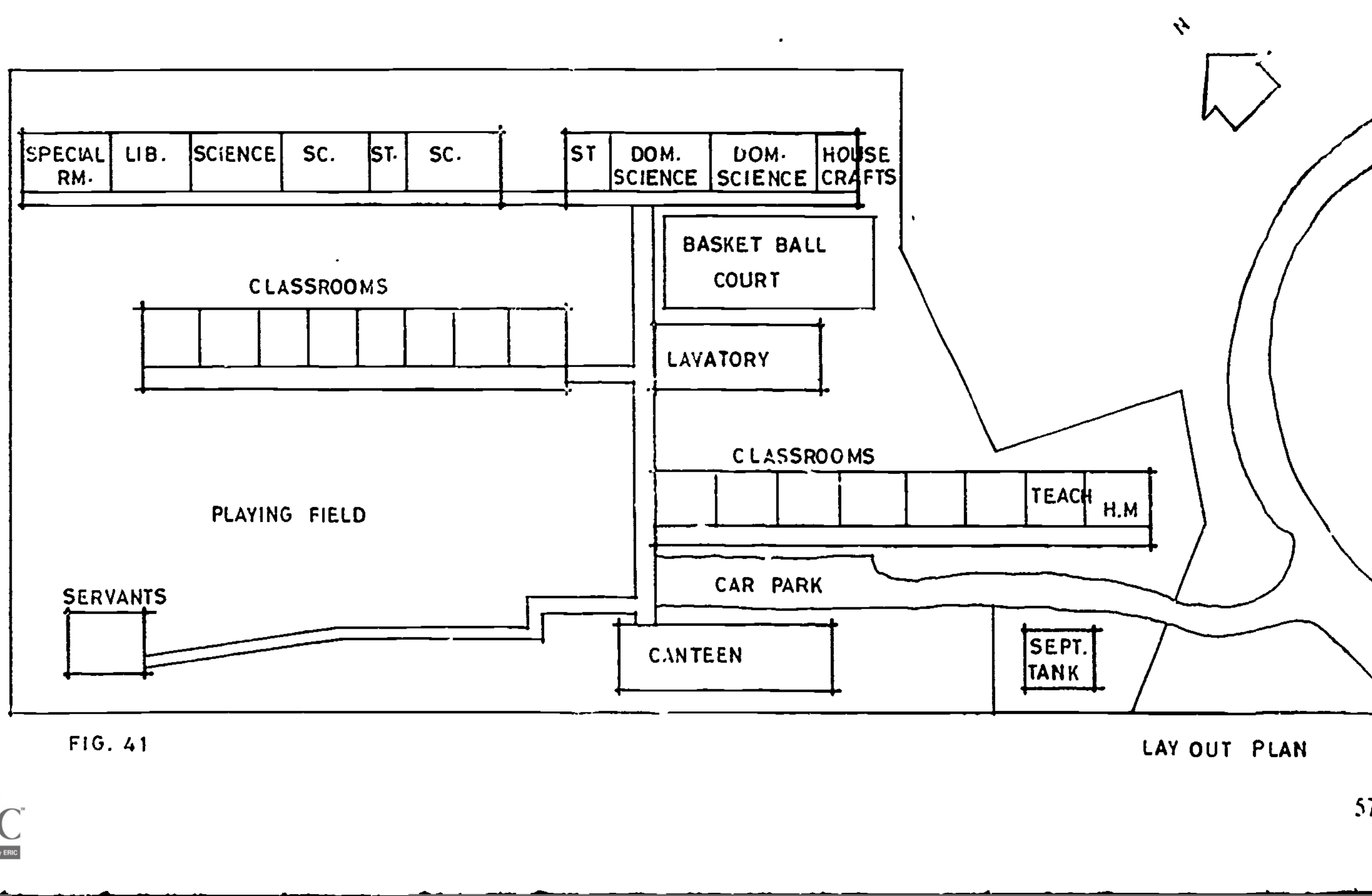


FIG. 41 LAY OUT PLAN

showed that the roof construction costs approximately 43% of the total cost of the building and a more detailed analysis showed that this form of truss had a cost which was disproportionate in relation to its function. The use of the lightweight truss, referred to in Chapter 2, would not only reduce the cost of the building but, equally important, it would consume a smaller quantity of timber, which in many countries, is rising steadily in cost and is becoming more difficult to obtain.

This is but one of many similar examples that could be quoted. No matter how simple the building; no matter how traditional the materials; no matter how standard the standard plan; there is always room for improvement. The cost analysis may not always indicate where a reduction in cost can be achieved, but it may point to a better distribution of costs and where some elements can be improved at the expense of other, less important, elements the overall quality of the building will be improved and better value given to the "client".

One of the problems – the main problem in fact – associated with the preparation of a cost analysis is that it requires detailed cost information in a form that is not readily available in many countries of the Asian region. But even in those countries where it is so often said that there is little cost information available, it is surprising, how much cost information can be obtained once the need for it is recognized. What is required is that the school building departments pull this information together and make use of it.

It may be possible for example, to obtain from the contractor the total cost of the building work of each trade i.e. mason, carpenter, plumber etc. (care being taken to check that the total cost for each trade is equal to the contract sum). This information is likely to be insufficiently detailed for the preparation of a cost analysis, which requires the total cost to be broken down into the various elements – the foundations, the frame (columns and beams), the suspended roof and floor slabs, the stairs, etc. In such a case the Building Department will need to measure the quantities of work in the various elements and apportion the total costs to each element. This method will add to the work of the School Buildings Department and the technicians who are to undertake this additional work, must be convinced of the usefulness and the necessity of preparing cost analyses.

More often than not the building departments prepare estimates of costs for new works. In such cases there should be no difficulty in preparing these estimates in an elemental form, and although departmental prices are not so useful as those which can be obtained from a contractor's quotation, the elemental type estimate will serve much the same purpose.

Where the School Building Department acts in the dual capacity of design and constructing authority, then there should be no difficulties whatsoever in obtaining the detailed cost information required. Experience shows, however, that many departments fail to keep detailed records of costs and it is in these cases that the introduction of a system of cost analysis will be most useful in introducing controls of the type described above.

There are no hard and fast rules concerning the number of elements into which a building is best divided. The number will depend on national practices of costing, the complexity of the building and the availability of cost information. The essential point is that cost analyses should always contain the same elements and the same conventions should be consistently used in deciding which items should go where (4.4). An element has been described as a component common to most buildings and which usually fulfils the same *function*, irrespective of its design and specification.

School buildings may be simply and conveniently divided into the following elements:

Foundations
Floors
Roof
Stairs
Walls
Services

or into the elements shown in Table X, which is in a form agreed between the three Unesco sponsored School Building Research Institutes. The form issued by the Building Cost Information Service of the United Kingdom contains 32 elements. Not all buildings will have all of the elements – obviously a single storey building will not have the element "stairs" - this is of less consequence than having a schedule of elements which has not been agreed to by all parties. It should be remembered that the criteria for defining an element is one of function and not necessarily one of cost or "trade classification". The work of a carpenter for example can be spread throughout a number of elements – floors, staircases, roof and occasionally foundations and walls.

The items which should be included in an element are largely a matter of common sense and convenience, the essential principle being that the same conventions are observed in deciding which items go where. Experience gained in the preparation of analyses may suggest that the adopted schedule of elements may require modification to suit particular procedures in the country concerned.

The most useful and most commonly accepted elemental cost unit is that related to the total net floor area of the building and is obtained by dividing the cost of the element by the total net floor area, the floor area being measured to the internal face of the external walls and over partitions and stair wells. Enclosed tank rooms, open verandahs and the like should be included in the floor area.

TABLE X

COST ANALYSIS – SENIOR SECONDARY SCHOOL

Summary Details

No. of places	640	Tender date	21.11 70
Net floor area	2593 m²	Description	4 storey teaching block including toilets, single storey administration block and assembly hall. Structure: load bearing masonry walls, R/C suspended floors, flat roof.
Area per place	4.05 m²		
Net building cost	$ 70,117 –		
Net cost per place	$ 109.56		
Gross cost	$ 84,419 – (includes additional works costs and design costs)		

No. element	*No. sub-element*	*Elements and sub-elements*	*Costs $ Element*	*Costs $ Sub-element*	*% of net cost Element*	*% of net cost Sub-element*	*Cost per m² $*
1		EXCAVATION AND FOUNDATION	5,656.51	-	8 07	—	2.18
	1. 1.	Excavation and earthworks	—	—	—	—	—
	1. 2.	Foundations	—	—	—	—	—
2		VERTICAL ELEMENTS	18,662.54	—	26.62	—	7.19
	2. 1.	Load bearing walls and columns	—	—	—	—	—
	2. 1. 1.	Load bearing walls	—	6,159 00	—	8.78	2.37
	2. 1. 2.	Columns and panel walls	—	—	—	—	—
	2. 2.	Partition walls	—	4,463.75	—	6.36	1.72
	2. 3.	Doors and windows		7,630 60	—	10.88	2 94
	2. 4	Sun screens		409.19	—	0 60	0.16
3		HORIZONTAL ELEMENTS	22,654 85	—	32.31	—	8.72
	3. 1.	Ground floor	—	1,274 22	—	1.82	0.49
	3. 2.	Intermediate floor	—	12,082.60	—	17.23	4.65
	3. 3.	Vertical circulation	-	770.03	—	1.09	0.29
	3. 4.	Roofs and roofing	—	8,528.00	—	12.17	3.29
4		FINISHING MATERIALS	10,106.[illegible]	—	14.42	—	3.90
	4. 1.	Walls	—	3,970.20	—	5 65	1.52
	4. 2.	Ceiling	—	835 50	—	1.20	0.32
	4. 3.	Floor	—	2,272.75	—	3 23	0.88
	4. 4.	Other surfaces	—	—	—	—	—
	4. 5	Built in furniture	—	3,028.00	—	4.34	1.18
5		PLUMBING AND SEWERAGE	4,228.06	—	6.02	—	1.62
	5. 1.	Sanitary installation	—	3,168 32	—	4.52	1.22
	5. 2.	P & S Special for laboratories	—	1,059.74	—	1.50	0.40
6		MECHANICAL INSTALLATION	8,808.54	—	—	—	3.40
	6. 1.	Electrical installation	—	8,808 54	12.56	12 56	3.40
	6 2.	Air-conditioning	—	—	—	—	—
		NET BUILDING COST Total	70,117.00	—	100.00	100.00	27.01
7		ADDITIONAL WORKS	5,432.00	% of net building cost		7.75	
8		DESIGN COSTS	8,873.00	% of gross cost		10.51	
9		GROSS COST	84,419.00				

Thus the elemental cost of the roof, sub-element 3.4 shown in Table X is obtained by adding together the costs of the various items to be included in the element, which is then divided by the total net floor area, which in this case is 2593m²:

Cost of roof element

Structure i.e. the reinforced concrete slab and beams, including the cost of the steel reinforcement, formwork and the bearing pads for the beams ..	$7,197
Roof covering, i.e. the weatherproofing of the structural part of the roof, including preparing the slab, applying the waterproofing membrane, screed and paving tiles, rainwater outlets and gullies, and the rain waterpipes ..	$1,331
Cost of element ..	$8,528

$$\frac{\text{Element cost } \$\ 8528}{\text{Total net floor area } 2593\text{m}^2} = \$\ 3.29 \text{ per m}^2 \text{ of total floor area}$$

Percentage of element cost to total net building cost:

$$\frac{8528 \times 100}{70117} = 12.17\%$$

where the total building cost is $ 70,117

Table X gives an example of an amplified form of cost analysis, which is sufficient to show the distribution of costs throughout the building and to isolate those elements which have a high cost and which should be the first to be examined for possible cost reduction. There is little point in the early stages of looking for cost savings in, for example, such an element as stairs, as the cost of this element is only $ 0.29 m² and it is most unlikely that significant savings can be made on such a small item. In point of fact, this elemental cost should be increased to allow the provision of at least one additional stair in order to improve circulation within the building and to provide better means of escape in case of an emergency. It is more likely that savings can be found in such elements as the intermediate floor (element 3.2) or in the external walls (element 2.1.1.). It will be seen that if about 5% could be saved on the elemental cost of the intermediate floors, equivalent to approximately $ 0.20, this would offset the cost of the additional stair. It should be further noticed that this decision would *reduce* the elemental cost of the intermediate floors from $ 34.71 to $ 34.51 and *increase* the elemental cost of the stair from $ 0.29 to $ 0. 49.

This redistribution of costs will improve the functional efficiency of this item by 100% and it will improve the functional efficiency of the building as a whole, thereby providing better value for money spent.

The form of cost analysis shown in Table X, although useful, has its limitations in that it says nothing about the "quantity factor" of the element, such as for example, how many square metres of roof are being used, or the "quality factor" i.e. the design and specification of the roof. Account must be taken of these two factors in the cost analysis if the analyses are to be used for comparing costs between buildings, or as the basis for cost estimating and cost planning of future projects. An amplified form of cost analysis is shown in Appendix IV. This form omits the percentage value of the cost element, but includes several other useful items of information, namely:

(I) The "quantity factor" which is provided for in the column "Element Unit Quantity". The area of the unit or the number of units is entered in this column, i.e. the roof area, or the number of persons using the toilets.

(II) The "quality factor" which is provided for by the specification and the "Element Unit Rate". The "Element Unit Rate" is obtained by dividing the cost of the element by the "Element Unit Quantity". Taking the previous example of the roof element in Table X, the cost of the element is $ 8.528 and the area of roof (measured on plan) is 1083m²:

$$\text{Element Unit Rate} \ \frac{\text{cost of element}}{\text{area of element}} = \frac{\$\ 8,528}{1,088} = \$\ 7.86 \text{ m}^2$$

The "Element Unit Rate" is an all-in rate for this particular design and specification for a flat roof. Other designs and specifications will of course have a different all-in rate. The value of including the "Element Unit Quantity" in the cost analysis is that it provides for a ratio to be established between the element and the total floor area which is necessary if the cost of an element in one building is to be compared with that of a similar element in another building.

To give an example, the elemental costs and ratio of wall to total floor area for the external walls in two buildings are as given below:

	Building A	*Building B*
Element Cost	32.4	28.6
Ratio (wall to floor area)	0.37	0.256

It would appear that the external wall used in building B provides a reasonable standard at less cost than that in building A, but it will be observed that the ratios of walls to floor are not the same and therefore the costs must be adjusted to allow for this. If the standard of building B is used then the adjusted elemental cost of the external walls in building A would be:

$$\frac{.37}{.256} \times 28.6 = 41.9$$

The adjustment shown above indicates that if the design and specification of the external walls of building B was used in the construction of building A, the element cost for building A would be increased from 32.4 cost units to 41.9 cost units. This example underlines the care that must be taken in interpreting the results of any cost analysis. One should not jump to hasty conclusions without checking through all of the factors which can influence the cost of the element.

Another form of cost analysis, in two parts, is shown in Table XI. The first part breaks down the capital cost into its component parts. The second part shows how the net building cost is distributed throughout the various units of accommodation and gives some indication of the variation in cost between the units. This form of cost analysis is perhaps more easily understood by a "non-technical" administrator. It also allows a ready comparison of the cost of similar units in other schools, and will provide a basis for arriving at an estimate of cost for future projects.

TABLE XI	COST ANALYSIS – CAPITAL COST & UNIT OF ACCOMMODATION COST	Ref: 56/001 R 107 Date: 1.10.69

ENROLMENTS: Designed 480. Actual Registered 395. Average Daily Attendance 262.

UNIT	COST	%	COST PER PUPIL PLACE Designed	Actual Regd.	Av. Daily Attdce.	Cost per m²	Ratio
CAPITAL COST	663,346	100 0	1,382	1,679	1,832		
Land	148,800	22 4	310	376	412		
Land Development Cost	150,000	22 6	312	380	414		
Additional Works Cost	27,338	4 1	57	69	75		
Design Cost	20,408	3 1	43	52	56		
Furniture	—		-	--	—		
Equipment	94,000	14 2	196	238	260		
Net Building Cost	222,800	33 6	464	564	615		
NET BUILDING COST	222,800	100 0	464	564	615	78.52	1.00
General Classrooms	56,091	25 3	117	142	155	73 61	0.94
Special „	11,900	5 3	25	30	33	70.66	0.94
Science Rooms	—			—	—	—	—
Laboratories	46,690	20.9	97	118	129	142.08	1 81
Home Science	22,167	9 9	46	56	61	104.69	1.33
Commerce	--			- -	—	—	—
Art	5,950	2 6	12	15	16	70 66	0 90
Work Shops		-		—	-	- -	—
Agricultural	—			-	- -	—	-
Library	4,734	2 2	10	12	13	78 04	1.00
Assembly Hall	—	--		- -	-	—	—
Gymnasium	—		-	—	—	—	—
Administrative Space	9,089	4.1	19	23	25	89 74	1.14
Service Space	23,098	10.4	48	59	64	93.18	1.19
Toilets	21,196	9 5	44	54	59	212.45	2 70
Circulation Space	21,885	9 8	46	55	60	28.08	0.36

Ratio — Cost per m² Net Building Cost to Cost per m² of Unit Building Cost. Note. Cost per pupil place rounded off to nearest Cost Unit.

The use of the second part of the analysis is illustrated by reference to the example on page 56. Assuming the costs to be constant, the savings can be estimated as follows:

Classrooms

Current cost per m^2 = 73.61 cost units.

The new classrooms will have an area reduced by about 12%, but as many of the costs will remain at the original full value, i.e. the door, electrical installation, partition walls, fittings etc., the cost per m^2 of the reduced classrooms will increase. It is estimated that the cost per m^2 will increase by 6%.

Net area of new classrooms 505 m^2		
Current cost of classrooms	56,091	
Estimated cost of new classrooms 505 x 73.61 x 1 06 =	39,403	
Savings	16,688	cost units

Home Science Unit

This unit has been drastically reduced in area and consequently the cost of fitting the unit with benches sinks, etc., required in a multipurpose unit will form a high proportion of the cost of the new unit and its cost will be at least as high as the science laboratories, therefore, allowing the same cost of 142.08 cost units per m^2.

Cost of existing unit	22,167	
Cost of new unit 72 x 142.08	10,229	
Saving in cost	11,970	cost units

It is considered that this last method of estimating the savings in cost is more realistic than using the building cost per m^2 multiplied by the total saving in area. The estimated savings in cost based on the cost analysis, Table XI, amounts to 35,700 cost units as against approximately 50,600 cost units using the building cost per m^2 method (647 m^2 x 78.52 = 50,623). This method completely ignores the fact that the cost of other, and expensive units, such as the science laboratories and toilets, will remain unchanged.

Yet another use of cost analysis (Table XII) shows a comparative cost analysis of three sizes of classrooms. (4.6)

There is only about 3% difference between the costs of classroom A and classrooms B & C, which is largely accounted for by the additional 2 m^2 of space, and, an increase in area will inevitably bring about an increase in costs. But what may not be apparent and what the cost analysis makes clear is that the main difference in cost between the three classrooms lies in the cost of windows. In this example the designer has simply provided the maximum area of windows without consideration of whether or not this is required to provide the desired level of illumination. A calculation of the required amount of window area in relation to the needs for illumination (see chapter 6), may show that a reduction of cost can be made in this element which will bring down the cost of classrooms type B & C to that of the cost of classroom A. If this can be done, and since the shape of classroom B & C is thought to be preferable for the present situation in the Asian region where most teaching is teacher-centred, then one can say that the efficiency of the unit has been improved at no extra cost.

4.06 Cost Planning

So far the point discussed has hinged on the fact that, if costs are to be controlled, there must first be an appreciation of how the money is being spent on school buildings and it has been shown how an overprovision of space affects the cost. The many ways in which the space within the building and the cost of the building can be analysed have been shown and it has been clarified how the analyses may point to areas where economies might be effected. The space and cost analyses will also produce a great deal of information that can be used in the preparation of the designs for new projects and the next step is to consider how this information can be applied.

It has been implied above that, if costs are to be controlled, there must be very strict control over the total areas of teaching spaces to be provided in the school as well as over the amount of money that can be spent on the provision of this minimum amount of space. It is therefore imperative that the designer begin to learn how to design the schools within the twin constraints of minimum space and maximum costs.

However, it must be emphasised that neither the minimum space nor the maximum cost limits can be fixed in an arbitrary manner and moreover the performance standards must be carefully controlled. It would be foolish, for example, to require a minimum level of illumination on the working plane of 300 lux if the cost limit was based on the cost of providing only 100 lux. In many countries of the region the budget for school building is so limited that it is insufficient even for the construction of basic classrooms. Somehow or other, money has also to be found for the construction of laboratories, workshops etc. In such instances a clear and unambiguous statement is required on whether quality or quantity is desired so that the designer can strike a correct balance in the final design.

The unfortunate side of all this is that the less developed the country is, the least value for money, so far as building is concerned, is usually obtained. No matter what is said about the high expenditure on school building per place in the United States of America, the school authorities get better value for their dollar than many other countries, including the United Kingdom which prides itself on its "low cost" schools.

TABLE XII

Comparative Elemental Cost Analysis of Varying Sizes of Classrooms

(Costs are given in Khmer Republic currency — Riels)

Type	A		B		C	
Classroom size	6,00 m x 9,00 m		7,00 m x 8,00 m		8,00 m x 7,00 m	
Net Area m²	54,00		56,00		56,00	
Storey Height m	3,60		3,60		3,60	
	Cost in Riels		*Cost in Riels*		*Cost in Riels*	
Work below ground level						
Excavation	204 33		261.80		250.50	
R c footings	5,065.83		6,296.29		6,361.74	
Brick work	2,802.36		2,522.12		2,462.68	
Back fill	2,272.16	10,344.68	2,393 60	11,473 81	2,288.00	11,362.92
R c frame and walls						
Columns and beams	13,181.95		12,153 57		12,870.90	
Walls	8,619 22		6,858.87		7,275.91	
Grills	1,971.20	23,772 37	1,971.20	20,983.64	1,971.20	22,118.09
Roof						
Framing	11,600.16		11,326.82		11,977.00	
Tiles	18,791 20		19,448.00		18,518 50	
Gutter and RWP	5,389.72	35,781.08	4,864.20	35,639 02	4,338.68	30,834.18
Floor						
Concrete floor and tiles	20,966.19	20.966.19	21,156.40	21,156.40	20,930.20	20,930 20
Joinery						
Windows	9,405.00		14,044.80		14,630.00	
Doors	1,279.87	10,684.87	1,279.87	15,324.67	1,279.87	15,909 87
Plaster and paint						
Internally	5,863.34		6,516.99		6,348.98	
Externally	1,938.42	7,801.76	1,428.53	7,945 52	1,144.90	7,493.88
TOTAL		109,350.95		112,523.06		112,649.14

Note: *Costs include a 2 metre wide verandah and are based on similar construction for all classrooms.*

This is perhaps a long way round of saying that space and cost limits must be such that they can be met by a competent designer and that the standards of quality which can only be achieved within the cost limit, must be acceptable by the community, the politicians and the educators themselves.

A technique known as cost planning developed by the Ministry of Education in the United Kingdom, early in the 1950's along with the development of the system of cost analysis, has as its purpose (4.2) to use the data obtained from cost analysis in planning other buildings so as to ensure that the total cost will represent:

(a) a proper balance between the total net area and the cost per square metre.

(b) a proper balance between the elements in the proposed building.

The cost plan provides a basis which enables the designer to judge what should be spent on each element and to control the costs of a building both in the early design stages and with respect of the ultimate expenditure.

By using the cost data from the cost analysis of a building similar in quality and type, a cost plan can be prepared virtually by discussion with the designer before detailed design commences. For example, it might be possible, at this early stage, to decide whether or not the building is to be of 3 or 4 stories.

The cost plan should thus, help in the improvement of the overall quality of a school building by guiding the designer's choice in the early design stage, so that, for example, an acoustic treatment to the ceilings can be provided by making savings on other elements. This will, in all probability, avoid the all too common situation in which a bid is received which exceeds the cost limit, thereby causing alterations to be made to the design so that the cost can be reduced and brought within the cost limit – usually with unfavourable results on the final design.

An example of the use of cost planning

The School Building Department has been instructed to prepare designs for the first of a series of 840 place Second Level (General) schools for boys within a new cost limit of $ 88.00 per place. This new cost limit was fixed without consulting the Building Department and represents an arbitrary reduction of 20% on the old cost limit.

Based on the agreed schedule of accommodation a target of 2578 m² has been set for the total net floor area of 3,07 m² per place.

In the preparation of the preliminary cost plan, given in Appendix V, the School Building Department has used the cost analysis for a 640 place school which is given in Appendix IV with the elemental costs per m² adjusted to allow for a 6% increase in costs since the date of that particular tender.

The Education Department has also requested that some "flexibility" be provided for the arrangement of the teaching spaces, and the designers are considering using a framed structure in place of the traditional load bearing brick structure. The need for the future extension of the building must also be kept in mind.

The preliminary thinking of the designers is to provide one three storey block providing a total net area of 2130 m² and a single storey block providing a net floor area of 448 m².

It is pointed out that neither this preliminary concept nor the specification or details of the cost plan should be considered as final. They simply provide a framework within which the designer can work with some guarantee that his final design will come within the cost limit. However, the designer cannot ignore the cost plan. If any element of his design should exceed the elemental cost target then either he must re-design the element to bring it within the target cost limit, or, he must re-design other elements so that sufficient savings in cost are effected, to offset the higher cost of that particular element. It is for these reasons that the designer must be involved in the preparation of the cost plan and he must be in agreement with any decision made on the quality of an element or the type of construction envisaged.

The estimated cost per place of $ 92.92 arrived at in the preliminary cost plan exceeds the cost limit of $ 88.00 by $ 4.92 and there may be a tendency at this stage to say "this is near enough", particularly as there is a reserve of over $ 7,00 per place. But this tendency should be resisted as, first, no detailed planning has been done at this stage – not even a sketch plan; secondly, the new cost limit was fixed without consultation with the Building Department; and thirdly, the request to build-in some flexibility would appear to be likely to add to the cost.

The correct procedure in this case is to report back to the Education Department that it is unlikely that the school can be built within the new cost limit and to seek agreement either to increase the cost per place or to reduce the facilities it is proposed to provide. A carefully prepared cost plan will provide a firm base on which to negotiate with the Education Department for a decision either way.

This example of a preliminary cost plan may appear to be cumbersome and unnecessarily complicated, due to the somewhat lengthy explanation of the procedure. Greater familiarisation with the technique will not only make it possible to consider the two stages as one, that is, the initial and revised solutions, but will allow simplification of many of the calculations. Nevertheless a record should be kept of the principal decisions made concerning any element and the cost plan should be updated against any later changes.

Purchasing and Contractual Procedures

When considering ways and means of controlling costs, it would be useful to check on out-of-date and cumbersome purchasing methods and contractual procedures. Regulations which needlessly add to the cost of building or which inhibit the introduction of more efficient methods should be reviewed and fresh regulations should be framed.

The success which many manufacturing industries have achieved in keeping down costs, is invariably based on long production runs and careful purchase of materials in bulk.

These principles can also be adapted to suit a school building programme.

In any school, there are certain elements which are standard, such as doors, hardware, light fittings, furniture, etc. This somewhat limited range can be extended into structural components – standard sized columns, beams, flooring units etc.

Any, or all of these elements could be subject to the principle of ordering in bulk. The building programme for at least one year and preferably more, will, of course, need to be established well in advance so that the number of elements required can be calculated, and competitive bids obtained, and delivery dates programmed.

Performance specifications will need to be prepared and tendering procedures amended to allow for this and to ensure that all contractors buy the elements from the nominated manufacturer. Stockpiling of the element is not required by building authority – it will be the responsibility of the manufacturer to ensure that adequate supplies are available and to arrange for delivery.

To obtain the benefit of long runs, serial contracting has been introduced into the tendering procedures by many countries where it is found that traditional forms of tendering are no longer entirely satisfactory.

Under this system selected contractors are invited to bid for a typical school building which is the first of a limited series. The contractor submitting the lowest and most satisfactory bid is then given the opportunity of negotiating for a number of schools at his original prices with a guaranteed minimum contract value. This form of contract must be subject to the constructing authority being satisfied with the performance of the first contract and legal safeguards to protect the authority can be written into the conditions of contract.

It has been found that bids by contractors are more competitive under this system as, with the anticipation of a series of jobs, they can better organise their work-force, their equipment and supplies of materials.

The system of serial contracting also allows the bigger contractors, who are often better organised better equipped and have substantial financial backing, to compete with the smaller contractor with the possibility of the building programme being completed on time and within the contracted sum.

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Chapter 5

SITES FOR SCHOOLS

5.01 General

It would be nice to think that the usual way a site for a school is selected was by the careful preparation of a list of desiderata followed by a search, at the conclusion of which the ideal site was found and acquired. No doubt this does happen occasionally as so many books have been written giving instructions on how to specify what is needed and how to conduct the search. (5.1; 5.2; 5.3; 5.4; 5.5). The realities of the situation are, however, usually somewhat different. Sites are often suggested (and sometimes given) by owners who have no use for the land. Many sites of this type are excellent; a large number are of less use to the school than they were to the former owner. Usually, sites are selected in urban areas, because they are the only urban sites available. (Figure 42). In rural areas, sites may be acquired because they are cheap to purchase, although often less than suitable for the purpose for which they are intended. In mountainous country, small areas of land near river beds are often the only possible level places on which to build schools (Plate 4) whilst, in desert areas, a source of drinking water may be a decisive factor in location.

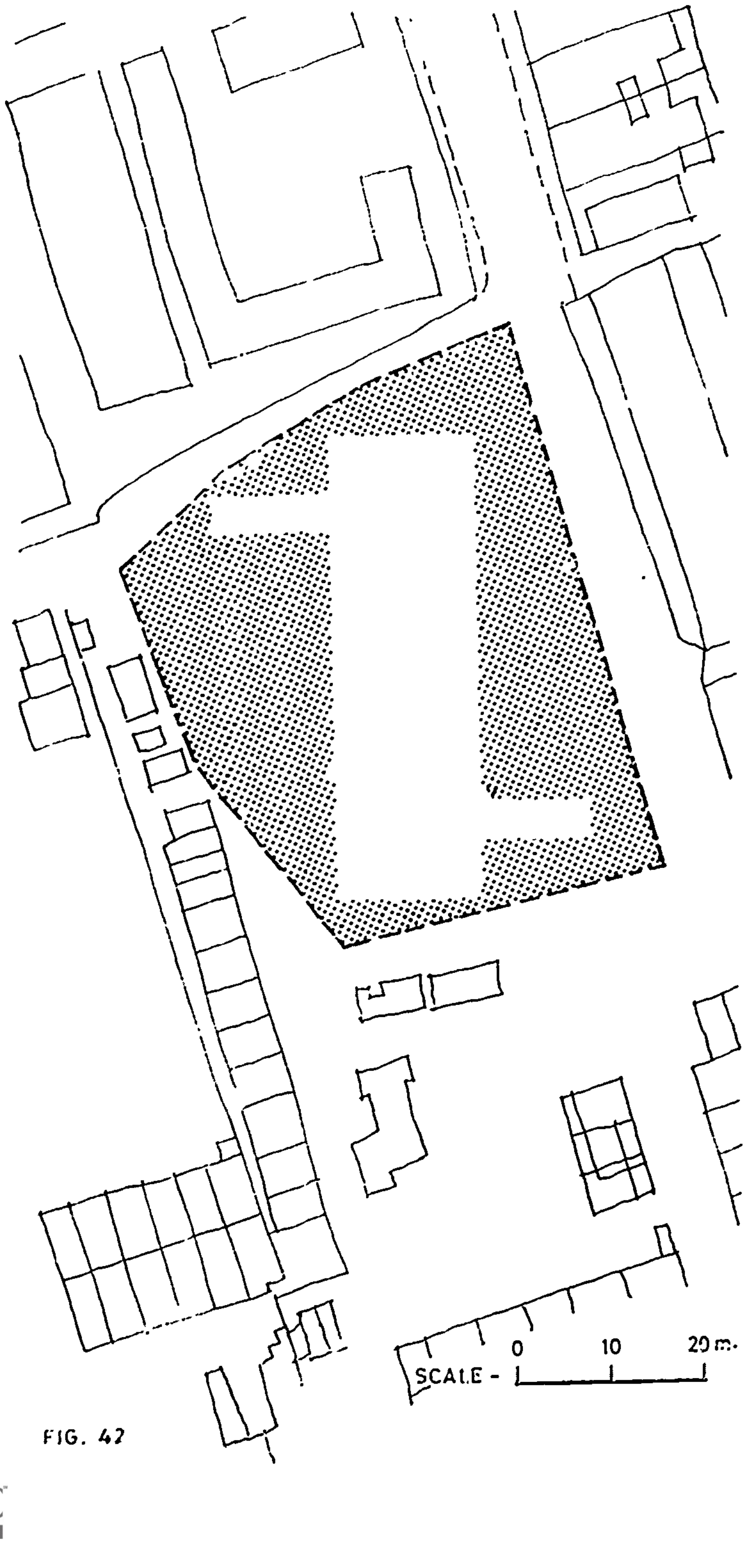

FIG. 42

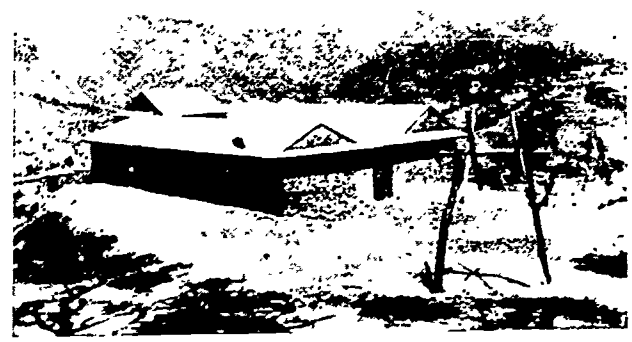

Plate 4

The approach to the site problem that is most likely to be of use is, thus, assuming a site is given, to find out what can be done with it? Those in the Asian region who are in the happy position of being able to *select* school sites, will be able to establish criteria for selection by "reversing" the approach suggested in this chapter.

5.02 The Population to be housed

(a) *Urban areas*. Urban sites are likely to be small. The education authority will usually specify the number of children for which the new school building is required.

Using the very rough guide of $2m^2$ per place for first and $3.5m^2$ per place for second level education, the plan area of the building and the number of stories can be approximately estimated. The approximate cost can also be determined and the sort of out-door facilities provided by that portion of the site left over after building, can be described.

The accommodation desired can then be discussed with the education authority and, if necessary, the population of the school adjusted so that it is more compatible with the capacity of the site and the budget.

Of course, from a theoretical view-point, any number of children can be housed on one site. A bold experiment by Singapore (Plate 5) with a 10-storey primary school on a small site (Figure 43) (5.6; 5.7; 5.8) resulted in a decision to continue with high-rise buildings for schools, but to reduce the number of stories (see also chapter 16). Thus, for a given site size, the population of the school will be limited by the constraint of height.

In the case of the school site illustrated in Figure 42, the education authority originally hoped to be able to house 1800 children but, after study of the building possibilities, it was eventually found that only 720 could be accommodated. Used for two shifts, 1440 places can be provided.

Much ingenuity has been used in designing for small urban sites. The ground and sixth floors of the school shown in Figure 43, have been designed as play areas and canteen respectively. Some schools, one of which is 14 stories high, in Hong Kong, have entire floors designed as play areas at various stories of the building.

Another possibility of providing facilities for education on a very small site is well illustrated in the design for a school at Pimlico, London, U.K. (Figure 44) (5.6).

Plate 5

The three sites shown in Figure 42, 43, and 44 have the following areas and pupil populations:

Figure 42: Area 2,124m²; 720 children, 2.95m² per place, (data for single session). (4 stories).

Figure 43: Area 3,863m²; 1534 children, 2.52m² per place. (data for single session). (10 stories).

Figure 44. Area 18,000m²; 1725 children, 10.43m² per place. (4 stories).

The Singapore school (Figure 43) has been the subject of a study subsequent to its construction and use (5.6; 5.7 and 5.8) and one of the important comments made was that, "most teachers felt that discipline was much easier to maintain if play spaces were adequate and not too far away from the teaching spaces." Thus, in discussing the number of children that can be housed on a small-site, facility for play seems to be as important a factor as facility for work.

One of the ways of ensuring that adequate sites are provided for schools and, moreover, that the schools are tailored in respect of their enrolment to a defined catchment area, is to integrate the educational plant in schemes of new housing development. Hong Kong provides many good examples of this approach, one of which is illustrated in Figure 45. The integration need not, of course, be at ground level. Kindergarten can, and often do, form one floor in a multi-storied block of flats; the site is then a building rather than a tract of land.

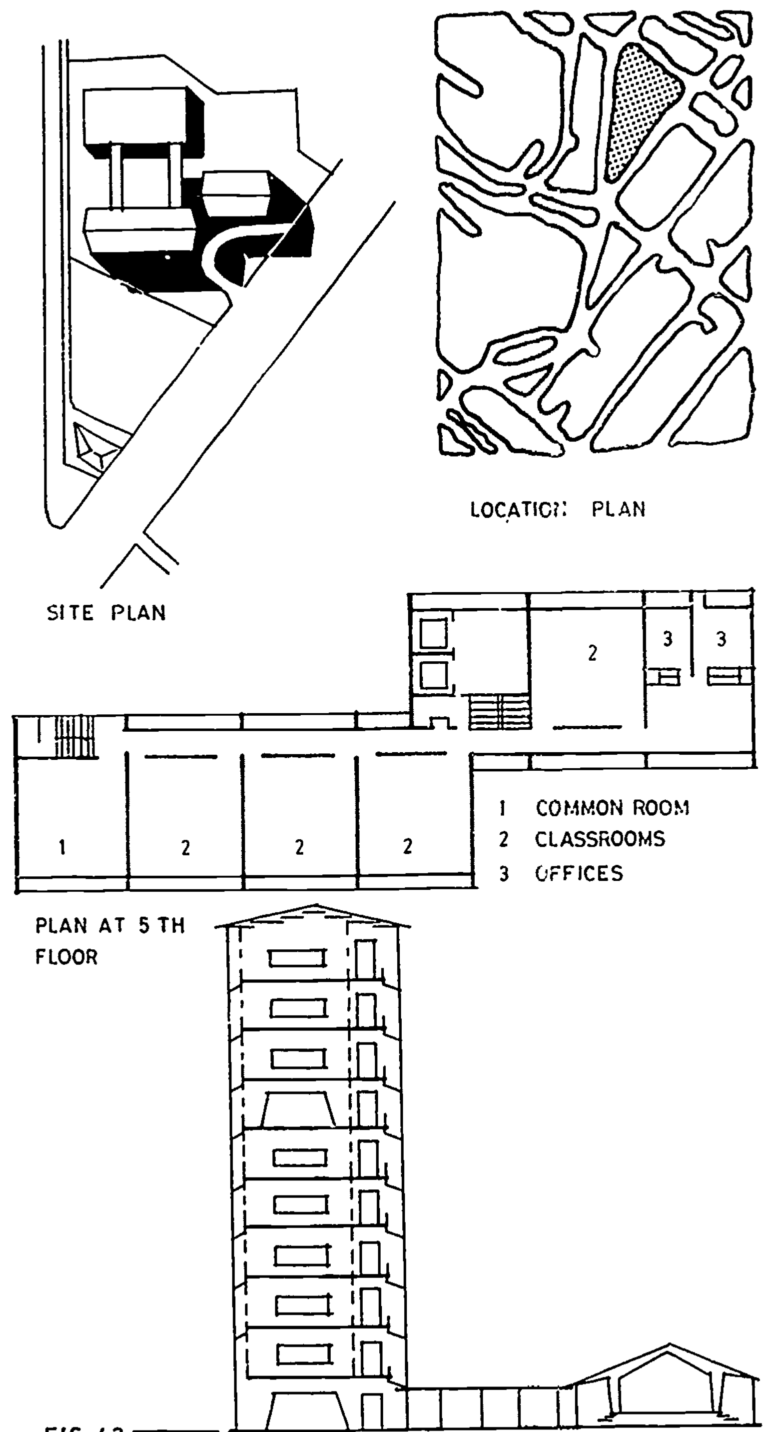

FIG.43

(b) Rural Areas

In some rural areas, where the terrain comprises mountain, rich paddy land or lagoon, sites suitable for construction may be as difficult to find and, when found, as small or smaller than those in urban areas. (Plates 6a, 6b and 6c).

Much of what has been said above concerning discussions with education officials on the enrolment planned for the school will be relevant, with the difference that, in rural areas, the height of the building will probably be confined to that of nearby houses. This is because the materials available for construction and the skills of the local builders will often result in the designer deciding to use familiar "local" construction methods, as those of the school shown in Plate 7a, which reflect the construction of a nearby house (Plate 7b).

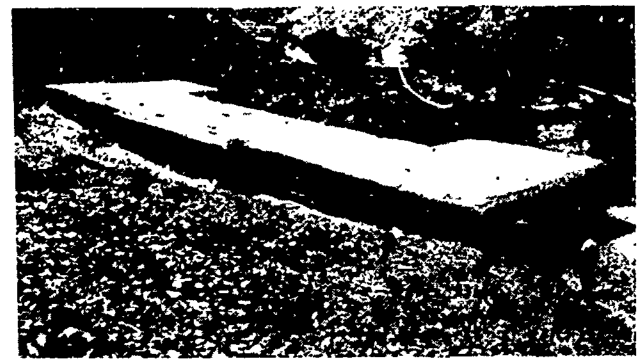

Plate 6a

Plate 6b

Plate 6c

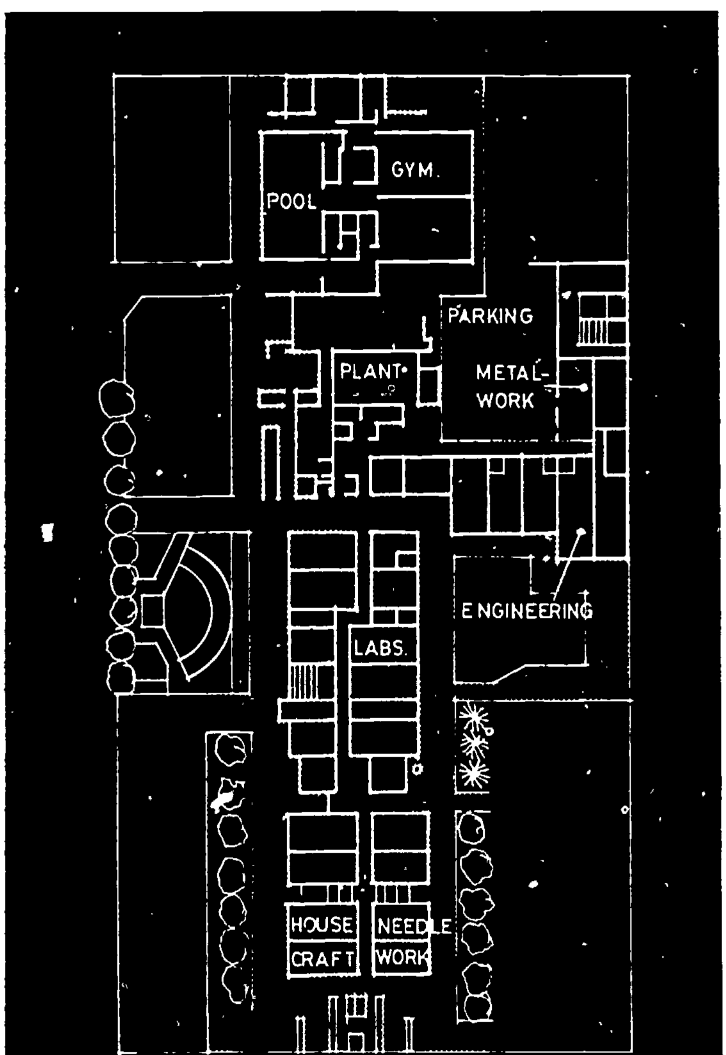

FIG. 44

Plate 7 a

Plate 7 b

If a rural site is small, then the discussions concerning the enrolment for the school building will follow similar lines to those for urban schools on small sites. If the rural site is large then another approach will be necessary. Experience with education authorities, providing schools in rural areas, suggests that they either under-estimate the size of the school or else seriously over-estimate it. Over-estimates are most common where new tracts of land are being opened and the Government is providing the basic amenities for the new farmers who will build their own houses. Most schemes of this sort take many years to develop and, if the ultimate target for development is say 1000 families, and the average family is 6 persons, then *ultimately* there may be a need for between one and two thousand school places. The designer will have to advise the education authority not to build a 2,000 place school at once, but to phase the construction over several years in such a way that the available accommodation is always just slightly ahead of the needs.

This is administratively a difficult thing to do in countries where the administration is already overloaded. That, of course, is why the administrator would prefer to build a 2,000 place unit, pay for it and move on to the next administrative problem instead of dealing with four or five separate building contracts, spread out over a ten year period. In matters such as this the designer proposes and the administrator disposes.

Under-estimation of the population likely to attend school is also a common feature of school planning in rural areas. It is often forgotten that a new school, because it is new, has new equipment and new teachers, will attract into the educational system, many of the children who would otherwise perhaps be reluctant to attend school in rural areas.

The designer should insist, in such cases, in a careful survey of likely enrolment and, if the site is adequate, show a second and third phase of expansion with the initial proposal.

Whilst room to expand is a useful feature of a site, lack of data on the nature of the expansion should not be used as an excuse to select very large sites for which no reasonable use can be foreseen in the immediate future. "Thus a high school of five hundred pupils would have a site of 60,703m²" (5.7), is strange advice in relation to the provision of a housing estate for 42,863 people with 48 shops, post office, 4 kindergarten, 4 community rooms, 2 primary and 2 secondary schools and 32 market stalls on 64,.45m² in Hong Kong! (5.8). Both may represent extremes. The best approach to site size, once the population is decided, is to regard the land as an area for programmed and unprogrammed activities and to calculate the use of its spaces or areas in the same way that the areas inside the school building itself are calculated.

5.03 The Site - Physical Education

The most familiar use for that part of the site not occupied by buildings and access paths, is for physical education which forms part of the curriculum of every Asian country. As a programmed activity it is commonly allocated about 2 or 3 periods of a 40 period week – about 6% of the total formal programme.

In many countries also, an aspect of physical education, distinguished by the name "sport" forms an important extra-curricular activity. This activity is, however, not commonly compulsory.

Paradoxically, the minimum areas required for programmed physical education can best be obtained from literature on physical education facilities published by countries with very cold climates. In a cold climate, the entire physical education programme in the winter is usually undertaken in a closed gymnasium and these spaces are expensive to construct. Their areas are thus kept to a practical minimum. These data on areas are also of use in countries where resources for the purchase of land are very limited.

Physical education as a curricular activity, has been well described and illustrated (5.9); (5.10). It comprises these components, namely, experience and understanding of movement, training and practice in specific skills; activities such as cycling, hiking, camping, climbing and the like. The first two components are commonly prescribed as programmed activities during school hours, the understanding of movement being mainly an activity for primary schools, changing its emphasis slowly to the acquisition of specific skills at games at the second level of education. Azam (5.9) makes it very clear that experience of movement requires little more than an open space with possibly a tree or two, and a blank wall, to implement a primary school curriculum in physical education.

In checking the area of site required for physical education, designers will want to be able to quantify the minimum needs. From a study of the minimum enclosed spaces required for physical education in the temperate zones, it is evident that an area of 20 x 12 metres is adequate for 40 primary school children. As physical education is uncomfortable in the tropics near mid-day, the utilisation of such an area would normally be confined to the early morning and late afternoon periods, – that is roughly 50% of the periods in the week.

If a six class primary school has 3 periods of physical education per week per class, then the space periods of utilisation of the 20 x 12 metre area will be

$$3 \times 6 = 18 \text{ space periods.}$$

and if there are 40 periods in the week, one area will have a utilisation of

$$\frac{18}{40} \times 100 = 45\%$$

which is reasonable.

As six classes comprise 240 children, the area per place of site required for this school is :

$$\frac{240 \text{ children}}{20 \times 12 \text{ metres}} = 1\text{m}^2 \text{ per place}$$

Secondary school children require a slightly larger minimum area of 25 x 15 metres for a group of 40 and, for a six class school the per place area needed would be 1.6 square metres.

In both primary and secondary schools, the area for physical education should have a firm, well drained surface which, in the case of primary schools, need not be in the form of a rectangle. "Over the past few years, an increasingly imaginative and varied use of these (play) areas has been made. Architects often find it possible to provide adequate and flexible play areas divisible into small dens for groups of children, into

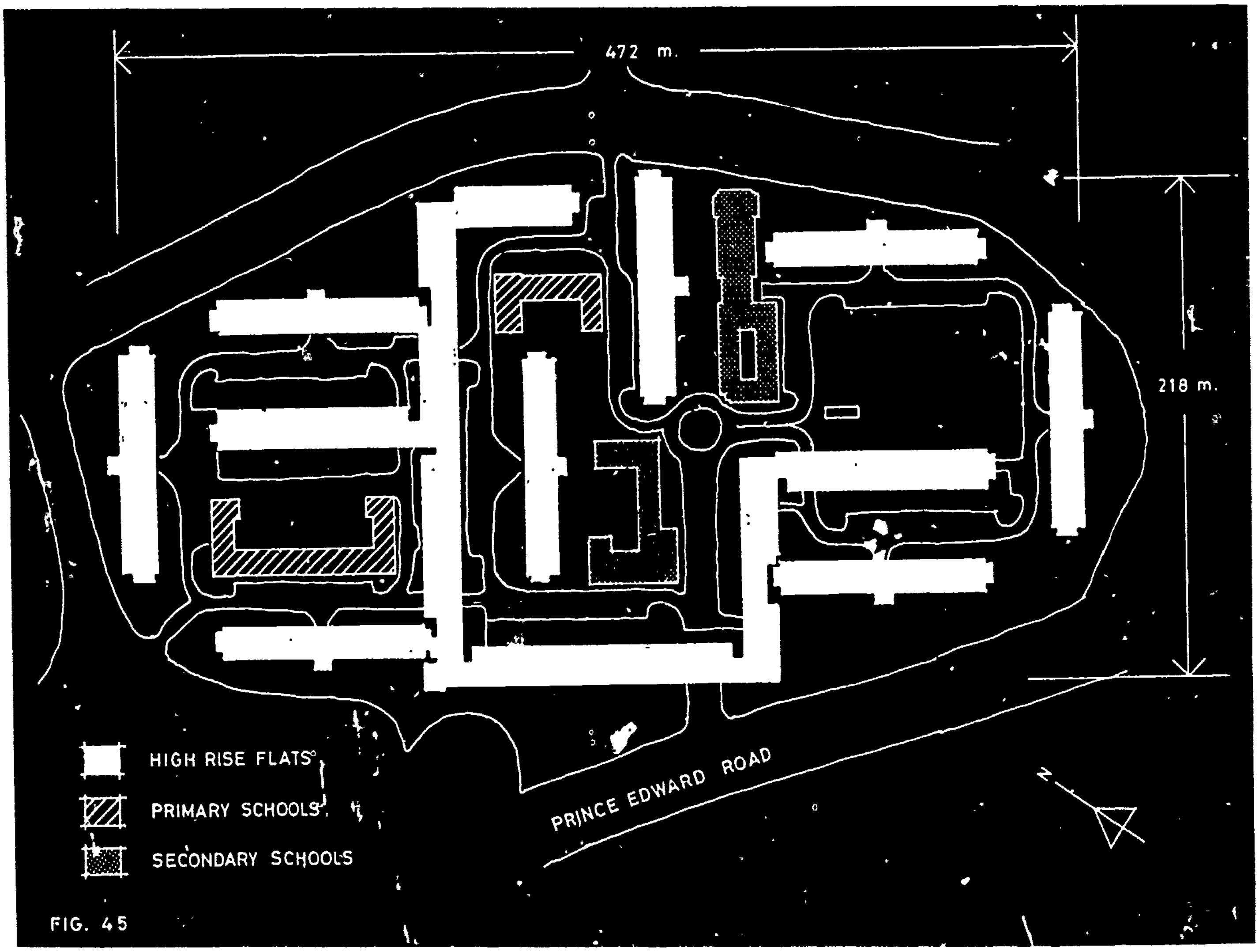

FIG. 45

larger areas for physical education or organised games and into spaces for adventure, activity and recreation." (5.13).

In urban areas there will rarely be sites large enough to accommodate organised sport. The spaces mentioned above will accommodate only one game of either basket ball, volley ball or badminton. Organised sport in the cities must and does, in most places, rely on communal sports fields. Azam (5.9), suggests that an area of 15 acres is needed for organised sport for a total community of 100,000 persons.

In rural areas, where land is sometimes cheaper and more readily available, a field for organised sport can usefully form part of the site, as suggested (5.13) below:

Very small primary school	½ hectare.
Largest primary school	1½ ,,
Small secondary school	1.8 ,,

As far as large secondary schools are concerned the size of site needed for organised sport will depend on the resources available, not so much for purchase of the land, but for its maintenance. In countries manufacturing mowing machines or having sufficient foreign exchange to purchase them, playing fields of the sort common in one country of the region and illustrated in Figure 46 will be easy to maintain. Other countries will acquire smaller areas that can be reasonably maintained without mechanical equipment.

5.04 The Site - used as Teaching and Learning Aid

Sites are often required to provide space for activities other than sport. "At its best, the school compound must function as a teaching-learning aid and as a suitable scene for outdoor lessons... But, given new teaching methods, utilisation of the compound, as a facility for crop or animal husbandry programmes, has now become an integral part of education. Even without crop cultivation, the compound's resources can be effectively integrated with all areas of the academic syllabus.' (5.14)

The resources of the site may be used for learning about –

- Crop cultivation;
- Animal husbandry;
- Playing with wet and dry sand;
- Pre-science and pre-mathematics;
- Light and sound, specific gravity;
- Botany and plant observation;
- Meteorology;
- Soil profiles.

What does this mean in terms of site area? The answer depends on the curriculum and, to some extent, on the sort of use that teachers commonly make of the site. Few teachers will think of introducing the topics light, sound or specific gravity outside the laboratory. Meteorology where it is included in the curriculum, has, by its very nature, an observation component that requires space on the site. One teacher in a remote Ceylon school, known for his enthusiasm in such matters, arranged that the children calibrate a pitot tube with a gramophone horn mounted on a cycle which was ridden up and down on a level stretch of the site at constant speed. The tube was subsequently mounted on a frame on the site to measure wind speed. Botany and gardening to produce food crops are also activities that require space on the sites of most Asian schools.

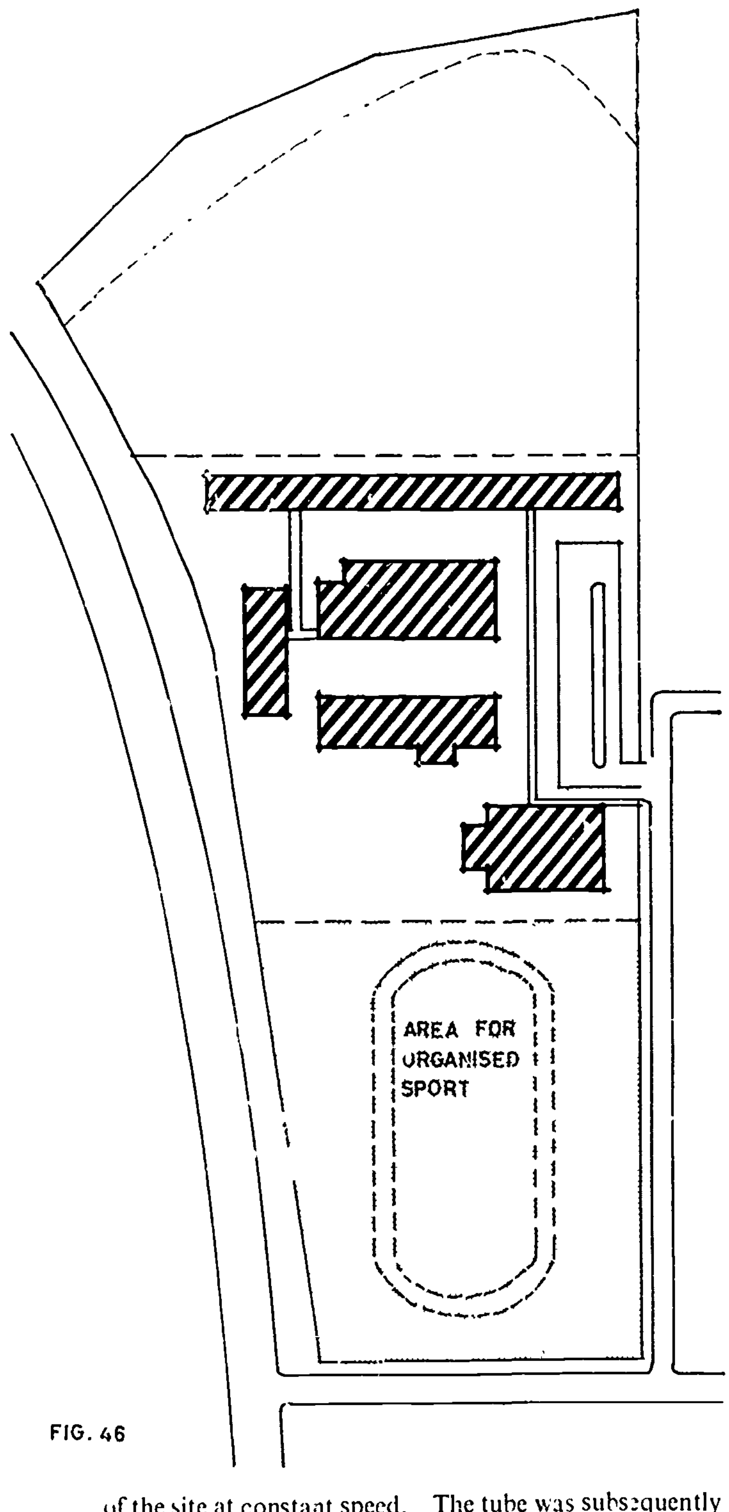

FIG. 46

The areas suitable for these activities are as follows:

Gardening for food crops - $1 m^2$ per child engaged in gardening.

Biology garden including small pond, terrarium, pot racks and water tank	– about 0.5m² per child studying botany or biology. maximum 900m²
Meteorological station	– 16m²

5.05 The Site – Circulation and Parking

The final factor affecting site size is that of circulation and parking. In areas where neither teachers nor students use cars or cycles, probably 5% of the site can usefully be set aside for paths, entrances and the like. In urban areas of some countries, 90% of the teachers and children will have motor vehicles and cycles and the area for parking will be substantial.

Access and parking for a car requires about 23m² and for a cycle about 1m².

The way in which the required area of site can be calculated as a check against the site selected is given in Figure 47 which shows two examples, one for rural and one for urban second level schools, each of 640 places.

RURAL	PER PLACE AREA m² (rural)	PER PLACE AREA m² (urban)	URBAN
16 MET. STATION			16 MET. STATION
46 CAR PARK – 2 CARS	23 PER CAR	23 PER CAR	368 CAR PARK – 16 CARS
50 CYCLE STORE – 50 CYCLES	1.0	1 0	500 CYCLE STORE – 500 CYCLES
160 BIOLOGY GARDEN – 320 PLACES	0 5	0 5	160 BIOLOGY GARDEN – 320 PLACES
320 GARDENING – 320 PLACES	1.0	•	0
1024 PHYSICAL EDUCATION	1.6	1 6	1024 PHYSICAL EDUCATION
1089 CIRCULATION PATHS ETC	5% OF TOTAL	5% OF TOTAL	131 CIRCULATION PATHS
2240 BUILDING SINGLE STOREY	3.5	3 5	560 BUILDING 4 STOREYS
17920 PLAYING FIELD	28.0		0
22865	TOTAL	AREA m²	2759
35 73	m² PER	PLACE	4.31

FIG. 47

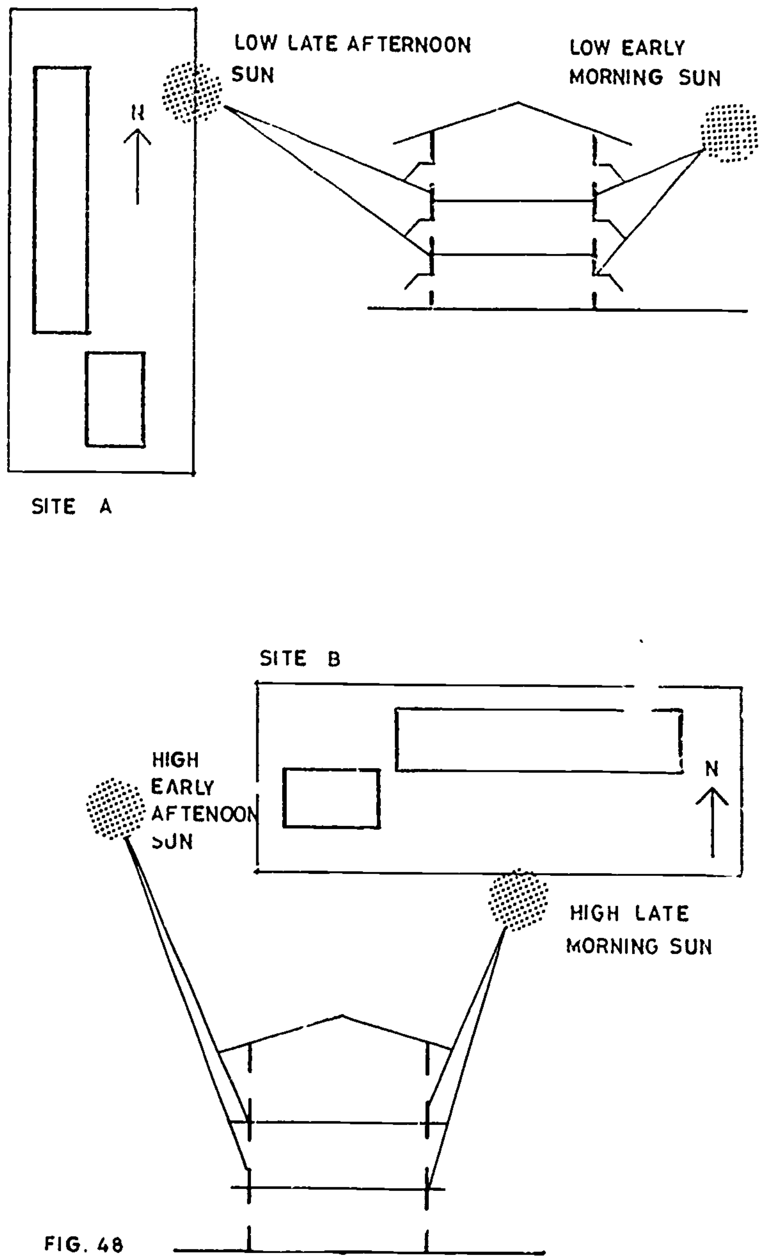

FIG. 48

5.06 Statutory Constraints on Site Size

In urban areas, the town planning or building regulations may impose two constraints on the use and thus the arrangement of the site. First, the regulations may prescribe a minimum distance from the centre of the road or boundary within which permission to build will not be granted. For example, the Building Bye-laws of the Municipal Corporation of Delhi (7.10) require that "...every institutional building (including schools) shall have a minimum set-back of 15 feet from any street..." Secondly, the regulations may govern the area of the site on which it is possible to build. The same Delhi Building Bye-law as mentioned above also states in respect of site coverage that the maximum permissible coverage (including covered parking) on a plot of the size mentioned in coloumn 1 below shall be as shown in column 2 below :

Size of plot	*Coverage*
upto 2 acres	$33\frac{1}{3}$% of the area of the plot
above 2 acres	25% " " " " "

It may be mentioned also that some bye-laws restrict the height of the building as well as the site utilisation.

Thus whilst it may still be possible to build quite satisfactorily on sites of the sizes shown in Figure 47, it may be that when design commences and the first attempts are made to arrange the building on the site plan, one or other of these constraints will operate to show that the site, whilst adequate from an academic view-point, is otherwise inadequate.

It is difficult to give any guide lines of a general nature which would enable the constraints to be taken into account in any calculation of site size as planning regulations and building bye-laws vary widely from place to place.

In short, the best that can be done in the initial stages of site selection is to calculate the place area needed – as shown in the text above and in Figure 47, and to use this area to estimate roughly how many children a given site can accommodate. It may be necessary subsequently to adjust the number of children planned to occupy the school if the constraints mentioned come into effect in a particular situation.

5.07 Useability of the Site

The last question to be asked when it has been decided that a site is large (or small) enough to contain an agreed enrolment is, "can the site be used economically?"

(i) *Orientation of Buildings*

Figure 48 shows two sites, one with its major axis north–south and the other east–west. Both sites are within the tropics.

The only sensible arrangement of buildings is shown. From this it will be seen that the buildings on site A will require much more shading against early morning and late afternoon sun than those on site B. (5.15) A practical example of this problem is described and illustrated in (5.16).

(ii) *Problems of Noise*

After the desired area of the site has been calculated on the basis of academic and circulation considerations, it is necessary to examine the ways in which the environment in which the site is set affects its size. First, of course, there will be the question of providing buildings in which good hearing conditions are possible. In chapter 6, 6.06, it is suggested that in humid areas where buildings are likely to have their windows wide open for ventilation, it will be necessary to locate classrooms and other teaching spaces at least 60 metres from any main roads adjoining the site boundaries.

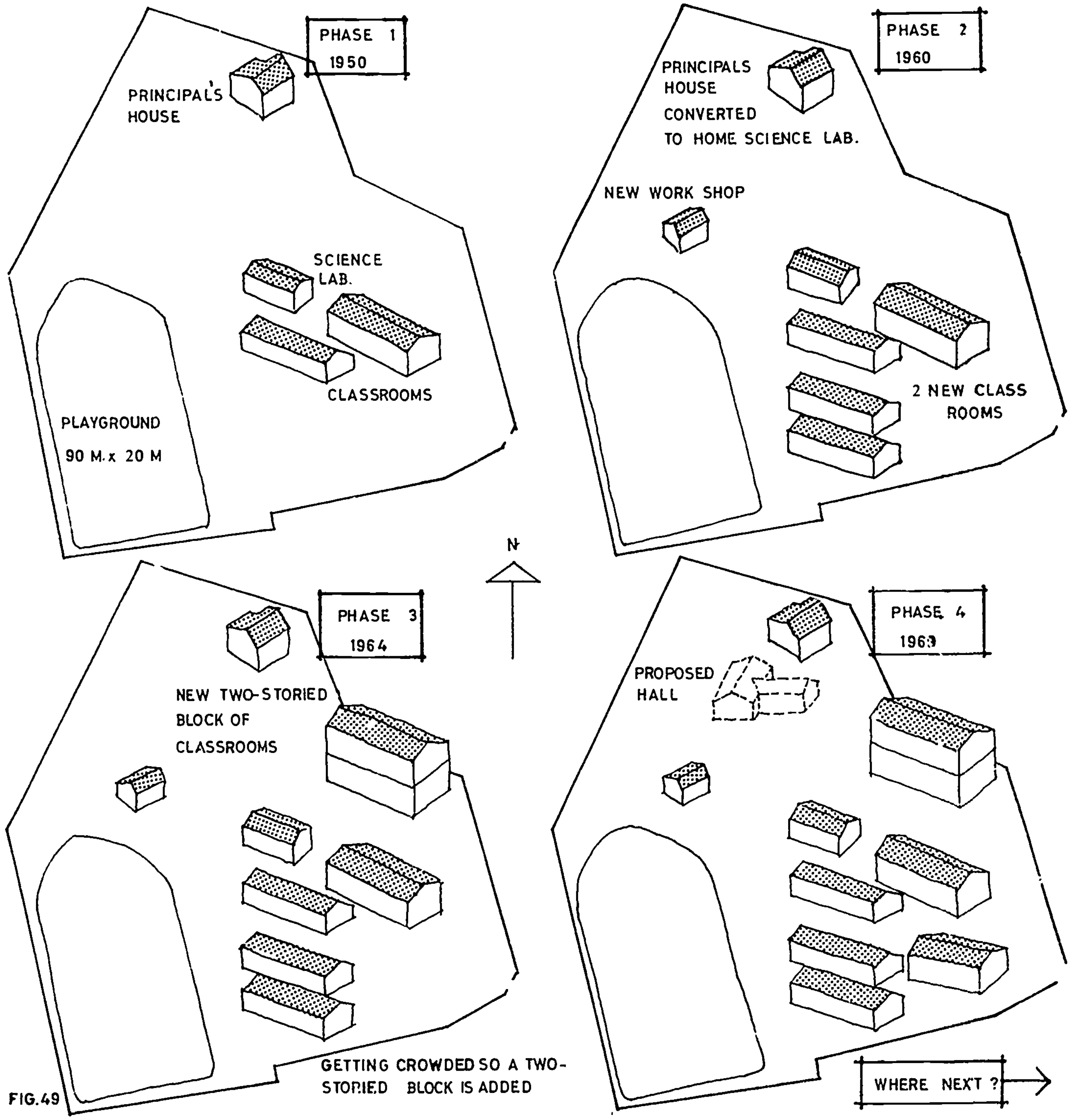

FIG.49

(iii) *Sites and the Arrangement of Buildings for Expansion*

In only two countries of the region, Singapore and Japan, are there sufficient buildings for the population of school-going age. In these countries the need for new buildings will in future be such as to provide only for population growth and the replacement of existing buildings as they deteriorate with age. In all the other countries of the region the same sort of needs exist but, *in addition*, large and continuing programmes of school building will be necessary to provide facilities for the *increases* in the numbers of children yet to enter the education system. The scale of the problem is indicated in Figure 4 and 5 of chapter 1.

From this it may be concluded that, whilst no doubt, many new schools will be built on new sites in the future, both they and all existing schools will be certain to expand due to continuing increasing enrolments.

This fact is of considerable significance in relation to sites and to the sort of buildings that are put on them. Figure 49 shows the unconsidered development of a site in the region over the course of recent years. It seems certain that this particular school will increase its enrolment perhaps to double that at present in the next 10 years. Where will the new buildings be placed?

A solution to this problem involves decisions of two sorts:

(i) Decisions on the *type* of buildings to be used. Obviously in the case illustrated, all buildings should be of at least two and preferably three or four stories in height.

(ii) The location and capacity of future buildings should be settled at the time the site is acquired so that the ultimate site capacity in respect of enrolment can be foreseen

Had this been done in the case illustrated in Figure 49, then the site might have been developed as is shown in Figure 50.

Malaysia provides a good example of one of the several countries of the region that exercises close control of sites for school building with special reference to the possibility of future extensions of buildings as well as of other considerations, mentioned below. (5.16) describes the procedure that has been developed in Malaysia for this purpose.

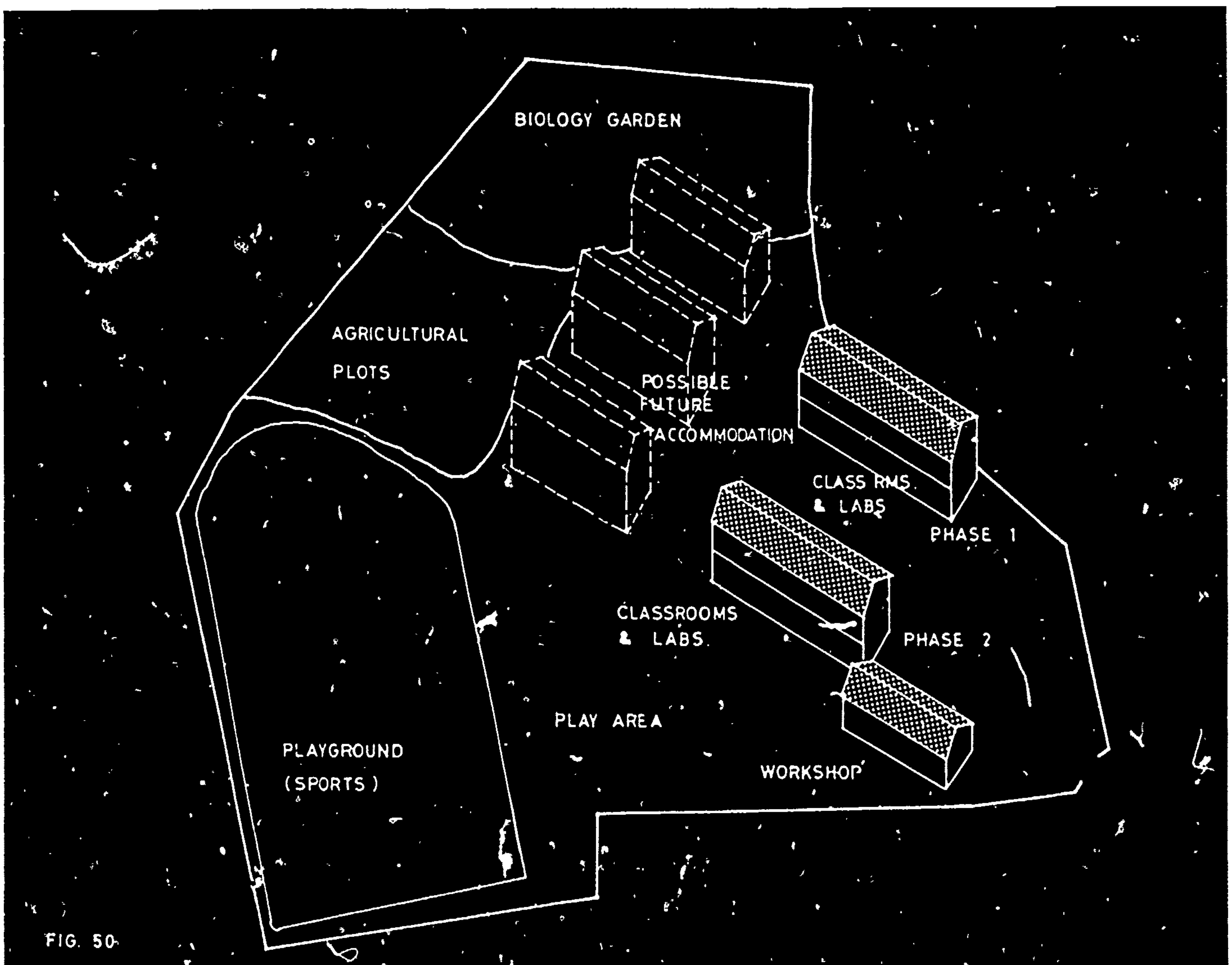

FIG. 50

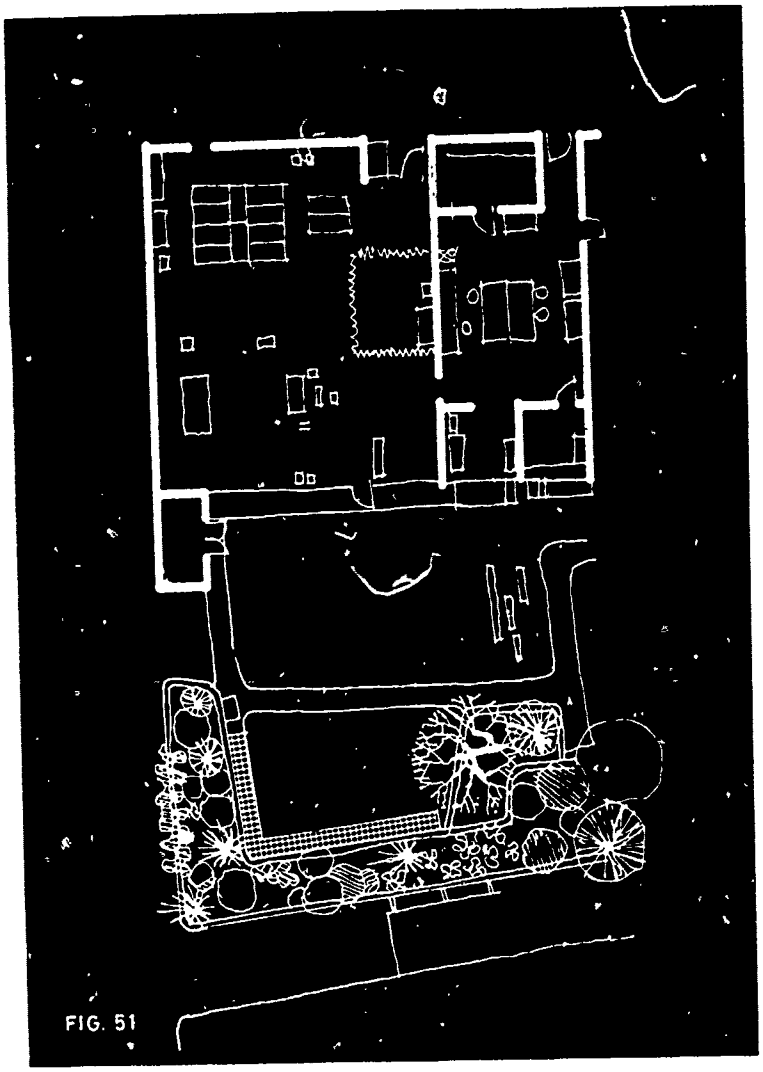

FIG. 51

5.08 Other Considerations

Given a site, the designer may, and as appropriate, point out to the education authority who have acquired it, that:

(i) Should the sub-soil conditions be unsatisfactory, the buildings will cost more due to the need to provide special foundations (see also chapter 4)

(ii) If there is a main road at the point of access to the school, sooner or later a child will run out and there will be an accident. Alternative means of access to sites are sometimes possible although this may cost money. A short wall in front of the main gate is a well known device to divert children to left or right, and prevent them running straight out onto a road.

Figures 51. 52. and 53 show some recent ideas on site development which are relevant to the material presented in this chapter and suggest that an important aspect of design of sites is their integration with the building and the preservation of scale.

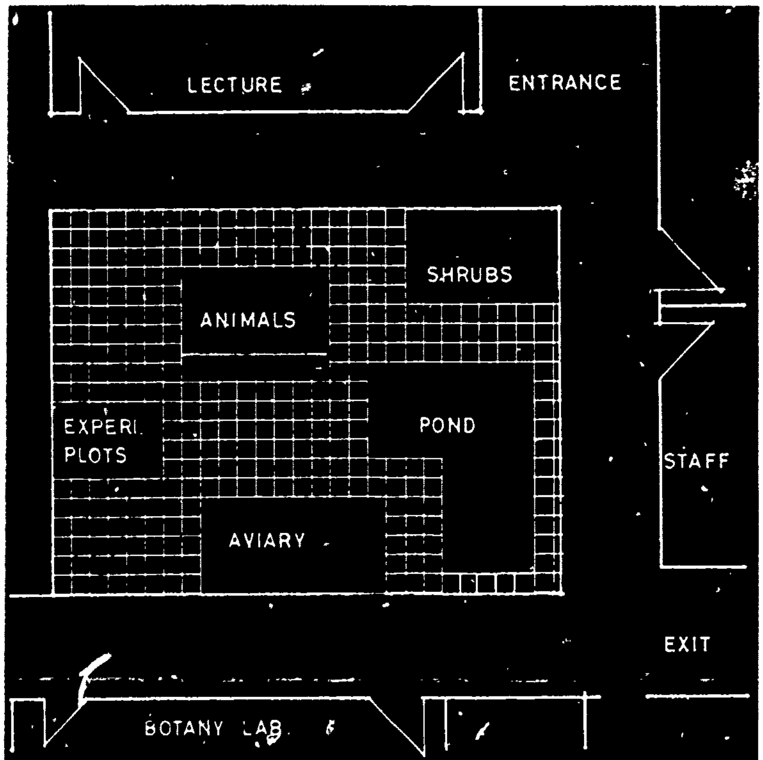
LECTURE
ENTRANCE
SHRUBS
ANIMALS
EXPERI.
PLOTS
POND
STAFF
AVIARY
EXIT
BOTANY LAB

FIG 52

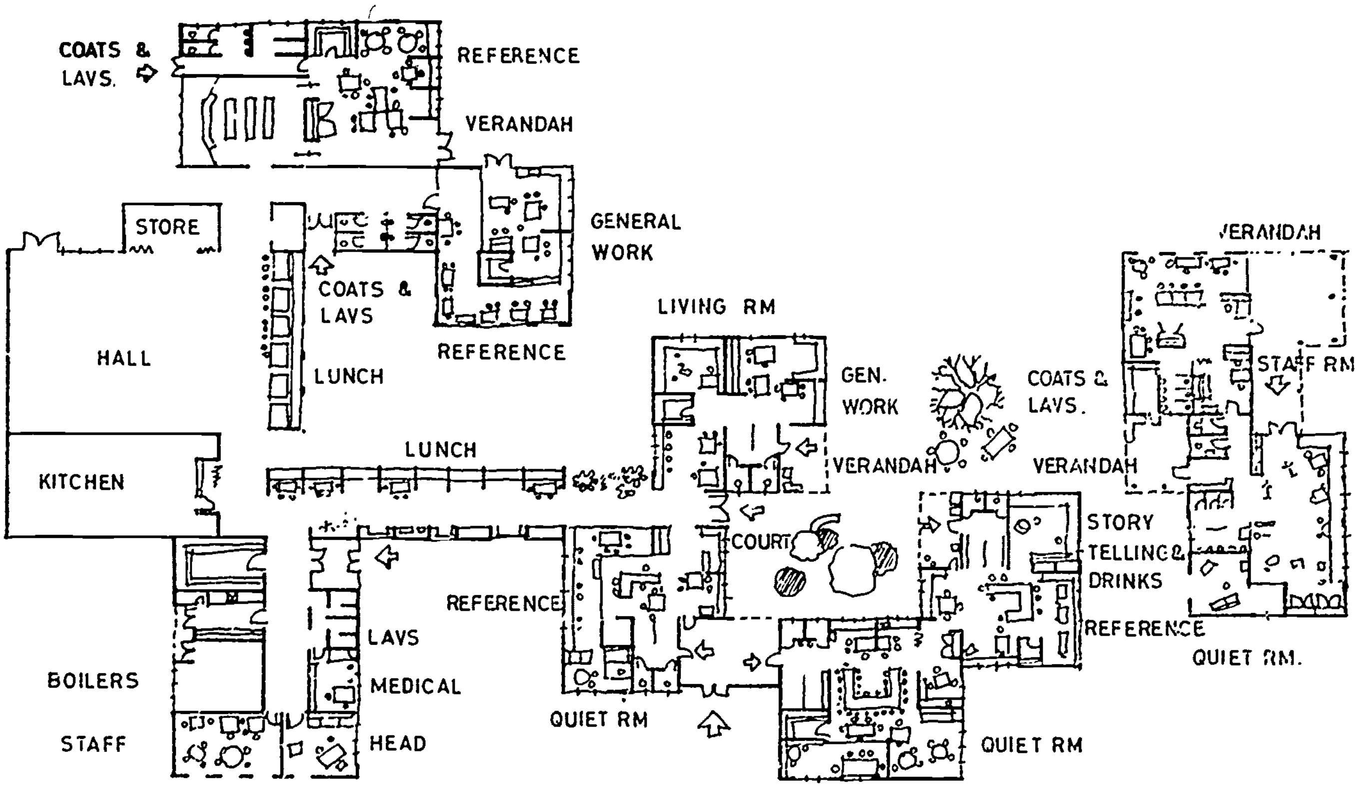
COATS &
LAVS.
REFERENCE
VERANDAH
STORE
GENERAL
WORK
COATS &
LAVS
HALL
LUNCH
REFERENCE
LIVING RM
GEN.
WORK
COATS &
LAVS.
VERANDAH
STAFF RM
LUNCH
VERANDAH
VERANDAH
KITCHEN
COURT
STORY
TELLING &
DRINKS
REFERENCE
LAVS
REFERENCE
QUIET RM.
BOILERS
MEDICAL
QUIET RM
STAFF
HEAD
QUIET RM
REFERENCE

FIG. 53

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Chapter 6

EDUCATIONAL ERGONOMICS

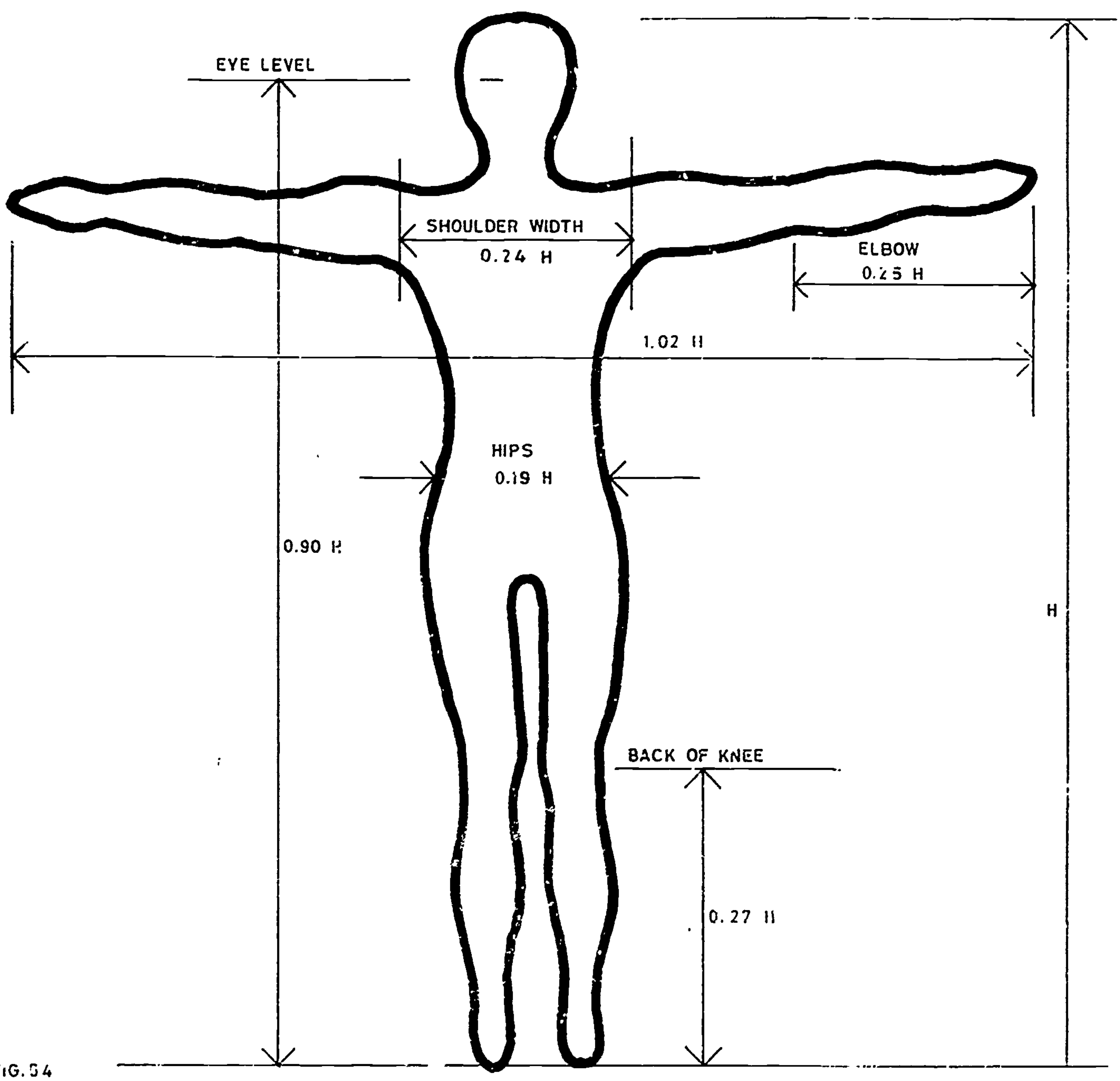

EYE LEVEL
SHOULDER WIDTH
0.24 H
ELBOW
0.25 H
1.02 H
HIPS
0.19 H
0.90 H
H
BACK OF KNEE
0.27 H

FIG. 54

6.01 General

The stress in educational development in the Asian Region in the 1970's is on improvement of quality. Ministers of Education of the Asian Region, at their quinquennial meeting in 1971 recommended that measures be taken "... to enhance the capability and performance of the education systems to meet the requirements of quantitative growth and qualitative improvement".

Ergonomics is appropriately enough concerned with ways of improving the performance of tasks through detailed attention to the environment. In the context of education, this means attention to furniture design, the layout of equipment and furniture, illumination of teaching-learning spaces, thermal comfort and the control of noise. Whilst the quality of education is usually and correctly regarded as a reflection of the quality of the teacher and his teaching aids, there seems little doubt that the realisation of this quality will be considerably assisted by the provision of the correct physical environment.

The chapter itself has been put at this position in the book because the material it contains affects the design of all the spaces in the chapters that follow and it is thus a key point of reference.

6.02 Physical comfort and the body sizes of children

Furniture and fittings should be designed to "fit" the user; not the reverse. Design for "fit" requires data on body sizes. These are available at present, for the following countries of the Asian Region:

Ceylon (6.1)
East Pakistan (6.2)
India (6.3); (6.8)
Indonesia (6.4)
Iran (6.10)
Philippines (6.5)
Thailand (6.6)
Territory of Papua and New Guinea (6.7)

Data are also probably available on the body sizes of Japanese children as a Japanese industrial standard has been published on classroom desks and chairs. (6.9)

These studies, and others made in various parts of the world, show that there is a constant relationship between the dimension of any part of the body and the standing height of the person measured. As far as can be seen at present, these ratios are similar for all the peoples of Asia, except those of Papua and New Guinea and thus also, presumably, West Irian in Indonesia. This similarity is of considerable convenience in two respects. First, it enables the sizes of the parts of the body of a population to be established quite simply by measuring the standing heights and, secondly, the constant ratios of parts of the body to standing height can be used for furniture design for any population of any age.

Figure 54 illustrates the ratio concept and figure 55 shows some of its applications in relation to the design of furniture. (6.11)

The difficulty in design occurs in countries for which anthropometric data are not available. A study of the data in countries where children have been measured suggests, with the exception of those in the Territory of Papua and New Guinea, that there is only a small variation of standing height in the children of the region – a variation of 4.5% at age 7 years and of 6.4% at age 14 years. That this is insignificant is shown by the fact that the variation in chair heights, which are a function of standing heights, is only 1.3 cm at age 7 and 2.34 cm at age 14.

It is thus possible to use mean data for the standing heights of Asian children as a basis for design in countries for which measurements have not been made, without too much risk of error. The data are given in Table XIII.

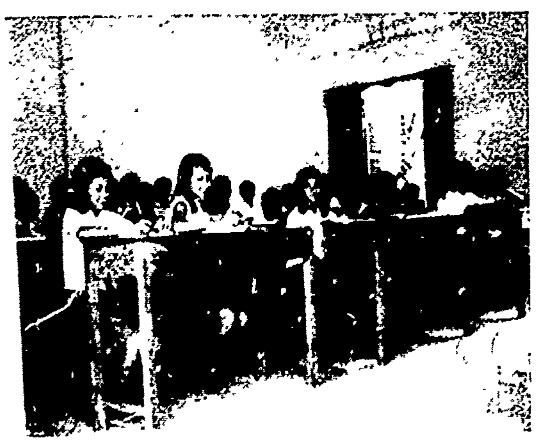


Plate 8

Plate 9

It is also important to note that data for European and North American children, which are often easy to obtain, should not be used as children from these temperate zones are some 12% taller than the average Asian child.

TABLE XIII

MEAN STANDING HEIGHT OF ASIAN CHILDREN (6.11)

Age in Years	*Height in cm*
6	107
7	113
8	116
9	121
10	126
11	131
12	136
13	141
14	146
15	153
16	160
17	163

Note: *The data for ages 7 to 14 years, inclusive, are based on large samples. Data for ages 6, 15, 16 and 17 years, are based on smaller samples. The increase in standing height above 17 years of age is usually small and certainly no average adult will find difficulty in using furniture or fittings designed for a 17 year-old.*

It is useful to remember that the data in Table XIII comprise *mean* standing heights. Boys are usually slightly taller than girls of ages 13 years and above as is shown by the comparative data given below, taken from a very large Indian sample. (6.3)

Age	*Girls in cm*	*Boys in cm*
10	127	127
11	132	132
12	137	137
13	142	142
14	147	150
15	147	155
16	150	160
17	150	163

Of course, all children of one particular age group are not of exactly the same height. The standard deviation of standing height for Asian children varies from 6 cm at 7 years to 8 cm at 14 years of age. This will result in about 2.5 per cent of the children aged 7 years having a standing height of 12 cm less than the mean and 2.5 per cent having a height 12 cm greater than the mean. The absolute variations in measured standing height for 7 year-olds – that is the range in heights measured, is 99 to 130 cm (against a mean – Table XIII of 113 cm). In designing for reaching or seeing, the smaller children should be kept in mind. Desks, chairs and movable furniture will usually be provided in a range of (paired) sizes and the children should be able to select the furniture that fits them best. Probably a range of three sizes for a group of 40 children will suffice, with most of the furniture – say 70% – to fit the children of mean body dimensions and 15% each of larger and small items of furniture for all the other children. The "fit" of furniture to body sizes is an obviously important element in the overall attempts of the designer to achieve physical comfort through furniture design. Another, and related aspect of the same problem is concerned with reaching, bending and lifting.

Perhaps the best illustration that can be provided of the need to assist improvement of the performance of tasks is provided by the traditional laboratory bench, which is too high for comfortable work, often too wide to reach to the middle – let alone the other side – and usually fitted with underbench cupboards that are so low and so deep that they cannot be used.

An eminent chemist who was small in stature and who worked long years as an adult with such furniture, reported the main function of his laboratory stool was that of a platform on which to climb to read his burette! Those that have inspected these traditional benches and looked into the cupboards, will be well aware that they are, more often than not, empty or, at best, used for dead storage.

Figure 56, illustrates examples of laboratory benches which are still very commonly installed in schools in the Asian region.

McCracken and Richardson (6.12) indicate that, from an energy conservation viewpoint, there are upper and lower limits for shelving (open or in cupboards) beyond which a very much greater effort is needed to place or remove items to be stored than is required in what might be called a "zone of conveniences". Figure 57 shows the convenience zone the dimensions of which are expressed in relation to standing height, and also compares the dimensions of the zones of convenience for 6, 13 and 17 year-old children. It will be noted that the highest level which is convenient for lifting items for storage is 0.86 of the standing height. Eye level is 0.90 of the standing height and thus the highest shelf, if it is correctly located, is just below eye level.

This is important as it means that it is possible to see what is on the shelf and also whether or not it is clean. Maximum use can also be made of it, because visible storage is more easy to use than that which is out of direct sight.

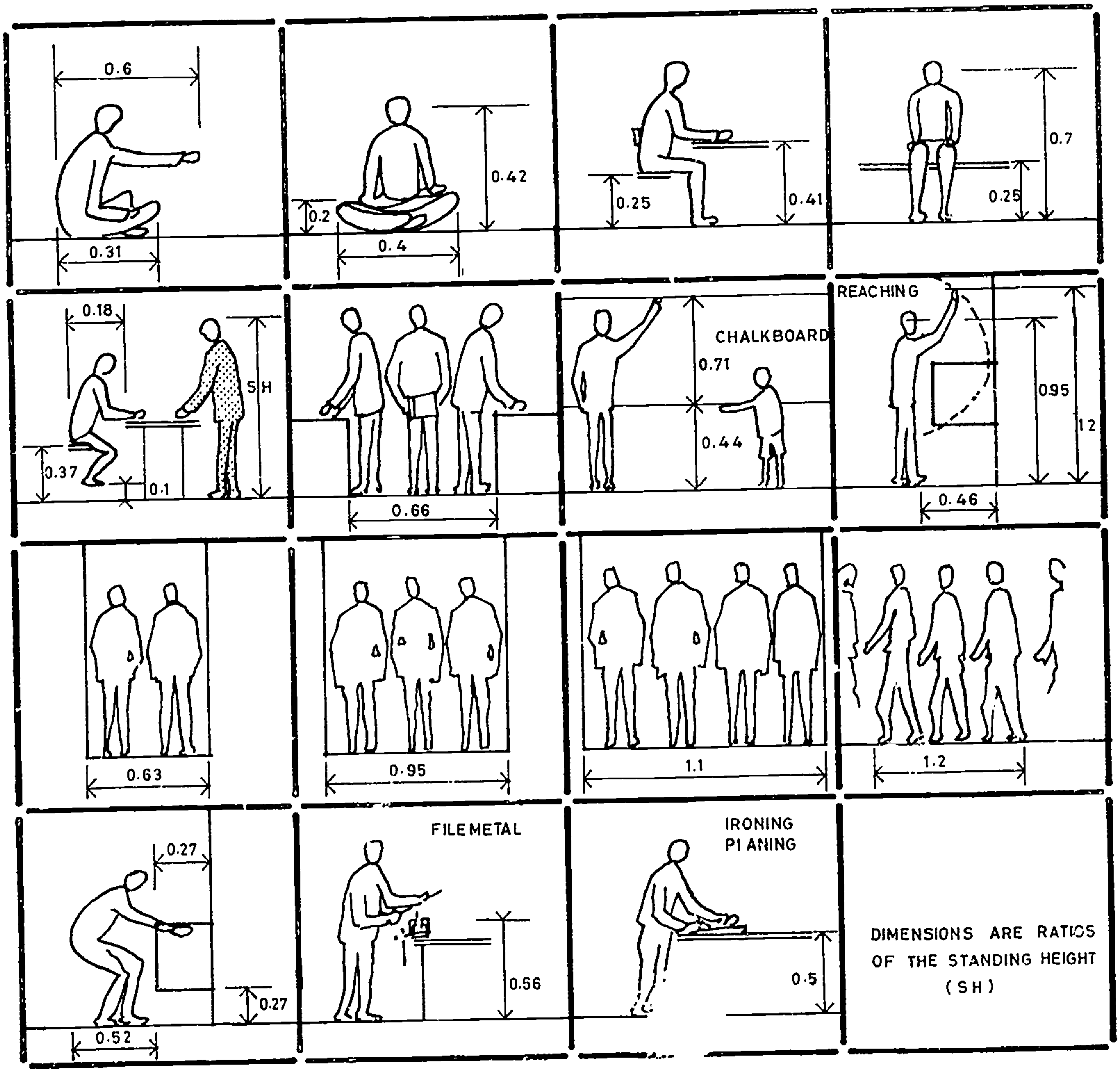

0.6
0.31
0.2
0.4
0.42
0.25
0.41
0.7
0.25
0.18
0.37
0.1
SH
0.66
CHALKBOARD
0.71
0.44
REACHING
0.95
1.2
0.46
0.63
0.95
1.1
1.2
0.27
0.27
0.52
FILEMETAL
0.56
IRONING
PLANING
0.5
DIMENSIONS ARE RATIOS
OF THE STANDING HEIGHT
(SH)

FIG. 55

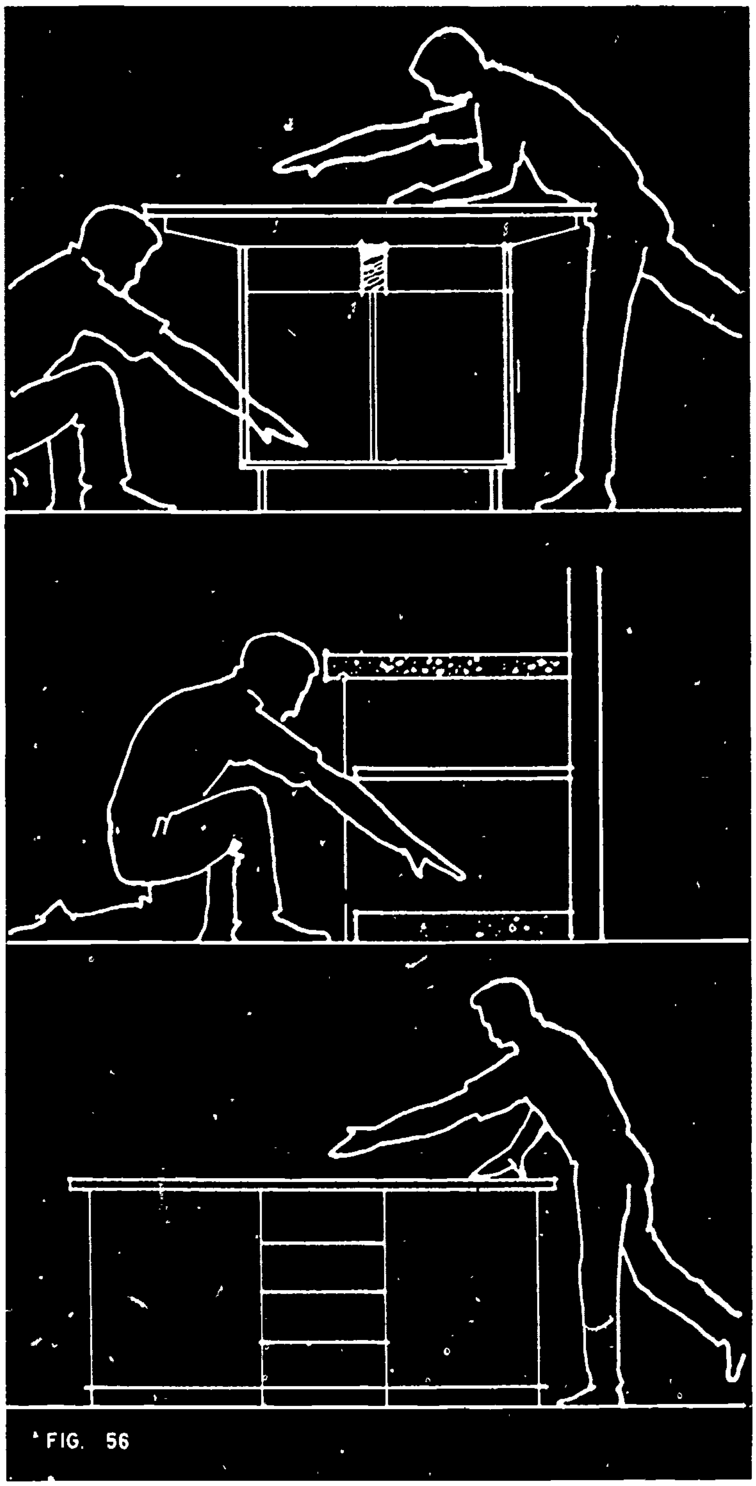


FIG. 56

Whilst there is a zone of convenience for lifting and storage, there are also similar zones for reaching forward in both horizontal and vertical planes. Figure 58 shows a vertical arm reach envelope. The envelope is for a situation in which the body is not restrained, i.e. the reach involves the motion of leaning forward with the body as well as of reaching with the arm. This is the natural state of affairs in a school, whereas, it would not be possible in, say, a motor vehicle if the passenger was restrained by a shoulder type safety harness.

From figure 58, and knowing the standing height of six and seventeen year-olds, it will also be seen that the maximum horizontal reach forward of a 6 year-old measured from the edge of the desk or bench, is 49 cm, and of a 17 year-old, 75 cm. For a science bench with 17 years old students working from both sides on a single experiment in the middle of the bench, the maximum width of the bench would be something of the order of 100 cm. An even narrower bench would obviously be much more convenient. (See chapter 9)

Perhaps the main conclusion that emerges from a study of anthropometric data relating to children's body sizes is that, if the data are applied to design, solutions are likely to emerge which are somewhat different and certainly more adequate than those currently observed in many of today's schools in Asia.

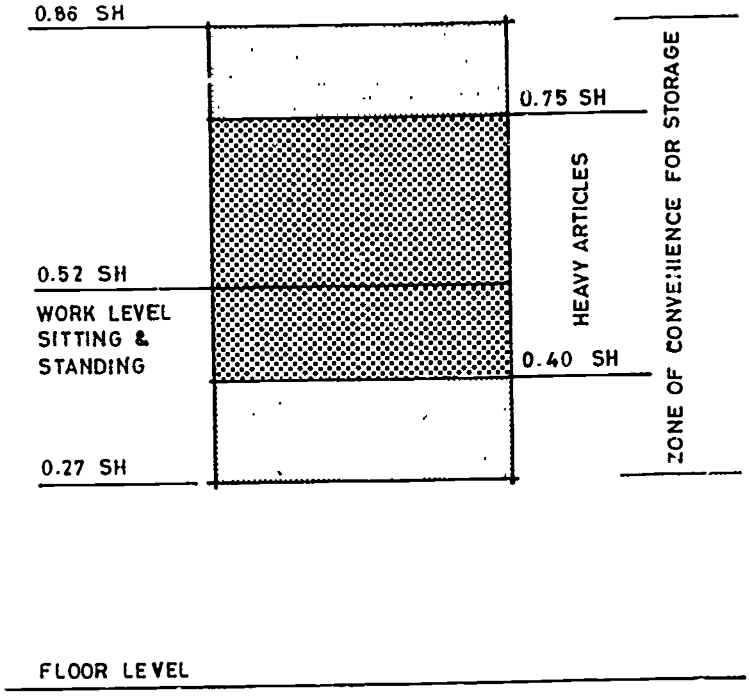
It also seems certain that design based on anthropometric data will result in reductions in cost, for in the case of furniture, chairs, stools, desks and benches are usually too big. Those interested in arithmetic will be amused to know that, if 5 cm were cut of the legs of every wooden school chair in the region, some 32,800 cubic meters of wood, worth about one and a half million dollars would be saved and, of course, the chairs would be much more comfortable to sit on. As school populations are likely to double in the not too distant future, cost considerations of this sort may reasonably be coupled with attention to comfort.

6.03 Illumination

The main problems of design for illumination in schools in the Asian Region are to provide enough light for the performance of the tasks - teaching and learning - and to do so without causing discomfort from over-heating, excessive contrast and glare.

The level of illumination most suited to perform a particular task has been, and, in most countries, still is, determined by the amount of light that can be obtained economically. Thus, in rural areas where the material resources strictly limit the maximum span of a window opening (Plates 10 a,b), they also limit the available illumination. Even where larger spans could be obtained, design to resist the effects of earthquakes or strong wind storms, often results in small openings in external walls. "Large openings should be avoided, particularly in external walls near the corners of the building." (6.13)

Fortunately, the human eye is able to adapt to a variety of conditions and this, coupled with the fact that sufficient general principles of design for illumination have been established to obtain useful practical results (6.14), enables the school building designer to proceed with, at least, some confidence in designing for adequate seeing conditions.



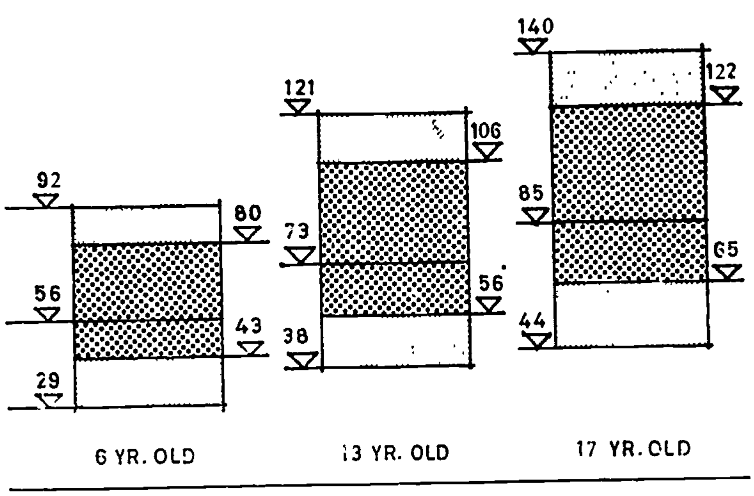


FIG. 57

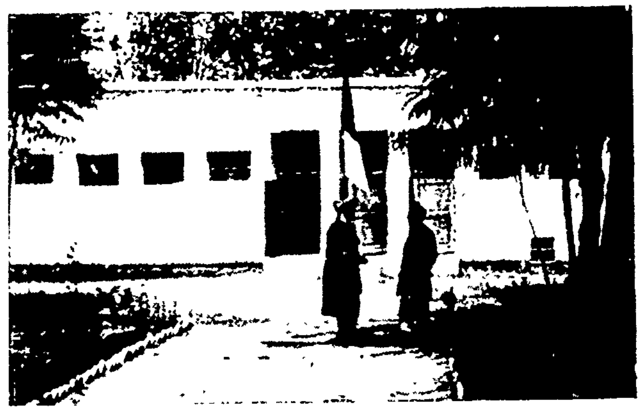


Plate 10 a

Plate 10 b

There are considerable differences of opinion on the question of illumination levels required for the performance of various tasks. Most investigators are however, agreed that, from a practical and economic viewpoint, a level of illumination is reached beyond which subsequent increases in the light available will produce relatively little increase in efficiency of output. This is shown (6.15) in figure 59, from which it will be seen that visual acuity improves at a decreasing rate as the illumination level is raised above about 108 lux. "A normal-sighted person can achieve a good level of visual performance on normal, high-contrast printing of 8-point type, viewed at a normal reading distance with an illumination which enables high contrast writing on a chalkboard to be read by normal-sighted persons without difficulty." (6.16)

Narasimhan and others (6.38) examining a sample of 2,200 school children in Uttar Pradesh, India, find considerable differences in visual acuity that are not connected with malnutrition alone. Sub-normal vision increases with age from 5 up to 13 years and it is concluded that this deterioration is due to the prolonged use of the eye under poor lighting conditions or use with strain. Primary classes, they argue, require a higher level of illumination than those in the secondary schools and not only should these levels not fall below 106 lux but could, with advantage, be increased up to 220 lux.

More difficult tasks such as sewing, where smaller and more critical detail has to be seen, require higher levels of illumination for efficient performance.

Table XIV gives the illumination levels in lux recommended for a variety of spaces in schools by a number of different authorities.

The desired illumination can be provided in two ways – either by daylight or by a combination of daylight and electric lighting (known as P.S.A.L.I. – permanent supplementary artificial lighting installation).

In many countries of the region it is not possible to provide electric lighting in schools for first level education because:-

(a) the installation costs are high and often involve foreign exchange payments in situations where the currency of the country is not readily convertible;

(b) of the recurrent costs for electricity

(c) maintenance costs are high and the administration of maintenance is often difficult having regard to availability of skilled electricians and often remote locations of schools.

(d) there is, more often than not, no electricity supply in rural areas.

In those countries or situations where these conditions do not apply then the references (6.22) (6.23) give guidance on the design of P.S.A.L.I. The main problem considered here is thus design for illumination by daylight.

TABLE XIV

RECOMMENDED ILLUMINATION LEVELS IN SCHOOLS

Activity Spaces	*Illumination Level in Lux Recommended by* (6.17)	(6.18)	(6.19)	(6.20)	(6.21)
Class and lecture rooms – desks	300	215	200	215	753
Class and lecture rooms – chalk boards	400	215	500	215	1604
Laboratories	400	215	200	215	1076
Embroidery and sewing rooms	600	323	1000	323	1604
Art rooms	600	323	500	323	753
Workshops/Metal work rough	200	108	—	—	1076
medium	400	215	—	215	1076
fine	900	323	500	323	1076
Woodwork – Carpenters	200	215	—	215	1076
Woodwork – Joiners	400	323	500	323	1076
Libraries – Shelves	special	—	200	—	323
Libraries – Tables	600	215	200	323	753
Offices	400	215	100	215	753
Staffrooms	200	—	100	108	108
Stairs	100	32	50	108	215

NOTE: The numbers (6.17), (6.18) etc. refer to the authority, full details of which are given in the references at the end of this chapter.

To determine precisely the size and number of openings needed for adequate illumination by daylight, it is necessary to know how much light is available.

The design illumination in some areas of the region is known and Table XV gives these data.

TABLE XV

DESIGN ILLUMINATION AT DIFFERENT STATIONS

Station	*Design Illumination*	*Latitude*
Colombo	7000 lux	6.55 N
Singapore	9000 lux	1.20 N
Bandung	7000 lux	6.57 S
Taipei	6000 lux	25.05 N
Hongkong	5000 lux	22.20 N
Manila	6000 lux	14.36 N
India (general)	8000 lux	
U. K. (general)	5000 lux	

These data for various places in the region can be used with some confidence for about 50 miles around the stations at which measurements were made. The difficulty arises in connection with other places. It is suggested, until more data become available, that there is unlikely to be serious error if latitude is used as a guide. It is evident from the table, that as latitudes become higher, design illumination becomes lower. Thus, for example, if it was desired to estimate the design illumination at say, Rangoon (latitude 16.47 N) then 6000 lux (the design illumination for Manila) would probably provide a reasonable working figure.

Once the design illumination has been settled, the size and disposition of the openings that are to admit the light evenly to the teaching space, can easily be determined using the method shown in Appendix VI: "A Method for Design for Daylight in Schools (an example for Manila – Philippines)." Reference is also made to (6.24; 6.25; 6.26; 6.27; 6.29; 6.30; 6.31; 6.32). The grids necessary for the calculations for Manila and for five other stations in the Asian region (Colombo, Singapore, Bandung, Taipei, and Hong Kong) can be found in the back cover pocket of this book.

Contrast is also another important factor in design. The task on which a child is working should be brighter than the surround. If it is not, then the eyes will tend to wander from the task to the brighter background. In general, maximum visual comfort will be achieved when the luminance ratio of task to surrounding does not differ by more than three to one. Medium quality white paper (reflectivity about 75%) on a plain white wood desk (reflectivity about 57%) would thus be visually comfortable.

In selecting the colours of chalk and chalkboard, the reverse of this idea is applied for, if the chalk is to be seen, there must be the maximum difference between its reflectivity and the reflectivity of the chalkboard.

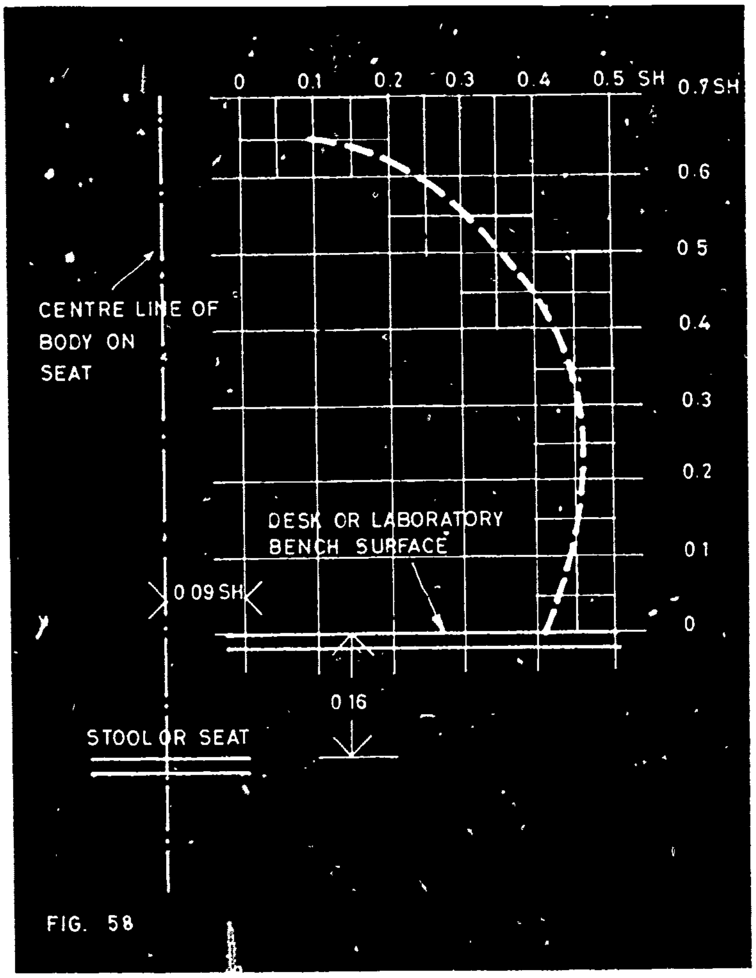


FIG. 58

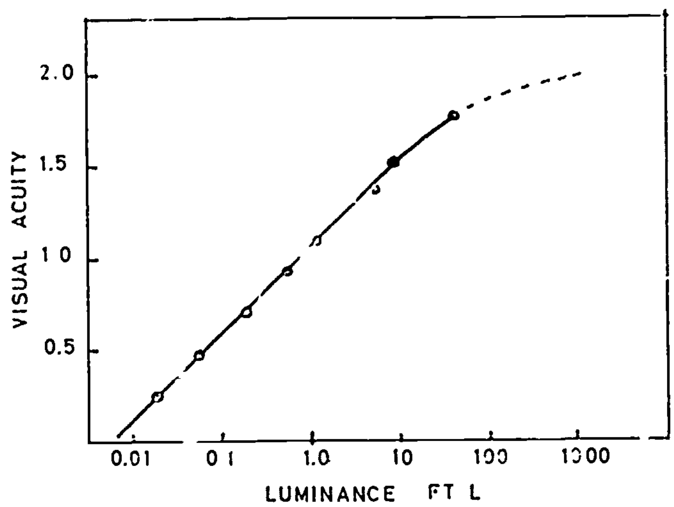
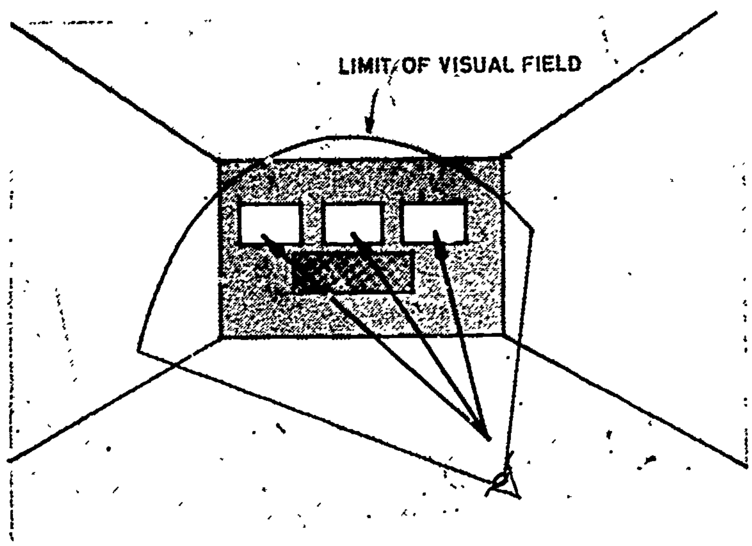


FIG. 59

Blackboards and white chalk, provide sharp contrast. So, too, do dark blue boards (reflectivity about 10%) and yellow chalk (reflectivity about 70%). Blue-green boards and yellow or white chalk are also comfortable to look at.

Finally, there is the question of glare. The eye, as is well known, tends to move towards the brightest part of the visual field. This phenomenon often presents problems in connection with artificial lighting schemes. It is not common in schools where the chalkboard is usually placed against a wall which is rarely bright enough to cause distraction. Sometimes, however at the ends of a building, windows are positioned as is shown in figure 60 and cause intense visual discomfort. Small windows in large areas of wall, as shown in the figure cause similar discomfort if a child looks up from a laboratory or workshop bench towards a side window.



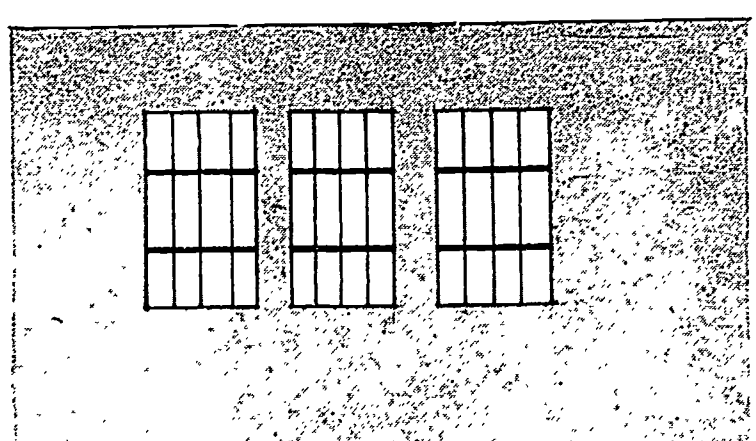


FIG. 60

6.04 Colour

Colour in schools is important because:-

(a) children respond affectively to it in various ways (excitement, restfulness etc.);

(b) it can help to define spaces in respect of shape and emphasise articulation – in this sense it may assist children's perceptual development;

(c) it can raise illumination levels through the internal reflected component of daylighting – see Appendix III;

(d) very skilfully used, it can help to reduce discomfort caused by glare.

Although colour, for young children "is almost an end in itself" (6.33) and, as explained above, it assists in the affective and perceptual development of children, it has been shown (6.34) that it does not affect student achievement as measured in terms of student grades assigned by teachers.

An important point is, of course, that very little research work on the psychological effects of colour has been undertaken in the countries of the Asian Region. That the people of Northern Thailand, for example, have been shown to prefer quite different hues from those of Northern Europe, has been demonstrated and indicates clearly the dangers of attempting to generalise in this particular area of school building design.

Murrell (6.14) wisely advises that, "... it does not matter very much one way or the other what particular colours are used in order to achieve the particular end in view, provided they do not conflict too outrageously with the accepted views of the people who have to live with them and do not violate the (primary) object of obtaining visual comfort by the avoidance of high contrast where this will be distracting, or the use of high contrast where compelling attention is needed".

6.05 Thermal comfort

It has been said (6.35) that, "modern techniques make it possible to transform the outdoor climate into practically any indoor climate". This is true, but those in Asia for whom this book is written, have rarely the resources needed for precise climate control. This section is therefore confined to suggesting ways in which climate can be modified without undue expense to give what is thought to be reasonable thermal comfort.

Thermal comfort is the area of ergonomics about which, for the Asian region, least is known. A great deal of work has been undertaken both in and out of the region on the thermal characteristics of building materials and if, in fact, it were possible to describe in quantitative terms, the desired internal climate of buildings such as schools, then it would be possible to link the two sets of data to design for thermal comfort. This, unfortunately, is not possible as we have only the work by Webb (6.36) on acclimatised citizens of Chinese descent in Singapore, which is for a humid zone population, and the work of Lambert and others (6.39) on comfort in the arid zones. The Central Building Research Institute, Roorkee, India, has now also commenced work on thermal comfort whilst the Asian Regional Institute for School Building Research has work in progress to determine thermal comfort indices for sedentary school children in Ceylon and Thailand.

Meanwhile, Webb reports (6.40) a new calidity concept which seems likely in years to come, to provide a new measure of thermal comfort for different ethnic groups and sub-groups.

The design effort in respect of thermal comfort has thus, *pro tempus*, to be directed towards a qualitative rather than a quantitatively determined end, relying on common sense, experience and observation of satisfactory traditional local solutions for its success. Why, it might be asked, if traditional and satisfactory solutions to thermal comfort design problems exist, is it necessary to comment on them at length? The reason is that traditional achievement of thermal comfort through design has been mainly in the field of domestic buildings and, moreover, usually for thermal comfort at night rather than during the day when people were more often than not outside rather than inside their dwellings. Moreover, in this century, new materials and types of construction have been introduced from the temperate zones, often with disastrous results as far as thermal comfort is concerned. The old traditions of design have slowly been forgotten and it is now common to find tropical houses and other buildings which would be more suitable in respect of climate, for occupation in Northern Europe than in Asia.

The achievement of thermal comfort (or a close approximation to it) through design depends on a clear understanding of warm *day-time* climates. Very little has been written on this topic, most of the work having been concentrated on day *and* night climate conditions. Schools, however, are occupied normally during daylight hours and occasionally in the early evening. There is thus little point in considering the full diurnal range of climate in relation to school building design.

A study (6.41) of climate during the school day in Java shows that in respect, for example, of dry bulb temperature, the variation is small and it can for all practical purposes be regarded as uniform between 8 a.m. and 4 p.m. Although annual rain fall is heavy, it occurs usually after 12 noon daily and thus in relation to primary school buildings which are occupied in the morning, precipitation can be correctly described as low.

This example of a climate study in Java is given here to illustrate the point that climate from the point of school building design requires to be viewed somewhat differently from climate in relation to other human activities.

The student with his or her sensation of what is and what is not thermally comfortable and the climate with its known variation throughout the school day and throughout the year, thus form the design parameters for climate control. The Asian region, as is shown in Table XVI – presents four basic control problems for:

(i) hot-humid zones
(ii) hot-dry zones
(iii) upland areas
(iv) temperate zones

The components of climate that are of major concern in solving these problems are:

(i) The sun and the solar load
(ii) Breeze
(iii) Humidity
(iv) Temperature

The school day and the school term are both variables which can be and usually are adjusted in relation to climate. Thus, for example, in Nothern Indian States such as Punjab, in winter when mornings are cold, the

TABLE XVI

CLASSIFICATION OF CLIMATES – THE ASIAN REGION

(Adapted from Atkinson – 6.42)

Table 1: A tentative classification of warm climates for building design.

warm, humid		intermediate	hot, arid		cooler, uplands		temperate or sub tropical
equatorial lowlands	tropical island trade wind coast	tropical inland savannah country	low latitude deserts or semi-deserts		equatorial	tropical	
			inland	maritime			
7½°N to 5°S of Equator; at or near sea level, and close to sea, large lake or river basin. Equable, never very hot nor very cold. Seasonal change may be less than 6°C. High wet bulb temperatures, average over 25°C. Air humid, and often still; heavy rainfall with rain most days of year. Cloudy skies but usually not overcast, sky therefore very bright.	Further north and south, and thus more seasonal. Still usually equable but more sunny and thus warmer by day. Humid but cooling breezes: trade winds, or off-on shore wind. Strong winds at times, especially on windward coasts; risk of cyclones (hurricanes). Wind, and particularly rainfall pattern much influenced by local topography. Wind driven rain. Blue, partly cloudy skies.	Inland away from Equator (5°–15N and S). Seasonal due to latitude. Effect of altitude especially above 1000 – 2000 ft. noticeable. Less rainfall than equatorial lowlands with dry and wet season (or seasons). Total rainfall may vary from year to year. During wet season – sun over-head – conditions like equatorial lowlands; dry season, hotter by day.	Near and beyond Tropics: 20–25°N and S or, extremes, 15-30°N and S. Hottest and most arid places in world. Meagre and very variable rainfall. Absence of settlement – until recently (strategic or minerals) – except where underground sources of water (oasis); traditionally populated by nomads taking advantage of localised rains. Dry; large seasonal range in temperature. May exceed 16° C – and diurnal – 10 to 20° C. Cold at night, especially in winter. Dusty. Clear blue skies frequent. Very sunny.	Resembles hot arid (inland) but less extreme. High humidity, which offshore-onshore breeze only partly counter-acts.	Altitude makes air temperature cooler. Rainfall varies with wind pattern and topography. May be overcast periods. Length of day constant.	More seasonal with higher latitudes. Rainfall more variable. Winter season may fall below 5°C and heating required.	Temperatures ranging from 18°C – 30° C with occasional freezing. Rain throughout the year with snow in winter. Strong winds approaching hurricane force. Internal heating of buildings essential for part of the year.
e.g. Malaysia, Borneo, Sumatra, West Irian	e.g. Indian and Philippine Islands, e.g. Andamans, and Palawan, Negros.	e.g. Central India, Khmer Republic, Thailand.	e.g. Iran, Pakistan.	e.g. Coasts of Iran, Pakistan.	e.g. Indonesia.	e.g. Burma, Laos.	e.g. China, Japan, Nepal, North India.

school day starts at 10 a.m. by which time the sun has warmed the buildings a little. In the summer, the school day starts at 7 a.m. so that most of the teaching and learning activities are over before the buildings become insufferably hot in the afternoon. Similarly, during and because of the season of heavy rains from March to June in Kerala State, schools are closed for a long vacation.

In hot, humid countries such as Malaysia, Singapore and Ceylon, however, administrative measures of the sort described above are unlikely to contribute significantly to the achievement of comfort in relation to climate most of the components of which do not vary significantly throughout the year during the school day and the school building itself remains the only other means of controlling the climate.

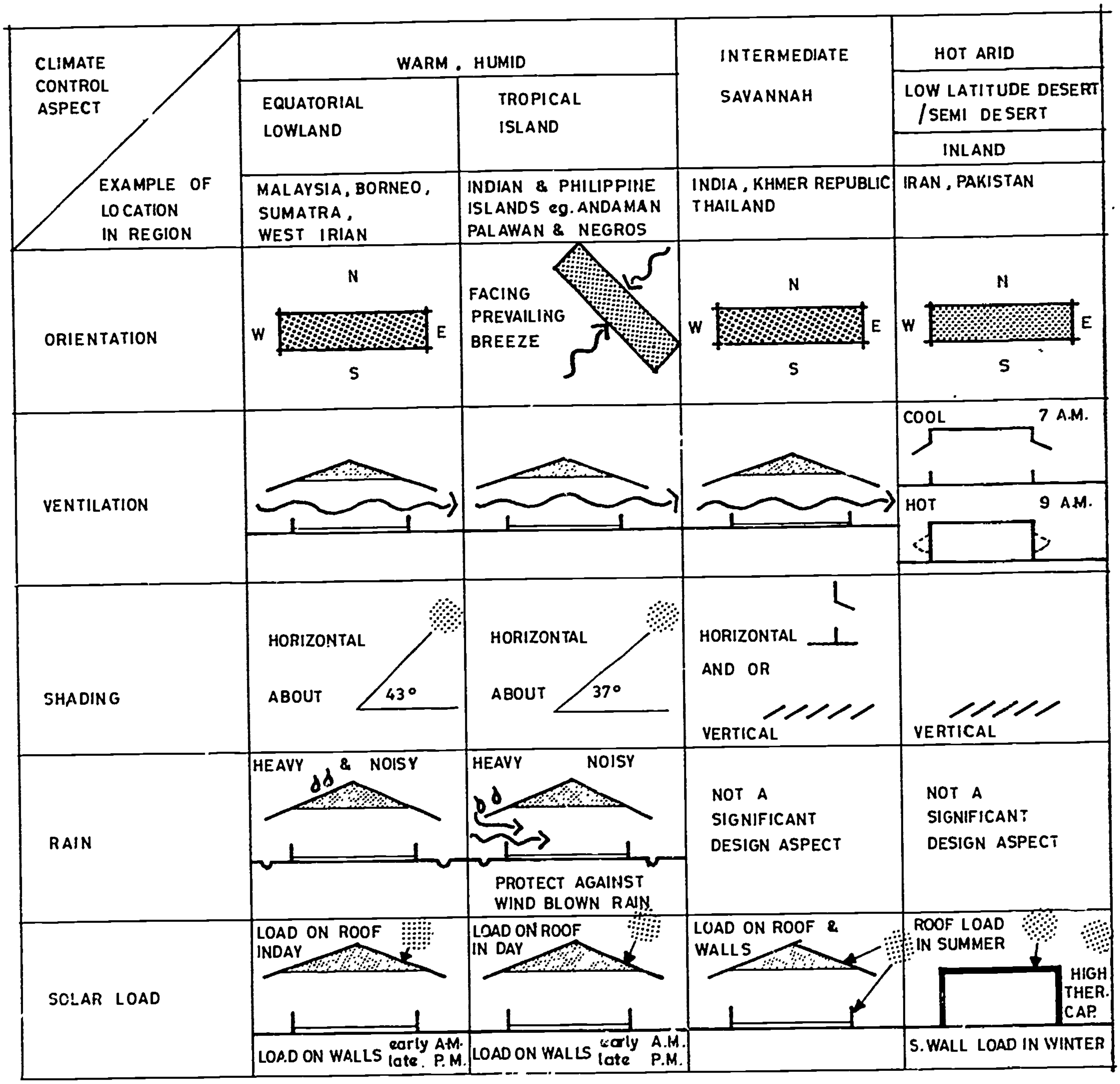


FIG. 61 a)

As has already been mentioned above, absence of information on desirable conditions of thermal comfort makes it impossible to control climate through design in any quantitative manner. The best that can be done at this stage is thus to indicate the main aspects of climate that require control. These are illustrated in Figure 61 (a) and (b). Where the designer is working in an unfamiliar district in the country, it will always be wise before design commences, to study and evaluate the solution provided by the older buildings to the problems presented by the local climate. Much additional information on this topic is provided in (6.37), (6.40) and (6.43).

Finally, it is not possible to refer to thermal comfort and its achievement, especially in the hot humid zone, without referring to the very considerable cooling effects that can be achieved by planting. The rate of plant growth in the humid tropics is little short of amazing. A single storied school with a hot asbestos roof could have its roof covered with the climbing Bougainvillea species within six years if the staff of the school were to encourage the care and cultivation

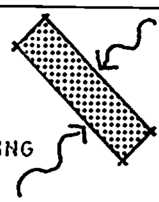
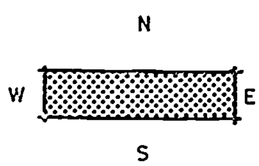
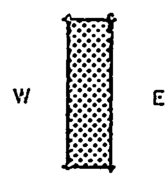
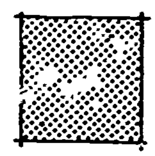
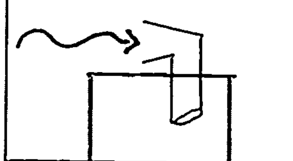
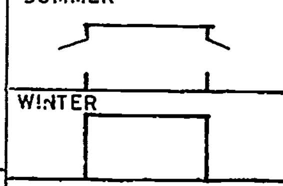
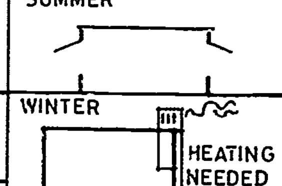
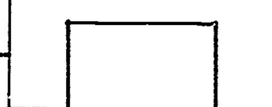
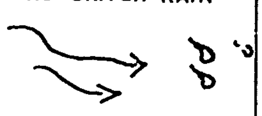
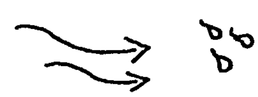
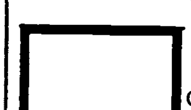
HOT ARID	COOLER UPLANDS		TEMPERATE OR SUB-TROPICAL	CLIMATE CONTROL ASPECT / EXAMPLE OF LOCATION IN REGION
LOW LATITUDE DESERT / SEMI DESERT MARITIME	EQUATORIAL	TROPICAL		
COASTS OF IRAN, PAKISTAN	INDONESIA	BURMA, LAOS	CHINA, JAPAN NEPAL, INDIA	
FACING PREVAILING BREEZE 				ORIENTATION
	SUMMER / WINTER 	SUMMER / WINTER / HEATING NEEDED 		VENTILATION
VERTICAL //////	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	SHADING
NOT A SIGNIFICANT DESIGN ASPECT	WIND DRIVEN RAIN 	WIND DRIVEN RAIN 	WIND DRIVEN RAIN 	RAIN
ROOF LOAD IN SUMMER  HIGH THERMAL CAPACITY S. WALL LOAD IN WINTER	NOT A SIGNIFICANT CONTROL ASPECT	NOT A SIGNIFICANT CONTROL ASPECT	NOT A SIGNIFICANT CONTROL ASPECT	SOLAR LOAD

FIG. 61 b)

of this remarkable plant. Not only would the roof become very much cooler, but the colours of the bougainvillea would do much to enhance the beauty of the surroundings.

There are a large variety of other shade trees with rapid growth which can be used to shade buildings, and some of these are described in (6.48).

6.06 Acoustics

School buildings in the Asian region are of two types. In the arid and upland zones they comprise a number of totally enclosed somewhat more quiet teaching spaces whilst, in the humid tropics they are open to permit good cross ventilation and often there are no division walls between teaching groups, which may give rise to unwanted sound in teaching spaces.

Figure 62 shows typical examples of each type of building, the closed schools from Iran and the open school from Ceylon.

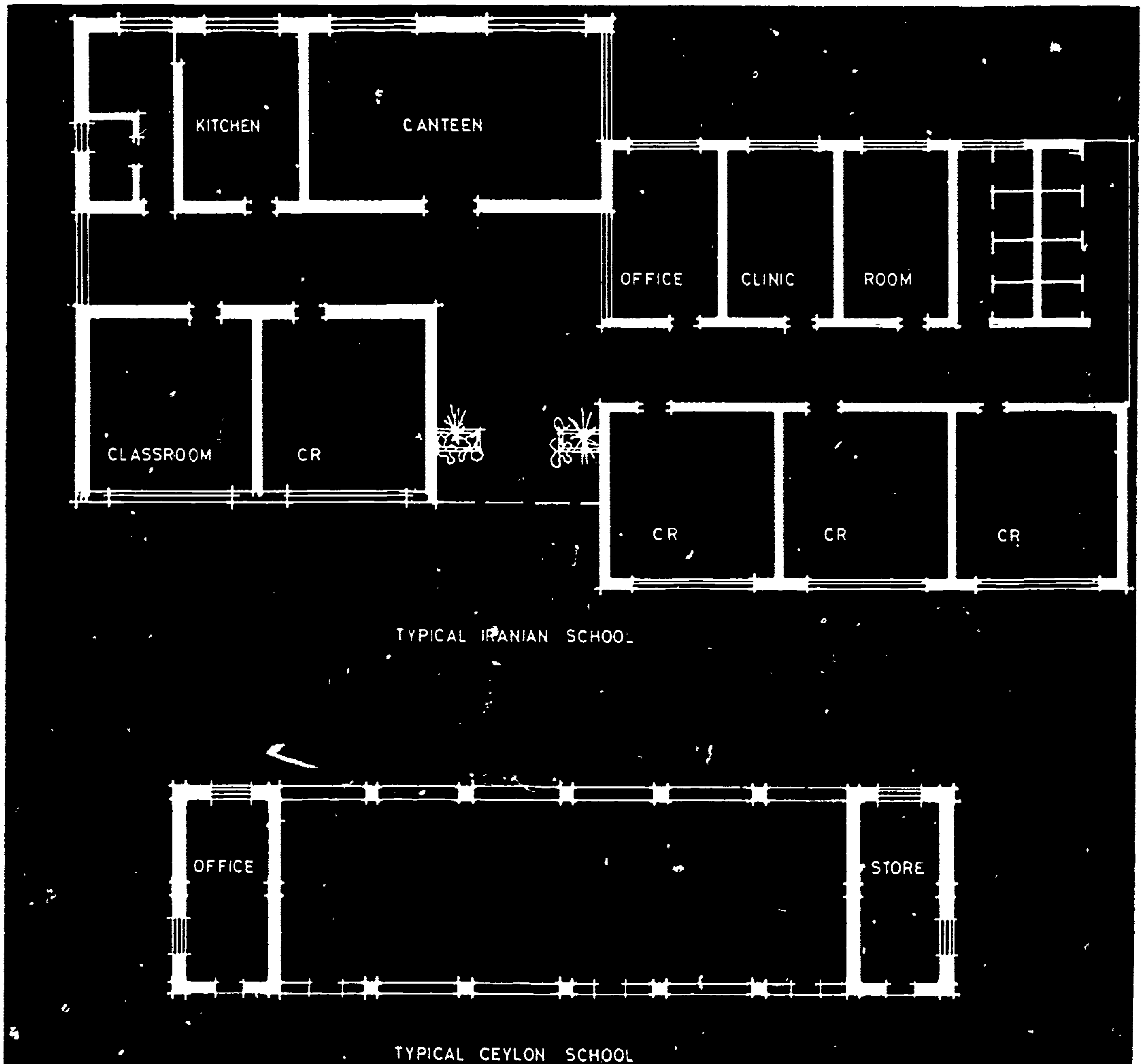


FIG. 62

Another characteristic of education in most countries, which is also relevant to design for good hearing conditions, is that teaching is mainly teacher centred or didactic in character (see 1.03., methods). This means that the teacher teaches, usually from a fairly restricted area close to the chalkboard and the children listen. Occasionally, especially in the lower grades of the primary school, the children repeat together some part or other of the material they are learning. Apart from these two sources of sound within the building, classes without a teacher will sometimes form a source of noise and, of course, where industrial arts or music is taught, the children will also make a noise.

Outside the building, and adding to the sound generated internally, there may be a variety of other sources of sound such as vehicles, children playing and other general background sounds.

The design of the teaching space from the view point of acoustics requires that every child in a class must be able clearly to hear his or her teacher articulate every spoken word. The situation is illustrated in Figure 63.

The way in which it is possible to determine the levels of sound (intrusive, external and background) that can be tolerated by the child without affecting the ability to hear the teacher distinctly is by means of speech perception tests in which similar but different words are read out by the teacher and written down by the child, (such as in English, man, pan hen, pen), whilst, at the same time, the additional sounds are being reproduced at various controlled levels of intensity. The words have, of course, to be in the child's own language and to date these tests have been carried out in India (Hindi, Malayalum, Tamil, Goan), Ceylon (Sinhala, Tamil and English), Malaysia (Malay, Tamil, Chinese, English), Singapore (Chinese, Malay, English).

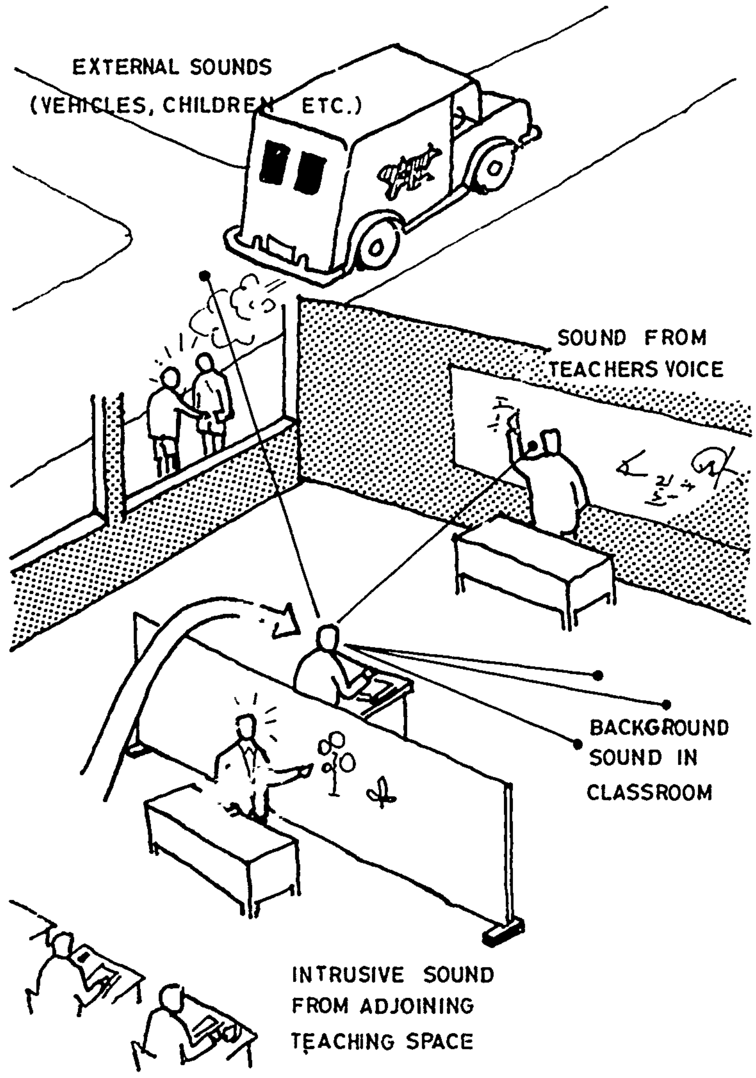


FIG. 63

The numbers of errors made by the child in the test is a measure of the effective proportion of normal speech which is available to the child having regard to the level of sounds other than that of the teacher's voice.

The results of these tests (6.45), apart from the useful design data that can be obtained from them, showed, incidentally, that children are able to adapt to high levels of noise. In one school, where five teachers were teaching at the same time in a higly reverberant space, the speech perception tests gave about the same number of errors as were obtained in significantly quieter situations. But, whilst the children were able to adapt themselves to learning in such noisy conditions, the rapid turn over of teachers in this particular school indicated the strain to which they were put in teaching and it is clear that, if there is to be effective use of the teacher, one of the prerequisites is a suitable acoustical environment in which the teacher is able to talk using a normal voice level.

The starting point for the design of the acoustic environment is thus the level of sound of the teacher's voice and the environment must be such that all the children, including the child furthest from the teacher, can hear the teacher articulate words and sentences *clearly above all other sounds* from both inside and outside the building. (6.46)

The sound level generated by a female teacher speaking with a normal voice is about 75dbA*. That of a male teaching with a raised voice is just over 80dbA.

But sound decreases in loudness inversely as the square of the distance from the source. Thus, a teacher speaking with a sound level of 75dbA will be heard by a child 7.0 metres away as producing a sound of loudness about 7dbA less, that is 68dbA.

*Note *db is an abbreviation for 'decibel'. An increase of one decibel is about the minimum perceptible difference in loudness that can be detected by the human ear for a particular frequency structure which is indicated by the letter A.*

As will be seen from Figure 64, the children sitting at the back of both classes will hear both teachers as producing sounds of roughly the same level. In such a situation the children will be quite unable to distinguish the words articulated by their own teacher from the words of the teacher in the adjoining space. What is needed in such a situation is to arrange that the intruding sound from the voice of the teacher in the adjoining space is reduced in loudness. The reduction required has been found to be of the order of 5dbA. Figure 65 shows the situation graphically. The problem of achieving the reduction of 5dbA can be solved in a number of ways. The main criterion in developing the solutions, apart from achieving the desired 5dbA reduction in sound level is that the physical device such as a wall or partition should have several other uses. Few countries can afford to create environments foi learning. the components of which have

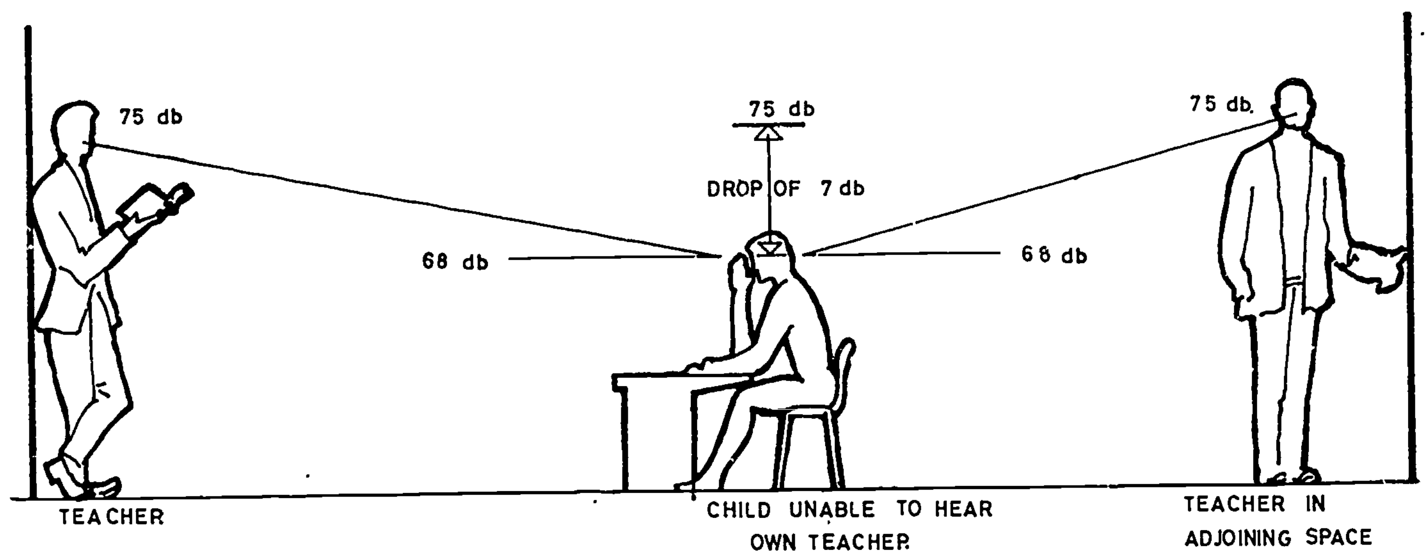


FIG. 64

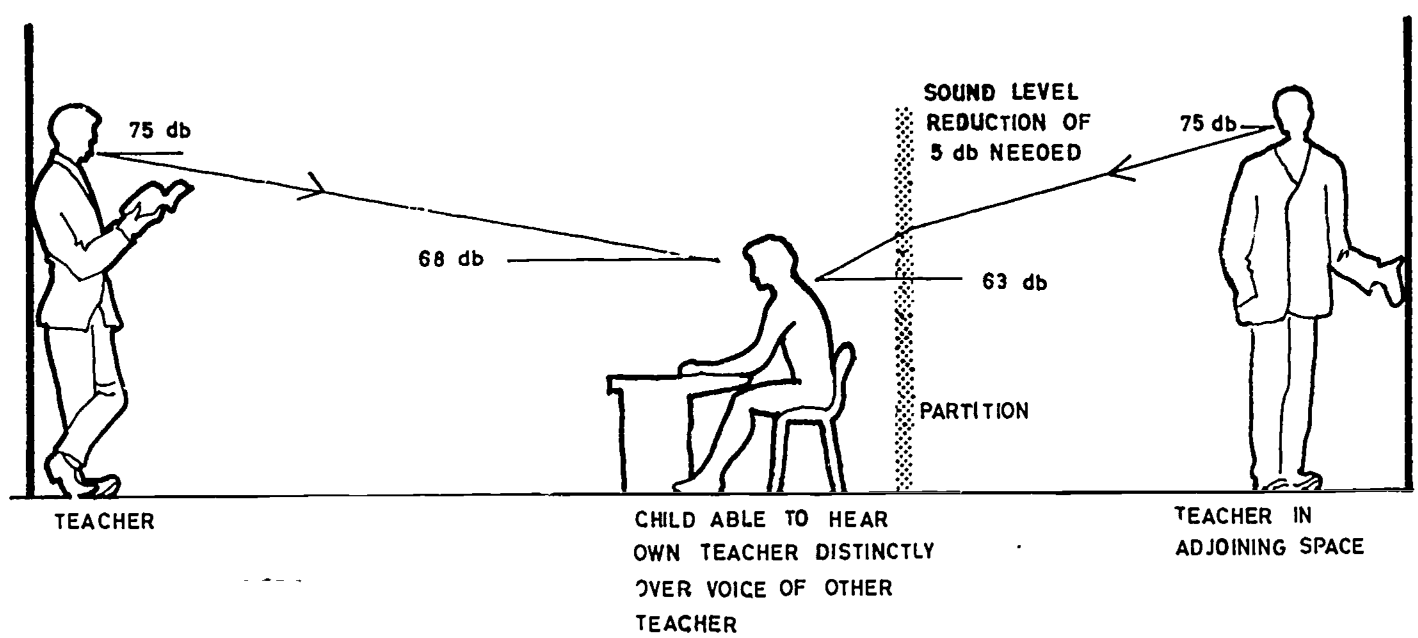


FIG 65

only one purpose. For example, it is usually possible to arrange that the component that admits daylight also admits breeze for ventilation.

In virtually all climatic zones of the region, the external walls will be used for the admission of day light. In the humid zones, both external walls will have to admit breeze. Thus the division *between* teaching groups is often the only element which can be used for the chalkboard, pin up spaces, projection screen, storage for teaching materials and the like.

The *double* function of the sound reducing element should thus at least comprise:

(i) sound reduction
(ii) teaching aid unit

In a hot humid climate, and for an open school of the type common in Ceylon (Figure 62) one of the possible solutions may be as shown in Figure 66 and Plate 11. From Figure 66, it will be seen the teachers adjacent in teaching spaces stand back to back and that the role of the partition is substantially to reduce the level of sound heard by the children in one space from the adjoining space. What in fact happens is that immediately behind the (useful) partition is an area of acoustic shadow in which very little can be heard from the teacher in the adjoining space and beyond this, the level of his or her voice is reduced to about 8dbA below the 68dbA level of sound heard by the child from his own teacher. Note that very little sound indeed is diffracted under the partition which is left open at the bottom.

Plate 11

In this way a useful partition element is provided which reduces sound from one space to the next, which provides an aid for the teacher and pupils, which permits cross ventilation where that is needed and generally, which can be moved as teaching group sizes change (see 1.01 and Figure 6).

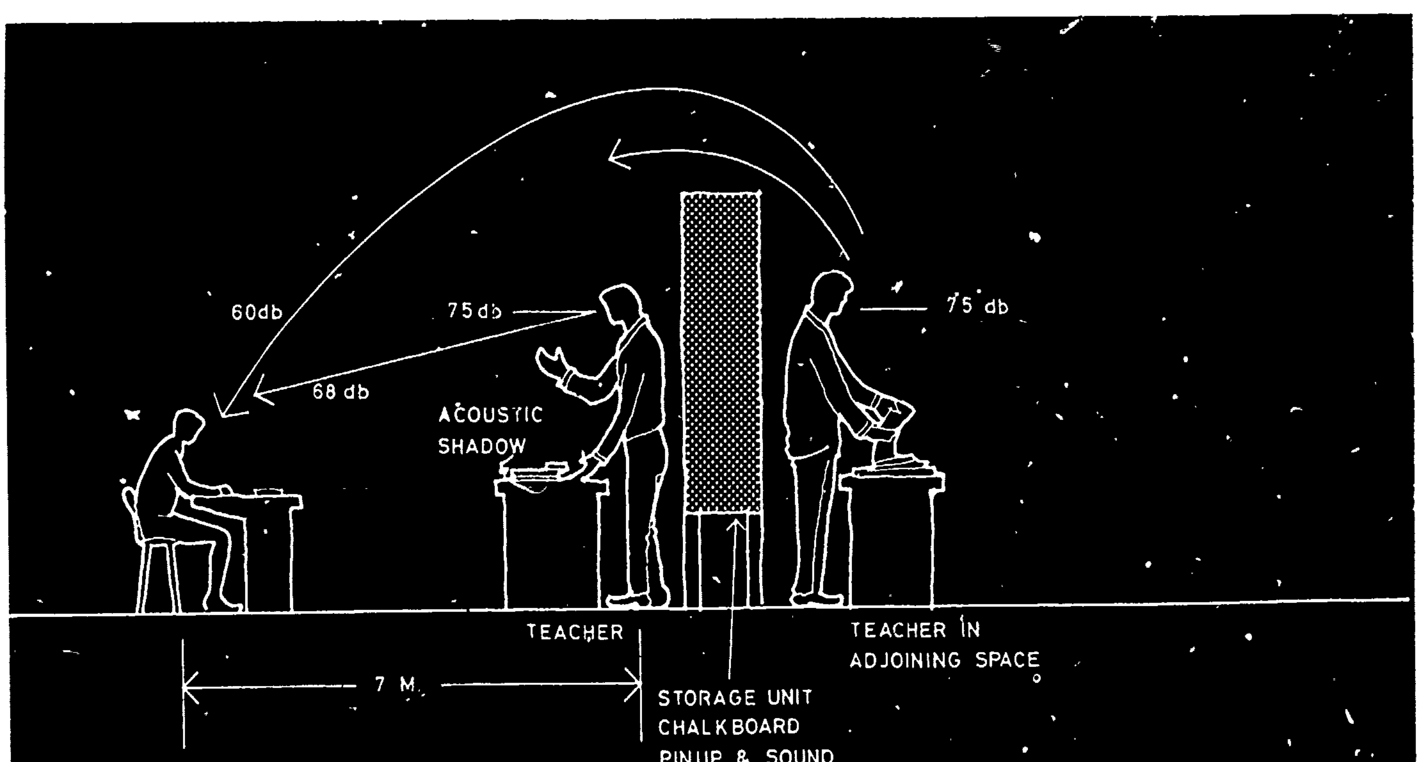


FIG. 66

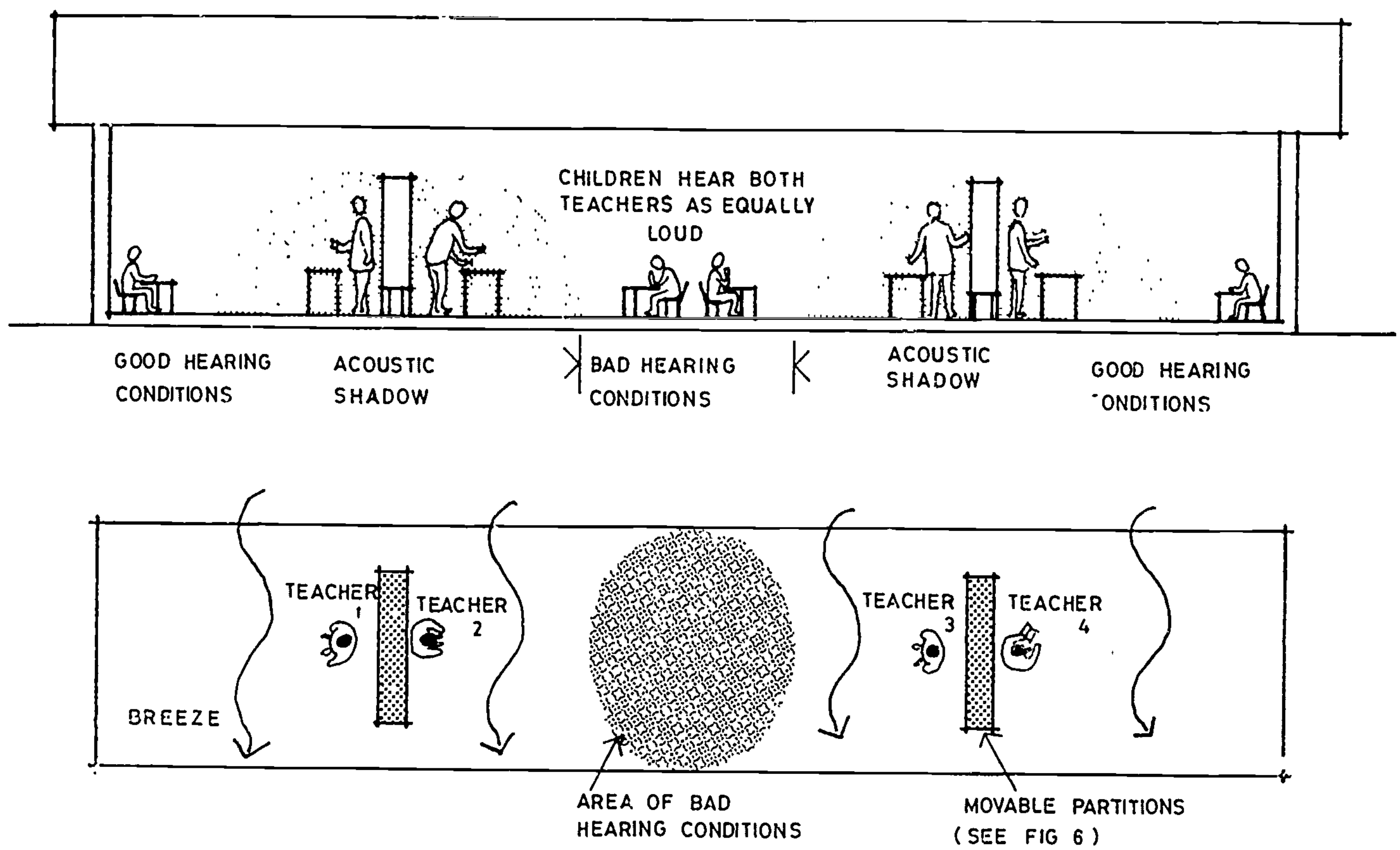
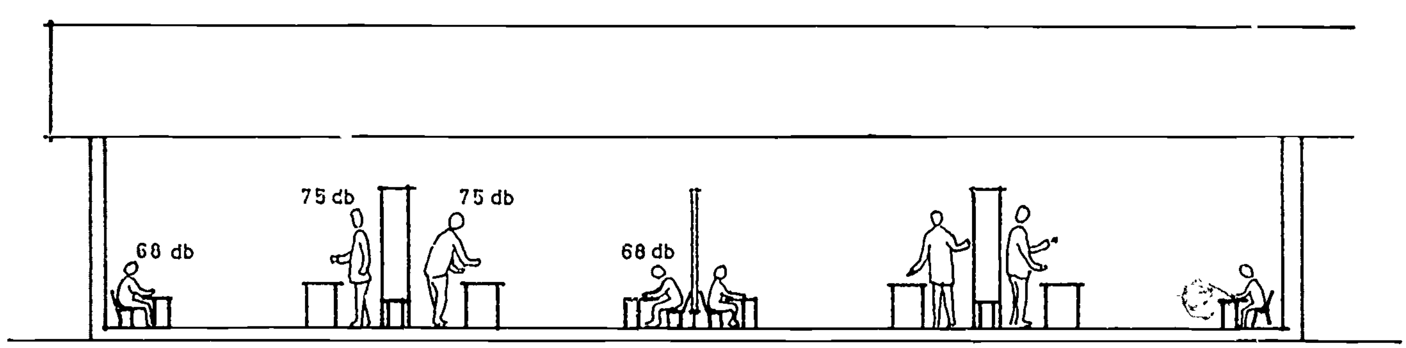


FIG 67a FIRST STAGE OF IMPROVEMENT OF SITUATION

Of course, if the Ceylon school illustrated in Figure 62 is considered in the context of the solution suggested above, then there will be a need to break up the space in respect of its length into units of two spaces each. Figure 67 illustrates the situation. 67a shows pairs of acoustically comfortable rooms which are also well ventilated and have facilities for storage etc. The area *between* the pairs of spaces will however be one of bad hearing conditions. 67b shows how, by the inclusion of another light partition, of boarding or matting, this area can become acoustically satisfactory.

In a closed type of school such as that for Iran, illustrated in Figur. 62, above, the noise reduction between one classroom and the next, is already satisfactory. Should, however, it be desired at some future time to vary the internal arrangement as is suggested in Figure 68, then, because the school has a flat reinforced concrete roof, there will be high internal reverberation of sound within the closed external walls. The achievement of



GOOD HEARING CONDITIONS IN ALL SPACES WHILST MAINTAINING FLEXIBILITY & PROVIDING AMENITY FOR TEACHING & STORAGE ETC

FIG 67b

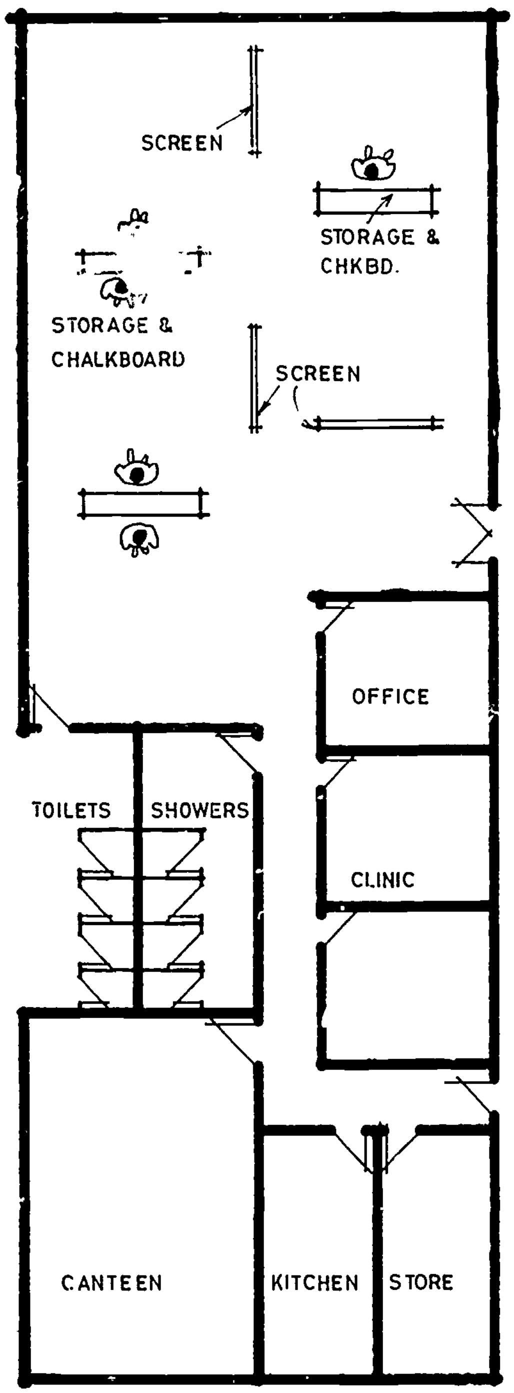


FIG. 68

good hearing conditions will then depend on the inclusion in the structure, of materi. able to *absorb* the unwanted sound. Soft board on the ceiling of the teaching area will be quite adequate for this purpose (6.44).

The preceding section has dealt with some of the problems arising from the creation of a good environment for hearing as between one teaching space and the next. However, there are, as is shown in Figure 63, a variety of other sound sources that may result in poor hearing conditions in the teaching space. If external sounds can be kept about 12dbA in level below that of the teacher's voice, then good hearing conditions can be maintained.

The common sources of external sound are:

(a) Traffic.
(b) Children playing on the site (a common source of noise in two or three session schools, when the second or third session children are waiting for the preceding session to finish) or children in nearby buildings.
(c) Music rooms and workshops in other parts of the school.

Sound, as has been explained above, reduces in intensity as the square of the distance from the source or approximately 6db every time the distance is doubled. Figure 69 illustrates this. Thus, if the loudness of the sound at source is known and a reduction to (75–12) = 63dbA is required (that is the teacher's voice level minus 12dbA) then the distance from source to teaching space can be calculated such that the desired reduction is achieved. The loudness of the sound sources listed above are approximately:

(a)	Traffic (heavy urban) at 10 ft. distance =	89dbA
(b)	Children playing =	80dbA
(c)	Workshops (with machines) =	105dbA.

To achieve a reduction of these levels to the 63dbA which is the maximum level of external sound acceptable in the classroom would require that the classroom be located at distances from the sources as follows:

(a) From a traffic source of 89dbA
Reduction required = (89–63) = 26dbA.
Distance of classroom from road = 60 m
(b) From children playing – source 80dbA
Reduction required = (80–63) = 17dbA
Distance of play area from classroom = 23 m
(c) From workshops of source level 105dbA
Reduction required = (105–63) = 42dbA
Distance of classroom from workshop = 300 m.

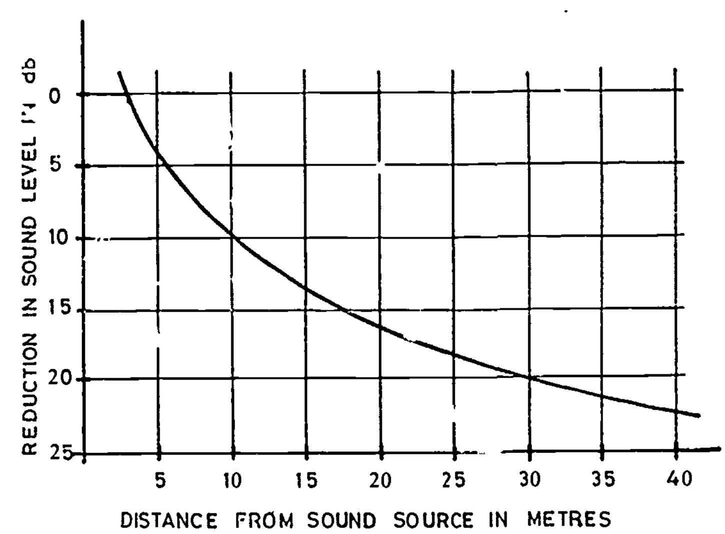


FIG. 69

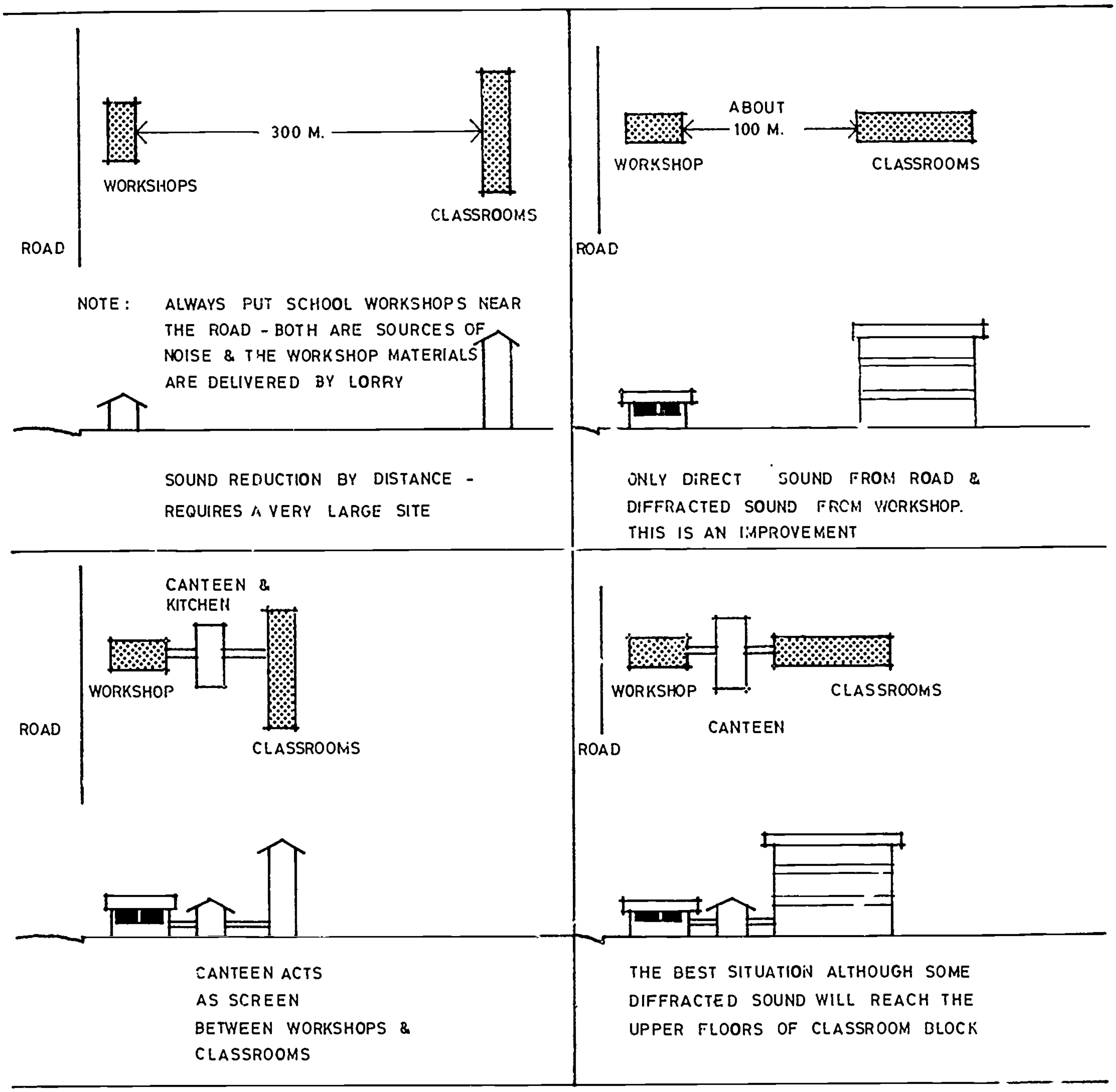


FIG. 70

On many school sites it will probably not be too difficult to arrange that the classrooms are 60 metres from the road and the play area is 23 metres from the classrooms. However, it seems likely on many sites that it would be neither convenient nor practical to locate the workshops 300 metres from other teaching accommodation and it will thus be necessary to find other ways of reducing sound transmission. The first and perhaps the cheapest approach will probably be through planning. Figure 70 illustrates some of the possibilities for hot humid climates where the problem is most critical due to the open design of the buildings necessary to achieve a thermally comfortable environment. Figure 19 which shows an acoustic "quarantine" area, also represents a solution to the problem.

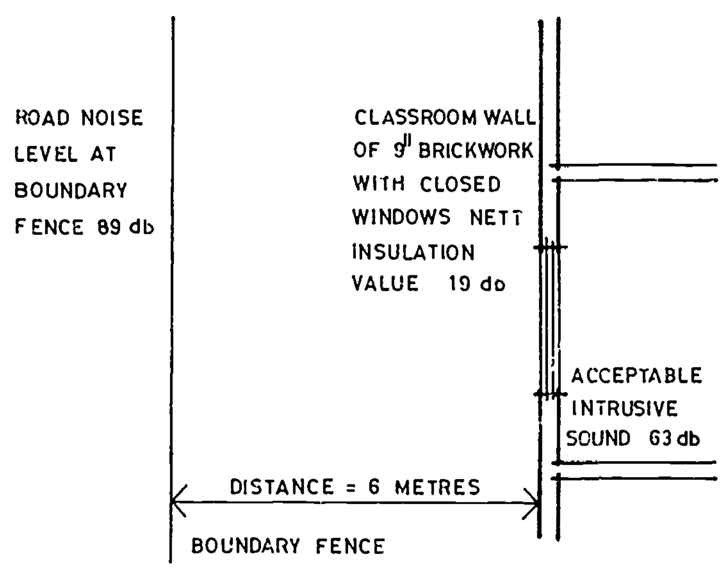
In closed schools in arid, upland or temperate areas, the desired reduction of sound between the noise source and the classroom can be achieved partly by planning as is shown in Figure 70 and partly by using the closed structure of the building to reduce unwanted sound. Figure 71 illustrates the point.

6.07 Circulation *or accommodation arrangement for minimum movement.*

Time is an important element in education. If there are six periods of 45 minutes each during the school day with a break of 5 minutes between each period to allow classes and teachers to change from one teaching space to the other, then the breaks represent almost 10% of the time available for teaching. As one of the problems of education in Asia today is that of finding enough time for teaching and learning both in respect of the many subjects it is desired to offer and the numbers of children to be educated, it seems very important that the design of schools should be such as to facilitate movement and reduce its duration to a minimum. In the 1960's increasing attention has been paid to this subject especially by those who have ready access to the computers necessary to assist in computing the time and hence, the cost of alternative circulation patterns. An example of the sort of problem considered is shown in Figure 72 from which it can be seen that, assuming all classes study science, the best place for the laboratory from the view point of movement, is near the middle of the group of classrooms. Alternatives (c) and (d) in the figure involve a saving of 29% in the distances walked by the students. If X = 8 metres the saving is 96 metres and at a normal walking speed of about 2.5 km per hour, the saving is roughly 2 minutes.

The building shown in Figure 72 was given as a simple example to illustrate the point that spaces in common use should be as near to the physical centre of the building as possible, having regard to other factors affecting performance, such as sound, ventilation etc. Figure 73, however, shows a more complex example of a school from one of the countries of the region and, also shown is a re-arrangement of the blocks which has the effect of reducing circulation considerably.

The distance along the corridors (B to A) and (C to A) and return is 266 metres in the actual school. Had the buildings been arranged as suggested the distance along the corridors (B to A) and (C to A) and return would be only 107 metres, a saving in distance of 133 metres. It can well be imagined that if the sum of the savings for all classes was totalled throughout the week, it would equal many thousands of metres and hours of time. Where there is access to a computer and the designer is engaged in designing standard schools for wide application, the circulation problem will repay detailed study. (6.47)



THE DISTANCE MUST BE SUCH AS TO ACHIEVE A REDUCTION OF

89 - (63 + 19) db = 7 db

DISTANCE = 6 METRES

NOTE. IF THE WINDOWS ARE EVER OPEN DURING SCHOOL HOURS THE REDUCTION REQUIRED WILL BE 26 db AND THE DISTANCE 60 METRES

FIG 71

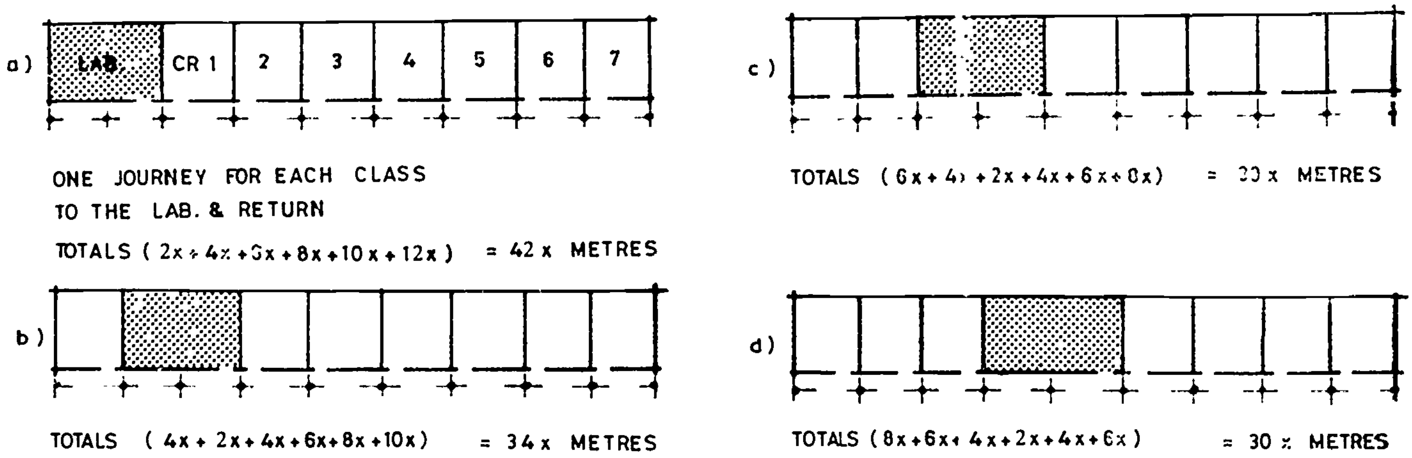
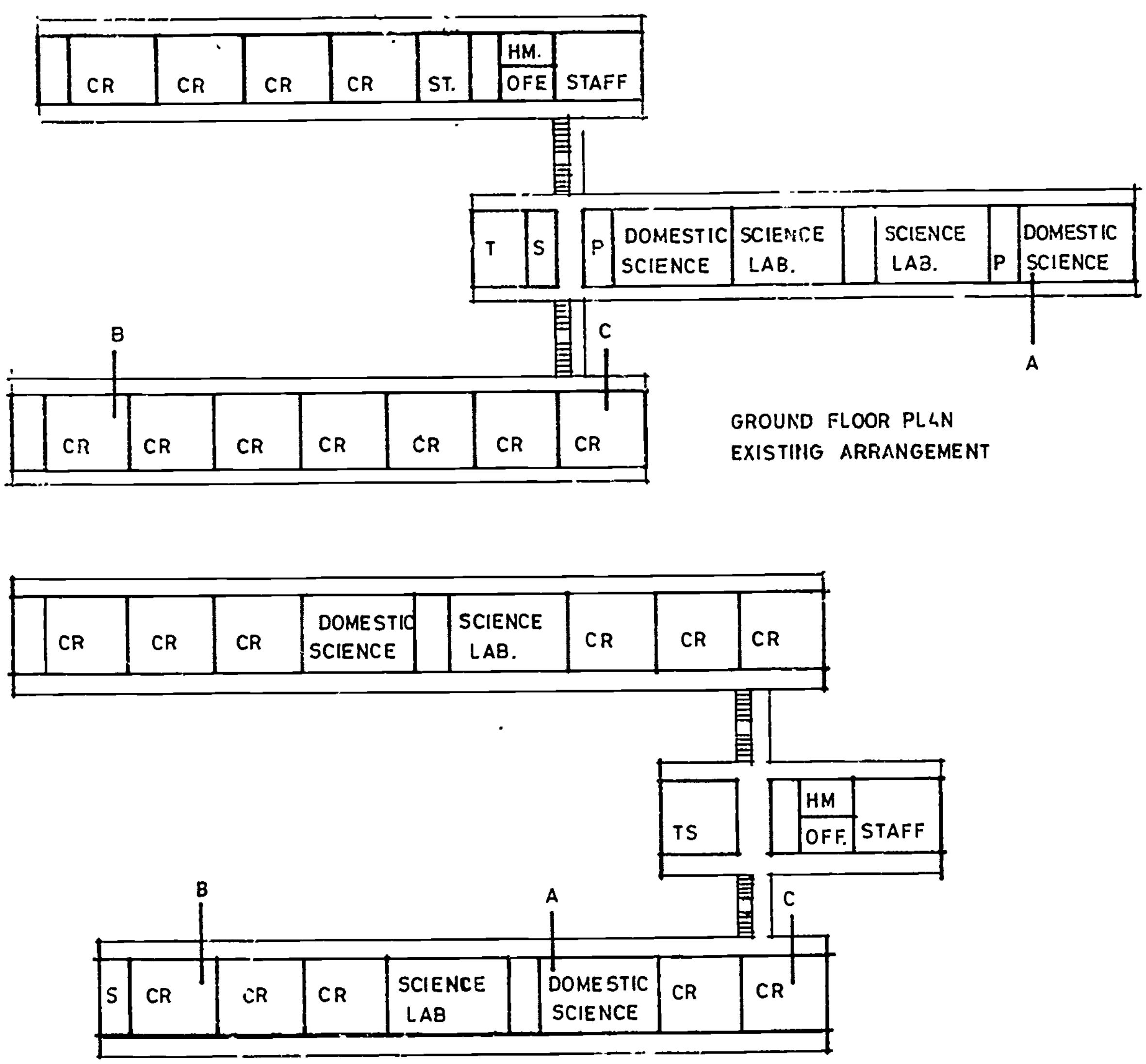


FIG. 72



GROUND FLOOR PLAN
EXISTING ARRANGEMENT

GROUND FLOOR PLAN
REARRANGED TO REDUCE CIRCULATION

FIG. 73

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Chapter 7

CLASSROOMS

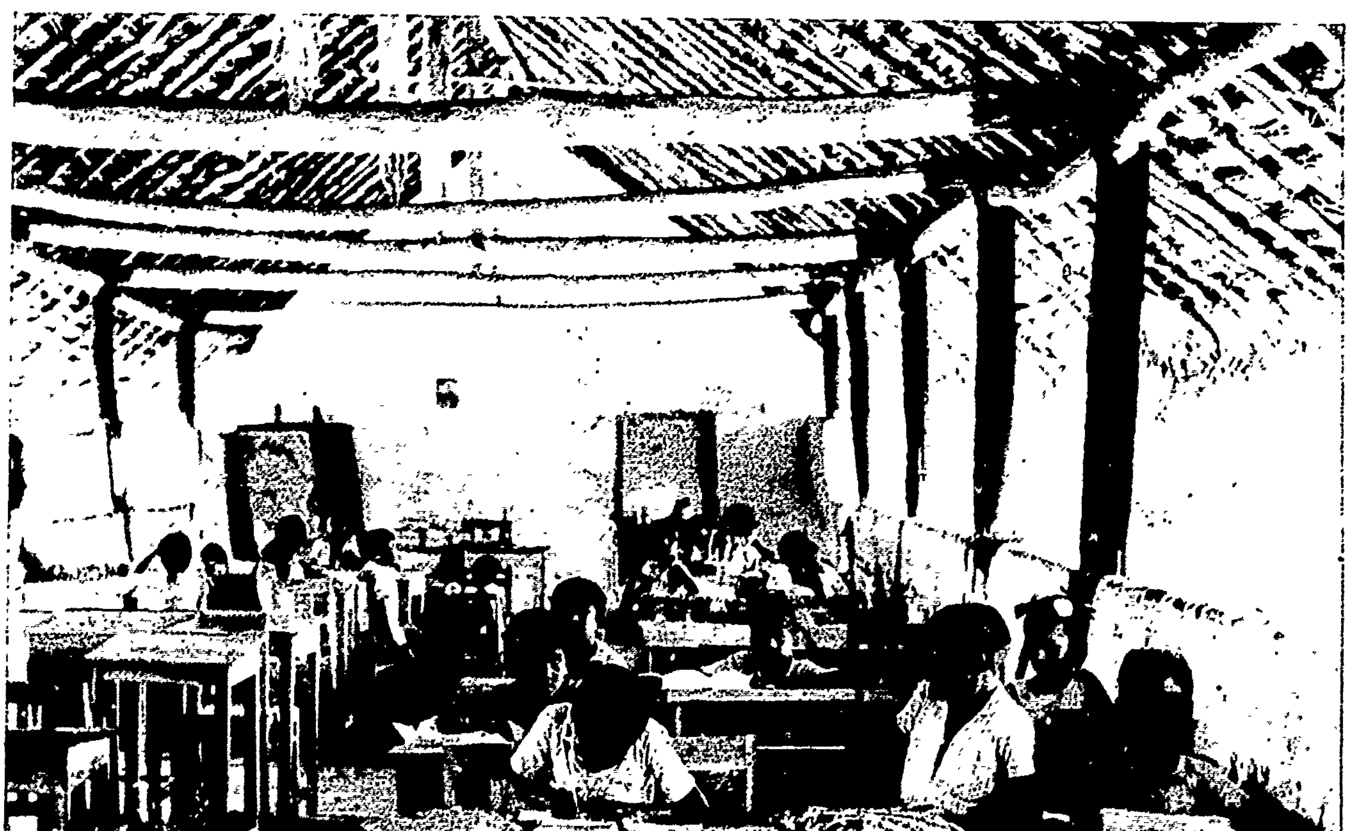


Plate 12 a

Plate 12 b

Plate 13 a

7.01 General

Classrooms in the Asian Region take many forms, as is evident from plates 12a & b and 13a & b. They range from large, comfortably furnished spaces designed to permit of a wide variety of teaching methods, to spaces in which children are packed rather like sardines in a tin and where the furniture is arranged in rows, in the same position, year after year. Sometimes there is no furniture and the children sit on the floor and write with their slates or books resting on their knees. Often, where there are wide verandahs in older schools, there are classes all along the verandah. In those parts of the region where it is cold in winter, classes are conducted in the warm sun outside the building, often facing chalkboards, painted on a convenient external wall or on a short length of brickwork especially constructed as a free-standing chalkboard. There are classrooms in rented houses, in court yards, in community and other halls, in temples, in tents, in barns which in years gone by, have been used to store grain, in converted hospitals, and in a variety of structures, the original purpose of which is no longer evident.

This situation poses two main problems:

(i) What guidance can be given to the designers of new schools so that they can provide for present and future (changed) needs in respect of classroom accommodation?

(ii) What can be done to improve the amenity of the very large stock of existing classrooms?

Before attempting to discuss these questions, it is important to understand the function of a classroom and the sort of activities that take place in it.

7.02 The Classroom

The term "classroom" is essentially connected with educational method. In most countries of the region, heterogeneous groups will be formed and populate a classroom. There are, however, other countries, in which the word "classroom" has no meaning at all because the method of education is such that children are not arranged in heterogeneous groups, but rather on the basis of interests, abilities and achievement. Homogeneity in grouping may lead to variations in group size throughout the week, depending on the particular factor used as a basis for grouping (interest, ability etc.). The logical outcome of this approach is the preparation of individual programmes for individual children.

Plate 13 b

Where this kind of educational change is taking place, there is no need for classrooms of the sort intended for heterogeneous groups and this is reflected in schools designed *without* any classrooms at all (Figure 74) (7.1) (7.2) (7.23). At the first level of education, undivided spaces for teaching such as that shown in Figure 75, (7.3) (7.4) have been in common use for the past twenty years or more. More recently, buildings for upper second level education have also shown a trend towards the provision of tutorial and seminar rooms and open suites for learning, and in this way, reflect the greater emphasis that is being placed on the individual and his or her education, (Figure 76), (7.5). an emphasis which is typified by the increasing appearance of the carrel in educational building design. (Figure 77) (7.6).

In almost all old and most of the new schools around the world, however, the tradition of providing classrooms for teaching and learning continues and the most that can be said at this time is that there is a slow but growing trend towards the loosening of the shackles formed by the traditional four walls, windows and door.

Of course in some Asian countries such as Ceylon, Burma, Indonesia and parts of India, the wheel has turned full circle as the traditional standard plans, for reasons of economy, have no fixed internal walls and the buildings are thus ideally suited for a variety of teaching methods, although they may be regarded as not entirely satisfactory for the methods of teaching and learning, currently in use in these countries. This type of school building is an asset which, if slightly adjusted and adapted to present use, will prove invaluable in years to come as patterns of teaching change.

It must be assumed however, that the practice common throughout the region of providing rectangular classrooms with permanent walls on all four sides, will continue and the question for the designer is how these spaces can be designed to provide the desired environment for teaching and learning within the constraint imposed by very limited resources. In providing the answers, the designer should keep the possibility of future change in mind.

The subject areas for which classrooms are used at the first and second levels of education are broadly as follows:–

Religion

Social Studies

Language Arts

Mathematics

at the first level handicrafts

at the first and second levels – science (part only)

The approach to teaching these subjects is generally teacher-centric, that is to say the teacher sits or stands

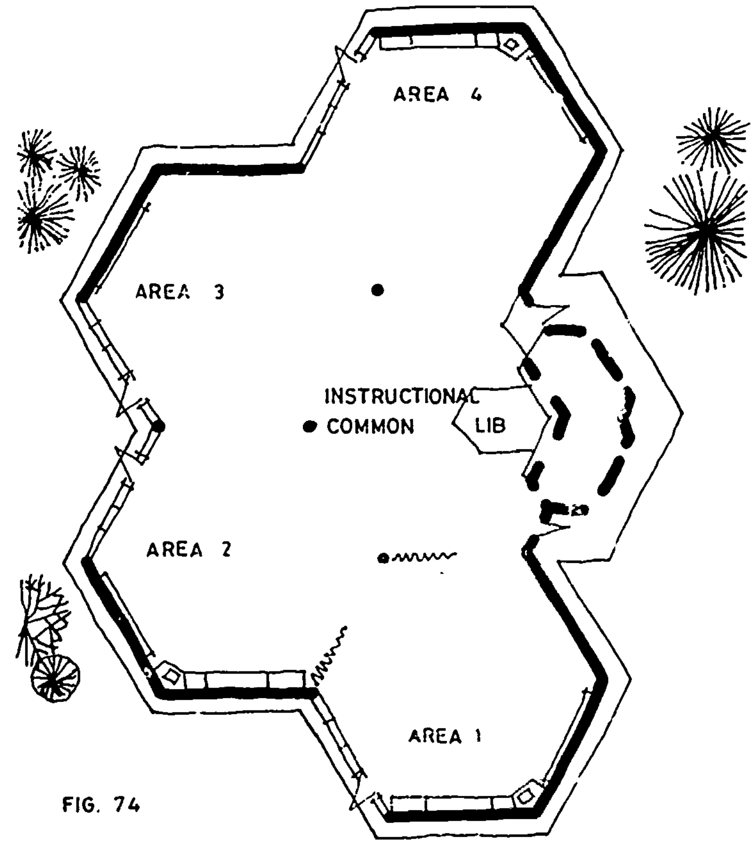


FIG. 74

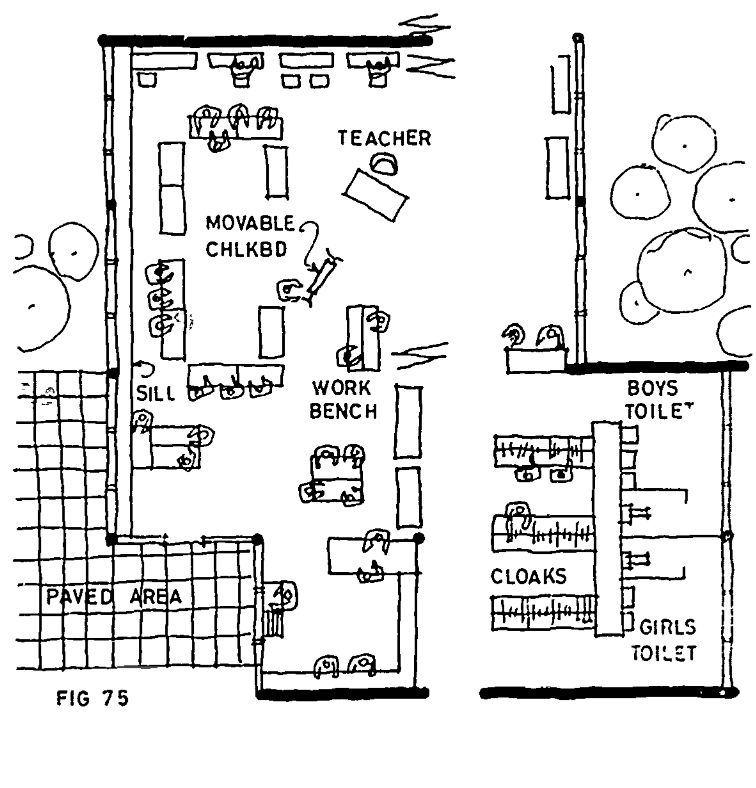


FIG 75

at one of the four walls with a chalkboard and teaches from that position. The average lesson will probably follow the sequence:

1. Recapitulation of previous work.
2. Introduction of the material for the lesson.
3. Development.
4. Exercise by the student with assistance from the teacher who may move from child to child.
5. Recapitulation of the main points.

There are, of course, a large number of variations to this general approach and the precise method used will depend on the nature of the unit being taught as well as on the ability and skill of the teacher. Not all teachers in the countries of the region are trained.

It may be assumed that the methods of teaching used by untrained teachers will be similar to those of the teachers who taught them when they were children and, in some cases, modified by newer methods introduced by headmasters, the inspectorate and occasional in-service courses of varying duration, conducted locally or by correspondence.

The classroom environment must be designed to assist both trained and untrained teachers to teach the subjects listed above as effectively as possible. What does this involve?

In making a lesson plan, the teacher will consider *how* the lesson is conducted and what *aids* are to be used. (7.8). Aids include text books, the chalkboard, maps, charts, diagrams, films, film strips, back projectors and the like. Often, especially at the first level of education for example, in work on number, stones and sticks may be used for counting. (See Appendix VII for a detailed list of aids commonly used in the countries of the region.)

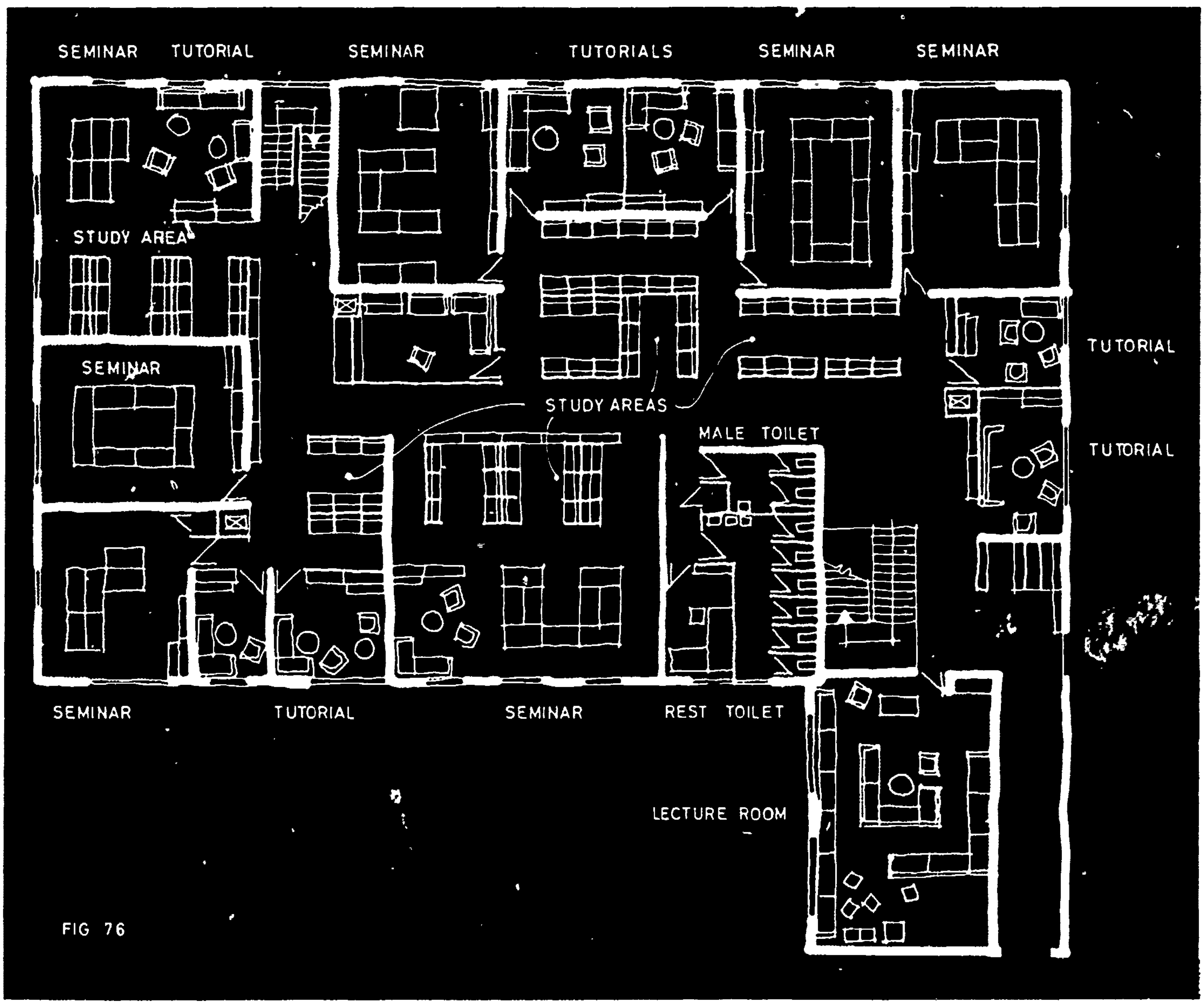


FIG 76

The actual aids will depend first on the subject being taught, the type of lesson and, finally, on the resources. It would be quite unrealistic, for example, to suggest that slide projectors are likely to be used in every school as, in many countries, the budget for education and the foreign exchange situation are factors which prevent their purchase. Appendix VIII suggests, in fact, that the most commonly used aids are those that can be produced locally.

7.03 Provision for Teaching Aids

The designer thus has to find out just what sort of aids are likely to be used by a good teacher and to provide the appropriate physical facilities for them.

A bare list of physical facilities for aids in any classroom at the first or second level of education would include the following:–

(a) Chalkboard.
(b) Pin-up board for pinning diagrams, maps etc.
(c) Hanging rail and hooks from which to hang maps, charts and the like.
(d) Storage space (lockable) for specimens, maps, globes, etc.
(e) Open shelving.

All of these elements are part of the building and should be provided. This comment is of especial significance in those countries where one agency (often the Department of Public Works) provides the building and the supplies branch of the Education Ministry provides furniture and equipment. Many classrooms in Asia have only the basic four walls, a floor and roof because the designer did not design for and *build in* the physical facilities needed for storing and using teaching aids and the supply agency has, for some reason or other, not provided them either.

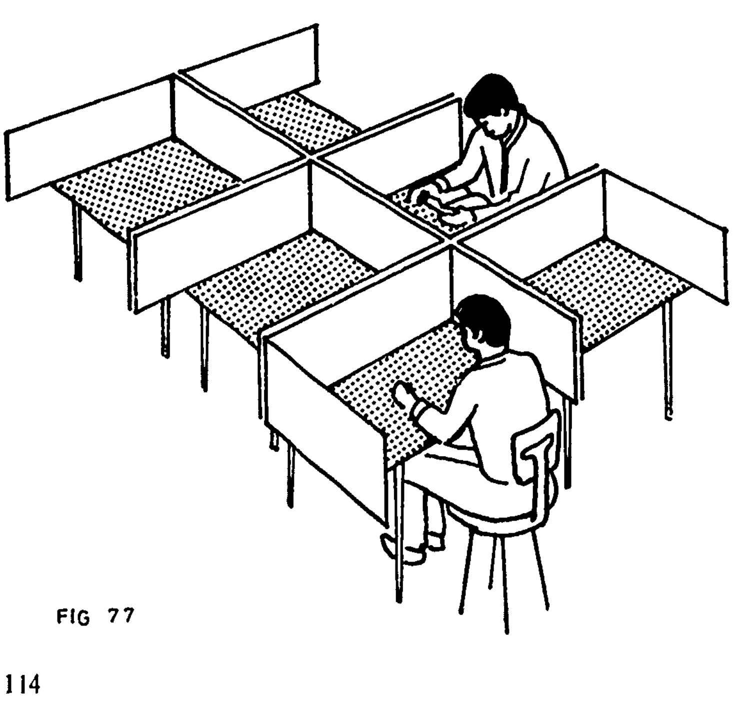


FIG 77

The heights of a chalkboard, pin-up board, hanging rail and shelving are suggested in chapter 6. Figure 78 gives details of a storage unit which provides a minimum facility for teaching aids.

In countries with slightly more money to spend on education, projected material may be used in addition to the non-projected visual aids for which provision has been suggested above. Projection requires a white, flat surface to receive the projected image and there may be a need for electricity where battery operated projectors are not in use. Five amp. socket outlets should be provided, one near the chalkboard for use with back and overhead projectors, and another at the end of the room opposite to the chalkboard for epidiascopes, slide and movie projectors. These outlets can also be used for power supply to tape recorders, radios and television sets. The simplest projection screens are an area of white wall, a piece of white card in a frame (80cm x 60cm is adequate) or an area of pin-up board, painted white.

Projected aids raise the problem of seeing. Overhead projectors and the use of back projection techniques do not require darkening of the classroom. (7.9). Front projection from epidiascopes and slide projectors requires the room to be darkened for good viewing conditions and, whilst this can be more easily arranged in closed buildings such as are usual in the arid and temperate zones, it is difficult to darken a room in the humid zone as, not only are windows very large, but the curtains or other darkening devices prevent cross ventilation.

It is important, therefore, to use the appropriate projection equipment in humid zone schools, namely either overhead projectors or back projectors for slides, loops and other film of this type. The answer to the very common question, "how can I darken the room in such a way that it doesn't get too hot?" is very simply "if you use the right equipment, it can be operated in day-light".

7.04 The Size of the Classroom

(a) Ceiling Heights

It is popularly believed in most countries of the Asian region in both the hot arid and hot humid zones, that the higher the ceiling is raised, the cooler the room will be. Examples of the coolness of old, colonial style buildings, with their very high ceilings, are usually cited as evidence to support this belief – a belief which is sufficiently strong in some countries to find a reflection in local by-laws and building regulations (7.10; 7.11; 7.12; 7.14) which require minimum heights of ceilings in schools of the order of 3.50 to 4.0 metres.

The evidence concerning the effect of ceiling heights on the heat in rooms, caused by radiation from the surface of the ceiling shows (7.15) the difference in heat gain by a standing person by radiation as between eight feet (2.44m) and a 12 feet (3.55m) height ceiling to be 2 Kcal/h which is "a 2% increase in the overall cooling requirements of the body" (7.16) and is thus of little significance. A similar study made in India (7.17) showed that, for all seasons of the year, no thermal advantage was gained by raising ceiling heights above 9 feet (2.74m).

Thus in the design of classrooms, the aspects affecting the determination of ceiling heights are anthropometrics, illumination and structural.

From the view point of anthropometrics, the maximum upward reach of an adult male teacher is of the order of 2.26 metres and with a ceiling at this height it is possible to design windows large enough to illuminate a classroom 7m wide.

The need to support the floor above the classroom will probably involve the provision of some structural beams that project down into the classroom. If the soffit of these beams is at 2.74 metres, the ceiling surface will be somewhat higher. Singapore (7.18) has legislated for 10' 6" (3.2m) ceilings in schools and in Hongkong (7.19) 10' (3.05m) is required from the floor to the underside of the ceiling. The Hongkong experience is of particular interest as the height most recently prescribed represents a reduction of 1 foot (30cm) from that prescribed in the regulations of 1964.

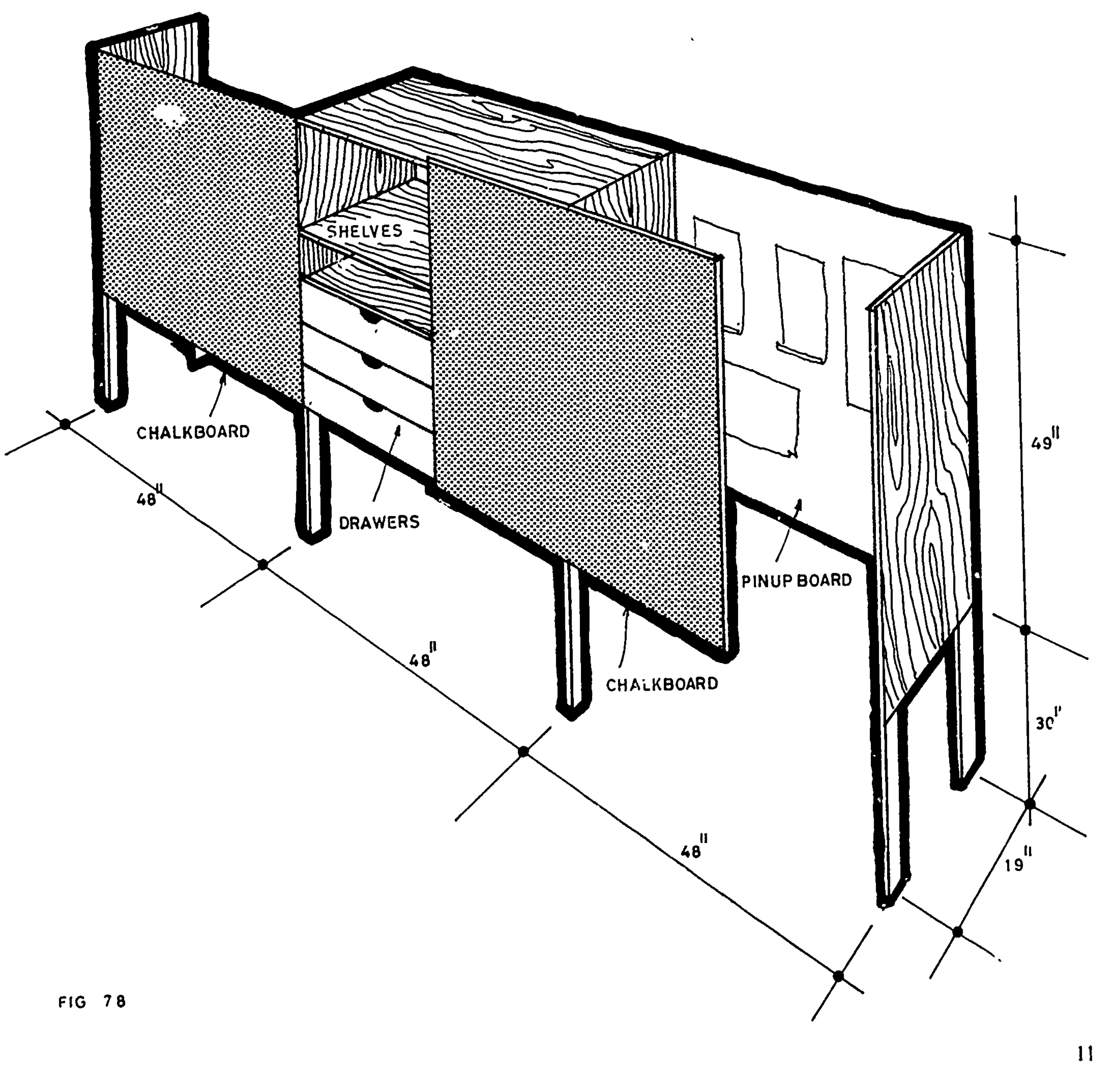


FIG 78

An important consideration in reducing ceiling heights and thus storey heights, is the saving that can be made in the cost of the building. A reduction of height from [illegible] to 3m will reduce the building cost of most schools, built of brick and concrete, by about 2½ %.

Much of what has been written above concerns, of course, the floors of the building other than the uppermost floor or single storey buildings. In such cases, where there is direct solar load on the roof, then the radiation from the underside of the roof surface may differ as much as (15 kcal/h) between surfaces 2.40 and 3.60 above floor level. This represents a significant heat gain and points to the importance of providing ceilings under pitched roofs or the provision of some insulation.

Where flat roofs are used, the construction of low-level asbestos or metal roofs without ceilings, as is the practice in some countries, always appears to cause considerable thermal discomfort.

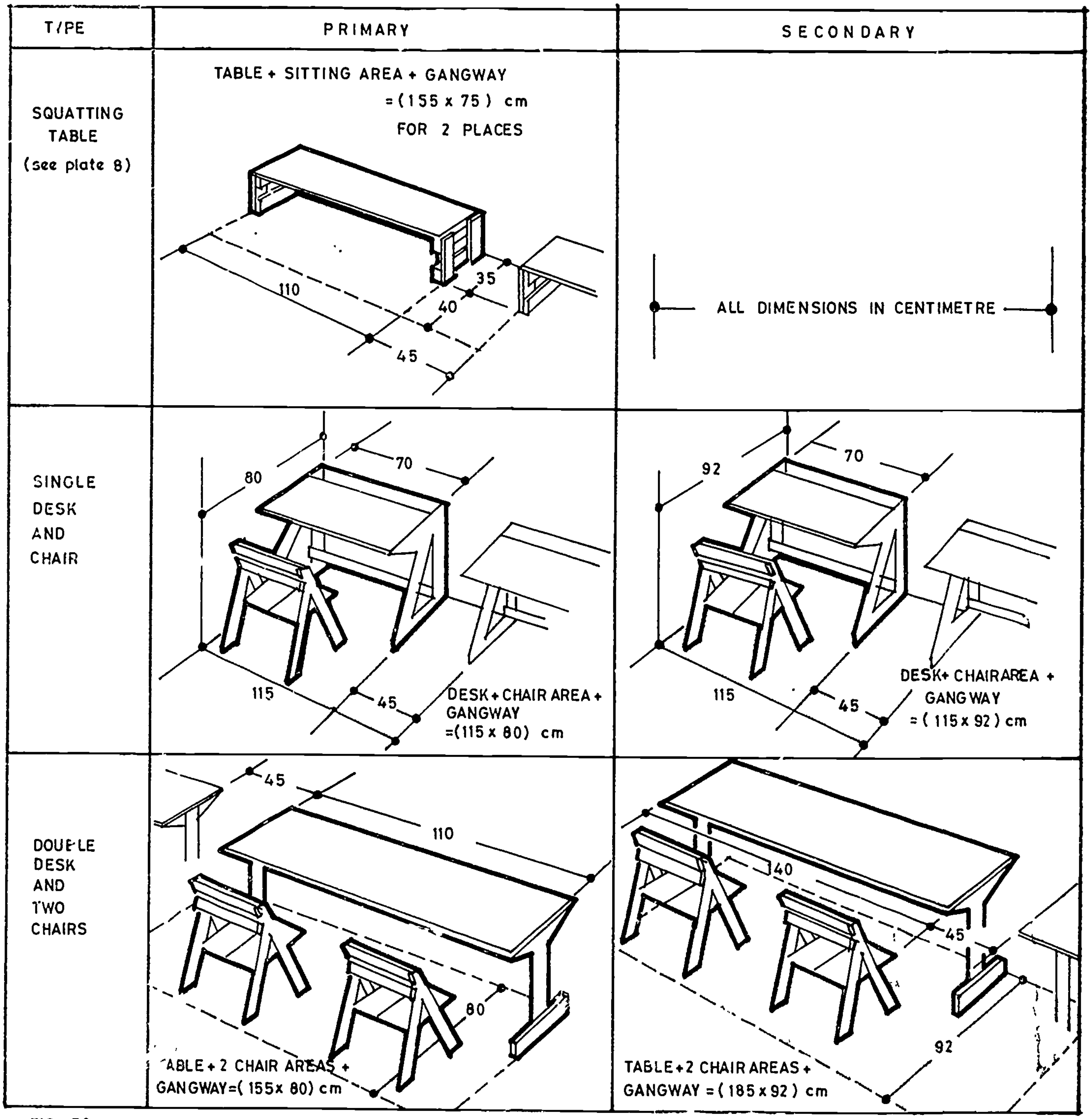


FIG 79

(b) The Length and Breadth of Classrooms

As the heading suggests, this section deals with the criteria affecting the plan dimensions of rectangular classrooms. It is not the intention to make a case for the rectangular classroom. The fact is that virtually all the classrooms in the countries of the region are rectangular and it seems most likely that, for years to come, all new classrooms will continue to be designed to have this same shape.

In passing, it should be said that the advantages of shapes other than the rectangle for teaching large groups of children are not overwhelmingly strong, *provided that* methods are teacher orientated. As far as design for thermal comfort and illumination are concerned, circles, pie shapes and irregular polygons pose problems of shading, illumination design, and ventilation which require the exercise of a considerable degree of design skill to resolve them. Expertise of this sort is available in the Asian region, but in nothing like sufficient strength to tackle a problem the merits of the various solutions to which, in any case, are not of very evident advantage.

Pro tempus the need is thus to provide a more rational basis for determining the size of the traditional rectangular room with a view to obtaining optimum amenity.

The present purpose of providing a classroom is to enclose space to contain a given number of children sitting in a limited variety of positions and usually facing the teacher and a chalkboard. The dimensions of the space will depend on the area allotted to each child and to the teacher. The area allotted to the child will, in turn, depend on the furnishing of the room and the circulation spaces between the furniture.

In designing classrooms it is unwise to tailor each room to a particular grade – that is a particular age group – of children as this will have the effect of reducing the flexibility of the school. The age of the highest grade in the school and the furniture appropriate to children of that age should determine the plan size of all classrooms.

Thus, for a primary school, grades 1–7, with 40 in each class, all classrooms in the school should be large enough for 40 grade 7 children. Similarly, in a secondary school, grades 8 to 12, the rooms, which may vary in size depending on grouping, should all be large enough to accommodate grade 12 children.

It may be assumed that most schools will use one or other of 3 types of classroom furniture:–

(a) Table for children squatting on the floor (tables for two children). (Plate 14).
(b) Single desk and chair. (Plate 15a).
(c) Double desk and two chairs. (Plate 15b).

Each of these furniture types, if suitably arranged, will give access for the teacher to every child in the room.

The dimensions of the three types of furniture, together with a minimum gang way, are summarised in Figure 79. The range of classroom furniture from which these dimensions are drawn is illustrated in Appendix VIII (7.20; 7.21; 7.22).

As furniture determines the sizes of classrooms, alternative arrangements of the furniture illustrated in Figure 79 can be used to determine over-all classroom dimensions as is shown in Figures 80, 81 and 82 and summarised in Table XVII, below.

TABLE XVII

CLASSROOM DIMENSIONS AND AREAS PER PUPIL PLACE WITH VARIOUS TYPES AND ARRANGEMENTS OF FURNITURE FOR FORMAL TEACHING

Furniture Type – (see Appendix VII)	*Number in Classroom*	*Primary* Classroom dimensions in metres	*Primary* Area per place m²	*Secondary* Classroom dimensions in metres	*Secondary* Area per place m²
Squatting	48	6.50 x 5.75	0.78	—	—
(see Figure 80)	48	6.50 x 6.65	0.90	—	—
	50	5.75 x 7.30	0.84	—	—
Single Desk					
(Type D & F)	40	8.40 x 5.05	1.06	9.36 x 5.05	1.18
(see Figure 81)	42	7.60 x 6.45	1.17	8.44 x 6.45	1.30
Double Desk					
(see Figure 82)					
MK 2 Type C	42	7.60 x 4.20	0.76	—	—
	48	6.80 x 5.75	0.81	—	—
	48	6.80 x 6.65	0.94	—	—
MK 1 Type F	42	—	—	8.44 x 5.30	1.06
	48	—	—	7.52 x 6.95	1.09
	48	—	—	7.52 x 7.85	1.23

Plate 14

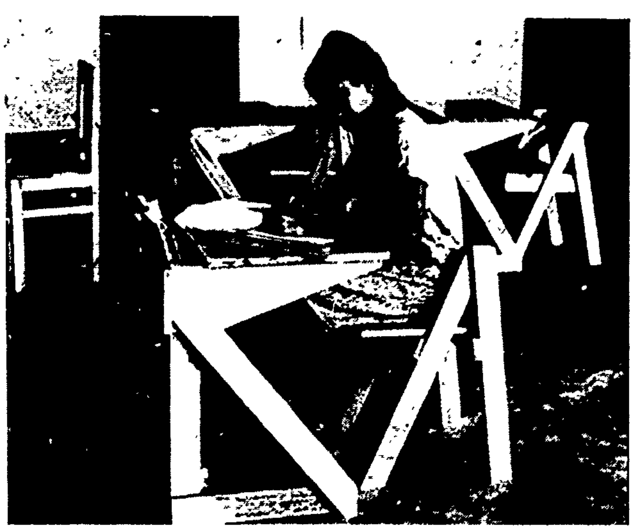
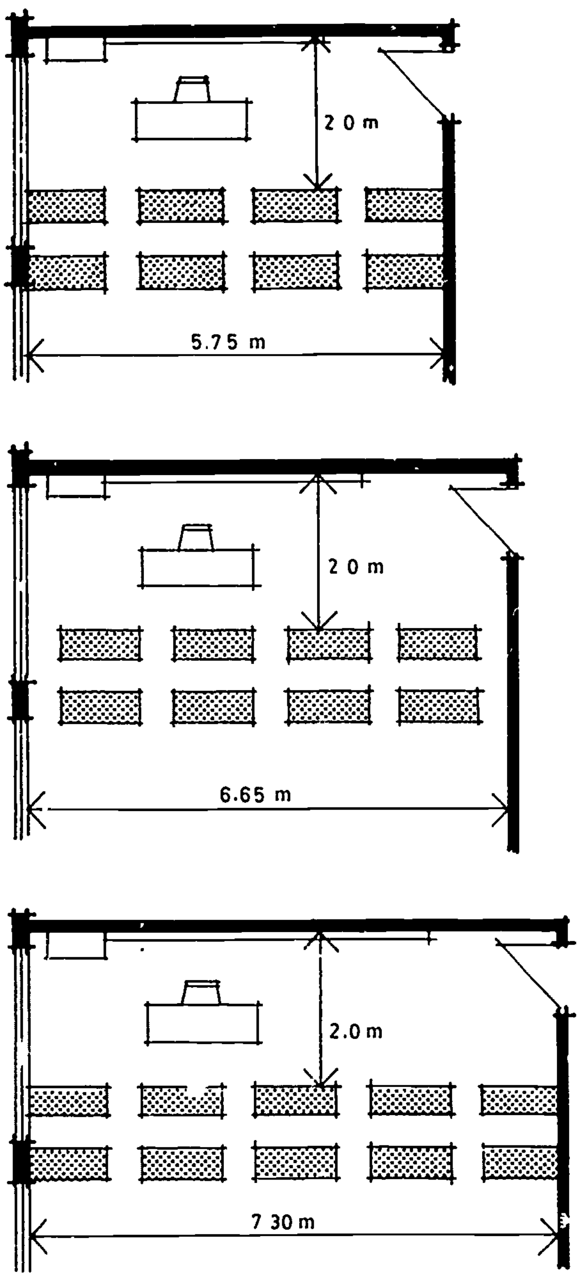


Plate 15 a

It is, of course, realised that whilst in a secondary school a minimum sized classroom is acceptable because most subjects such as physics, chemistry, biology, industrial arts and home economics may be taught *outside* the classroom in special laboratories or workshops provided for the purpose, in the primary school the classroom is the base for all activities such as science and handicrafts, as well as for language, religion etc. It is obvious that primary school classrooms of the dimensions given above will never provide enough space for teaching and learning in all these primary

ARRANGEMENTS OF SQUATTING TABLES IN PRIMARY SCHOOL CLASSROOMS AND RESULTING ROOM DIMENSIONS



8 children per row – no side gangways
6 rows = 48 children
Classroom dimension 6.5 m x 5.75 m
Area per pupil place = 0.78 m²

8 children per row – with side gangways
6 rows = 48 children
Classroom dimension 6.5 m x 6.65 m
Area per pupil place = 0.90 m²

10 children per row – no side gangways
5 rows = 50 children
Classroom dimension 5.75 m x 7.30 m
Area per pupil place = 0.84 m²

FIG 80

school subjects, yet those who know the region well will realise that it will be years before many countries can afford to build the "minimum" classrooms suggested above. Thus it is necessary to reconcile these minimum spaces with the sort of needs expressed in chapter 9 for "plenty of space for primary school science". The answer as subsequent chapters suggest, may be to accept the minima suggested above but to enclose the spaces with elements that can be moved to provide larger spaces as more classrooms come to be built in the future.

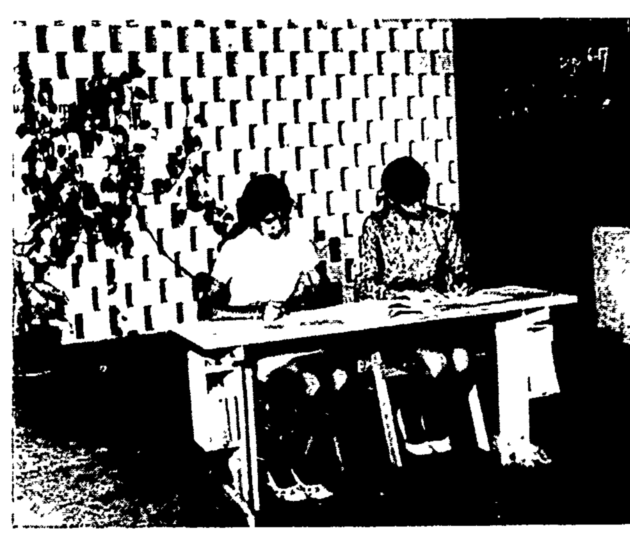
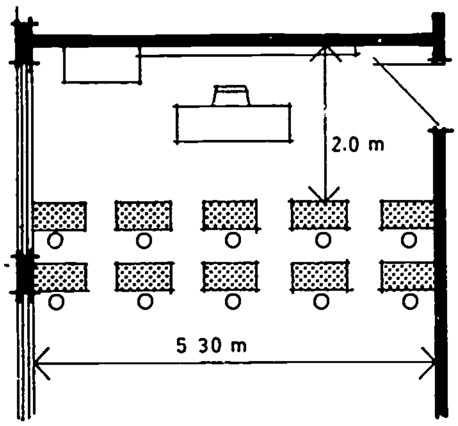


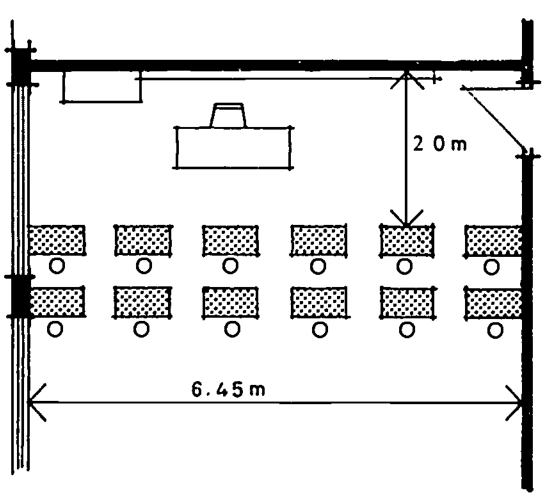
Plate 15 b

ARRANGEMENTS OF SINGLE DESKS AND CHAIRS IN PRIMARY AND SECONDARY SCHOOL CLASSROOMS AND RESULTING ROOM DIMENSIONS



5 children in a row - no side gangways
8 rows = 40 children

Primary school classroom dimension	= 8.40 m x 5.30 m
Area per pupil place	= 1.11 m²
Secondary school classroom dimension	= 9.36 m x 5.30 m
Area per pupil place	= 1.23 m²



6 children in a row – no side gangways
7 rows = 42 children

Primary school classroom dimension	= 7.60 m x 6.45 m
Area per place	= 1.17 m²
Secondary school classroom dimension	= 8.44 m x 6.45 m
Area per place	= 1.30 m²

FIG 81

ARRANGEMENT OF DOUBLE DESKS AND SINGLE CHAIRS, PRIMARY AND SECONDARY SCHOOLS

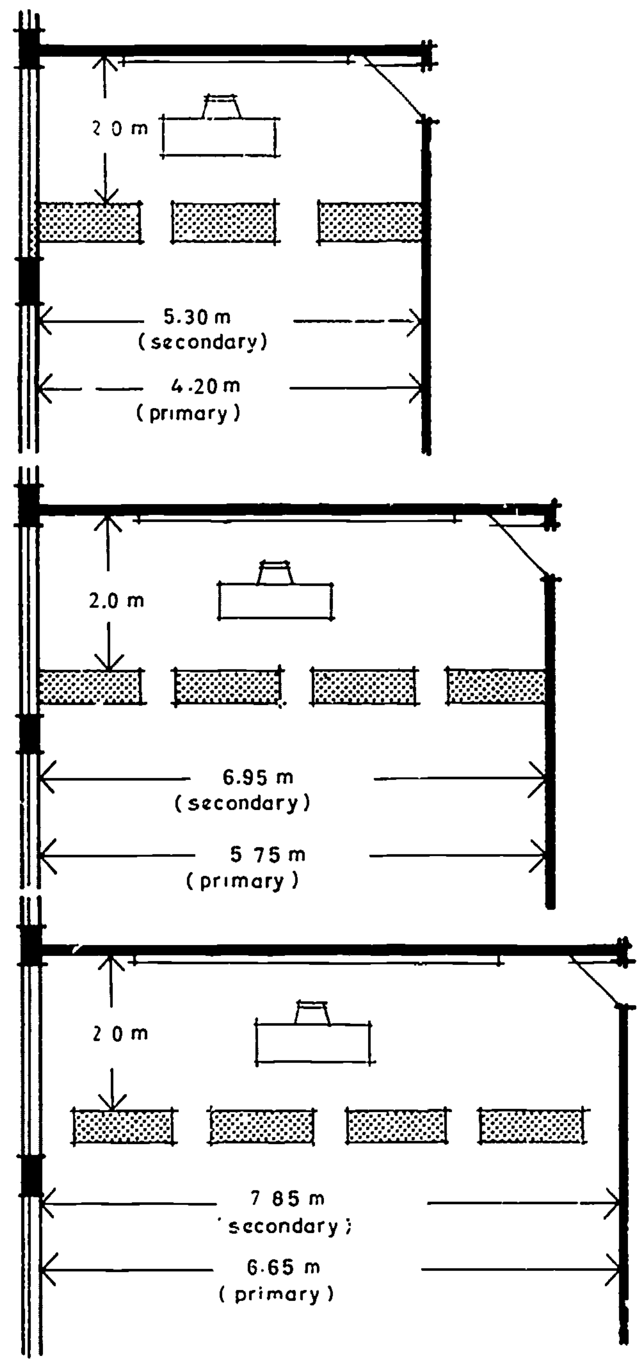


FIG 82

6 children in a row – no side gangways
7 rows = 42 children
Secondary school classroom
dimensions = 8.44 m x 5.30 m
Area per pupil place = 1.06 m^2
Primary school classroom dimension = 7.60 m x 4.20 m
Area per pupil place = 0.76 m^2

8 children in a row – side gangways
6 rows = 48 children
Classroom dimensions = 7.52 m x 7.85 m
Area per pupil place = 1.23 m^2
Primary school classroom dimensions = 6.80 m x 6.65 m
Area per pupil place = 0.94 m^2

8 children in a row – no side gangways
6 rows = 48 children
Secondary school classroom
dimensions = 7.52 m x 6.95 m
Area per pupil place = 1.09 m^2
Primary school classroom dimensions = 6.80 m x 5.75 m
Area per pupil place = 0.81 m^2

Table XVII highlights several points of interest in relation to classroom design:–

(i) As mentioned above, the size of furniture has a marked effect on the plan dimensions of classrooms.

(ii) If 9 metres is accepted as a maximum length of room and 8 metres a maximum width, then the numbers that can be accommodated using a particular type of furniture can be calculated.

(iii) 50 children would seem to be the absolute maximum number that can be accommodated with a minimum of amenity in a conventional classroom situation *provided that* the furniture is carefully selected for size.

There are, of course, some exceptions to these comments. In the mountainous areas of the Himalaya and the Hindu Kush, building materials and techniques in the necessarily remote villages are such that classrooms are commonly 3 metres and occasionally 4 metres wide. Using double desks, it will be seen that classes of about 40 are a maximum if the room is not to become excessively long. It is also clear from the table that single desks require larger rooms than double desks in both primary and secondary schools.

7.05 The Conventional Classroom Reviewed

In a number of countries of the region, efforts have been made to provide something more than the four bare walls, floor and roof, that so often are thought to comprise a classroom.

In countries where walls have to be very thick because of the materials available or to provide adequate thermal resistance to heat gain or loss, useful cupboards or shelving are often constructed in the thickness of the wall. Figure 83 shows examples of this from Afghanistan and Iran. Another method of using a structural wall for storage is that it is fairly common use in new schools in parts of India, where wall is recessed to give added strength and the recess used for shelving and cupboards (Figure 83). Occasionally, concrete is used to form open shelving as is shown in the example from a new standard school from the Punjab (Figure 83). Another common location for built-in shelving is behind the door which opens into the sterile, 2 metre wide area occupied by the teacher at the front of the class (Figure 83). In Hongkong, storage in the standard, 24 classroom secondary school is provided below the window sill between structural columns. This has the advantage of providing a small additional working surface as well (Figure 83).

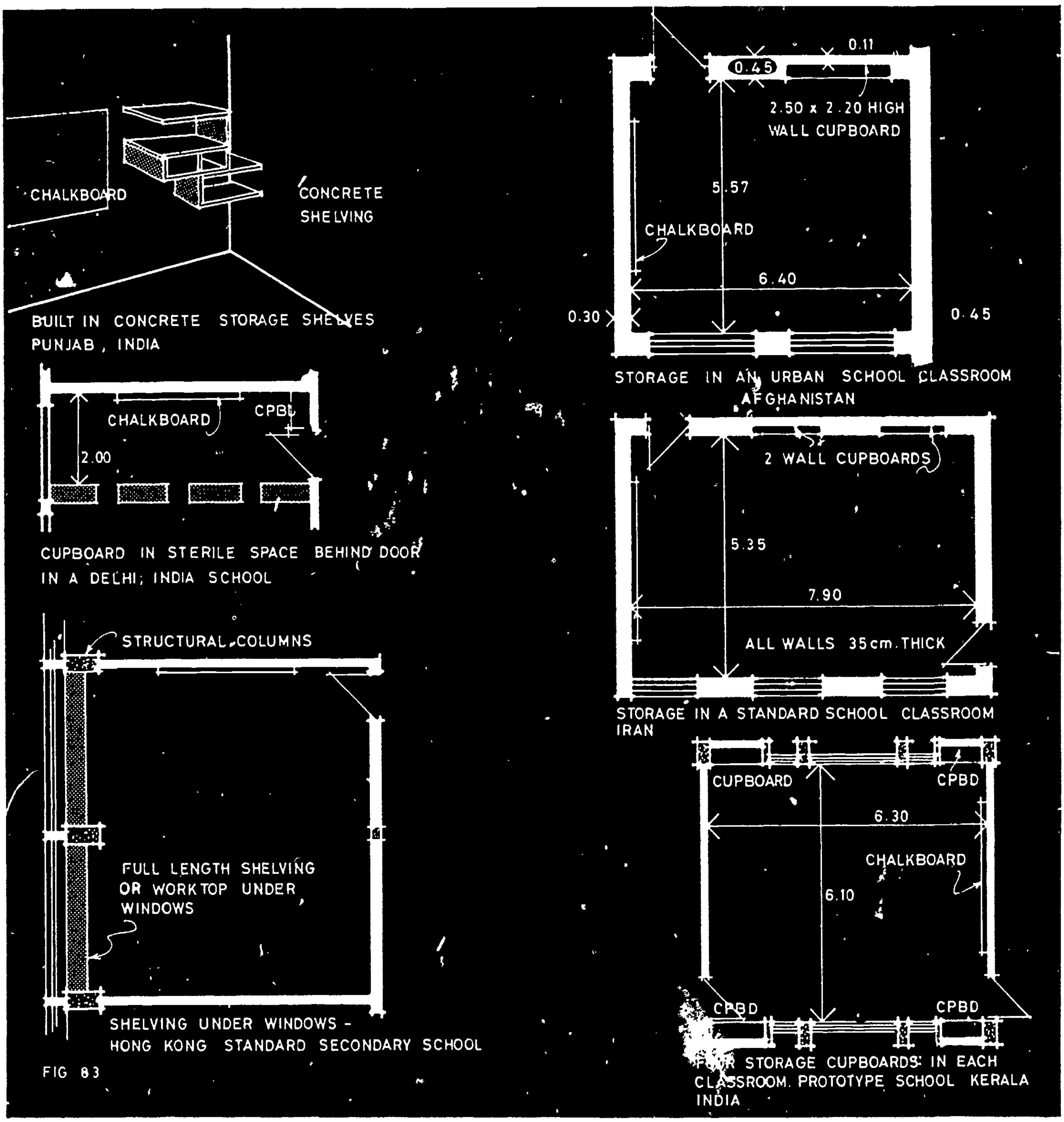
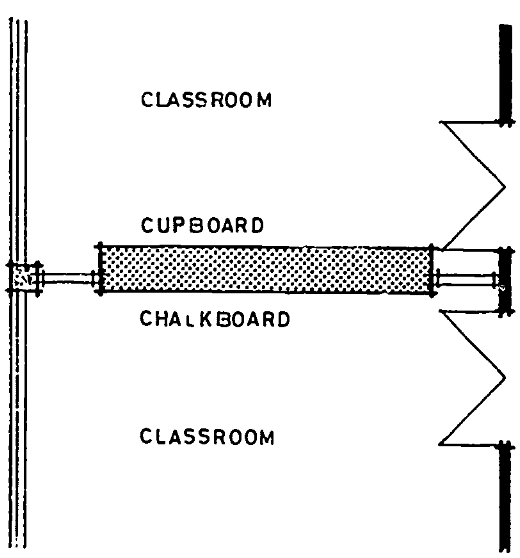

CHALKBOARD
CONCRETE SHELVING
BUILT IN CONCRETE STORAGE SHELVES PUNJAB, INDIA
CHALKBOARD
CPBD
2.00
CUPBOARD IN STERILE SPACE BEHIND DOOR IN A DELHI, INDIA SCHOOL
STRUCTURAL COLUMNS
FULL LENGTH SHELVING OR WORKTOP UNDER WINDOWS
SHELVING UNDER WINDOWS - HONG KONG STANDARD SECONDARY SCHOOL
0.45
0.11
2.50 x 2.20 HIGH WALL CUPBOARD
5.57
CHALKBOARD
6.40
0.30
0.45
STORAGE IN AN URBAN SCHOOL CLASSROOM AFGHANISTAN
2 WALL CUPBOARDS
5.35
7.90
ALL WALLS 35cm. THICK
STORAGE IN A STANDARD SCHOOL CLASSROOM IRAN
CUPBOARD
CPBD
6.30
CHALKBOARD
6.10
CPBD
CPBD
FOUR STORAGE CUPBOARDS IN EACH CLASSROOM. PROTOTYPE SCHOOL KERALA INDIA

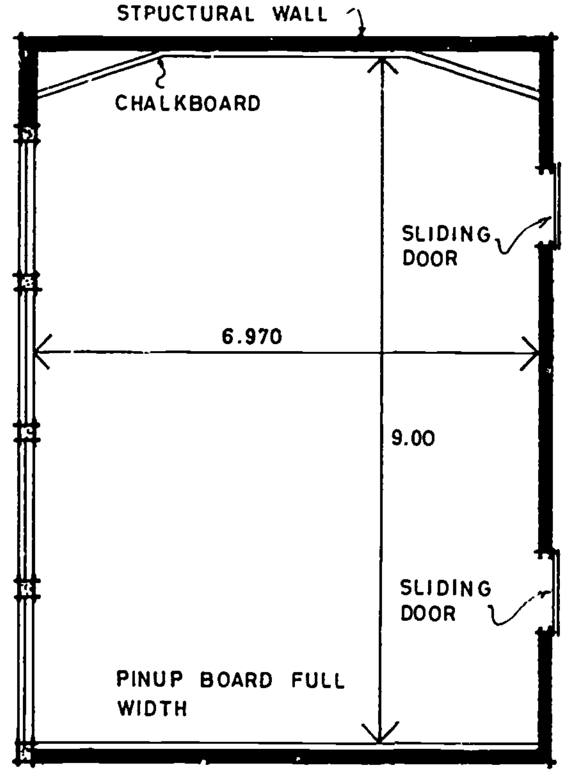
FIG 83

Chalkboards in the region are usually either an area of hard, smooth plaster or cement on the division walls between classrooms or of plywood or hardboard, fixed to the wall. Occasionally, there are variations on this theme as is shown in Figure 84. In Japan, the board is modelled so that its extremities are turned slightly inwards for better seeing conditions. In other Japanese designs, the chalkboard is incorporated in a wall of shelving. It is of interest to note also that classroom doors in Japan are often hung to slide rather than to swing inconveniently into classroom or corridor. In Singapore, the division walls between classrooms are sometimes fitted with a unit which has a chalkboard facing one class and cupboards facing the class next door (Figure 84).

A final question of concern in connection with classrooms is the monotony and institutional character of buildings in which the classrooms are strung out in rows like peas in a pod. There is a strong case for this in the humid zones where the need for positive cross ventilation requires singlebanked rooms and where the expense that results from over-provision of excess walling prevent too much lateral displacement of classrooms on plan. In hot dry upland and temperate zones, where cross ventilation is to be avoided, there is a case to be made for considering more attractive grouping of classrooms. Figure 85 illustrates some possibilities suitable for these zones of climate.



A CLASSROOM DIVIDER UNIT
CHALKBOARD & CUPBOARD . SINGAPORE



CHALKBOARD & PINUP BOARD
IN A JAPANESE SCHOOL

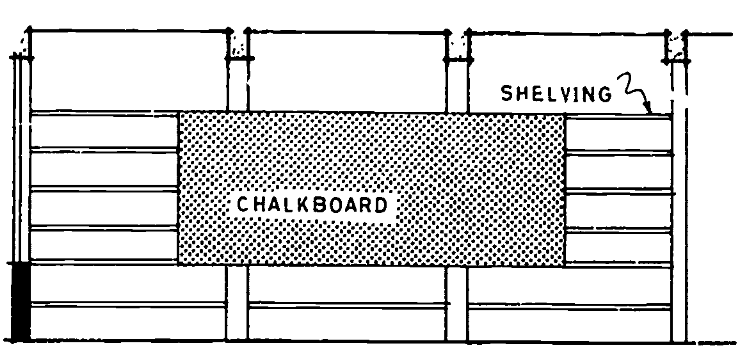
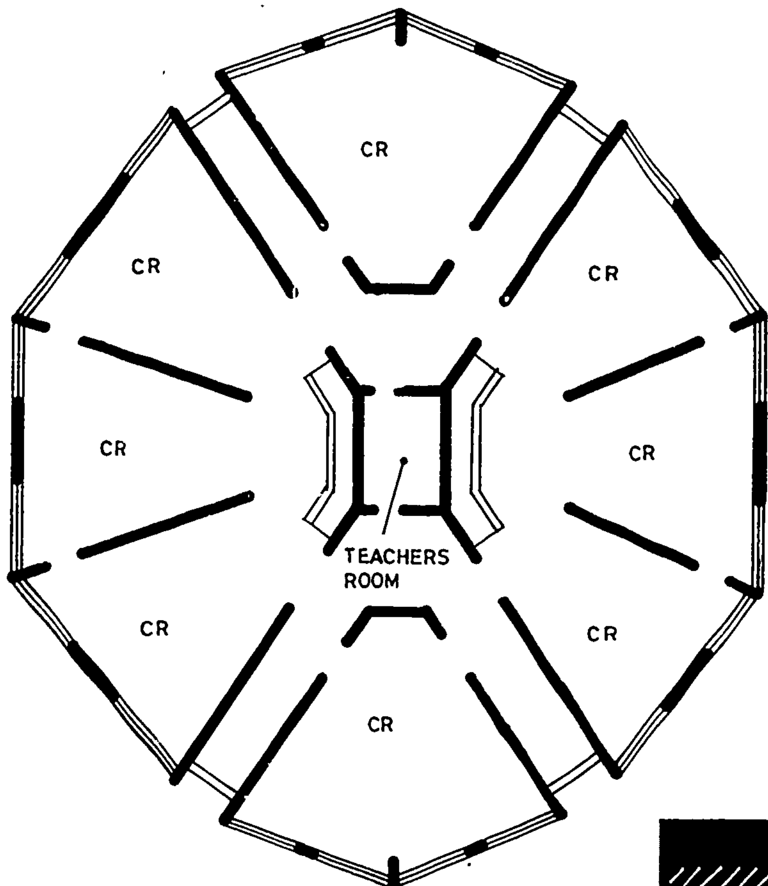


FIG 84 CHALKBOARD SET IN SHELVING IN A JAPANESE SCHOOL



ARID, UPLAND & TEMPERATE ZONES
EXAMPLE FROM AFGHANISTAN
FIG 85

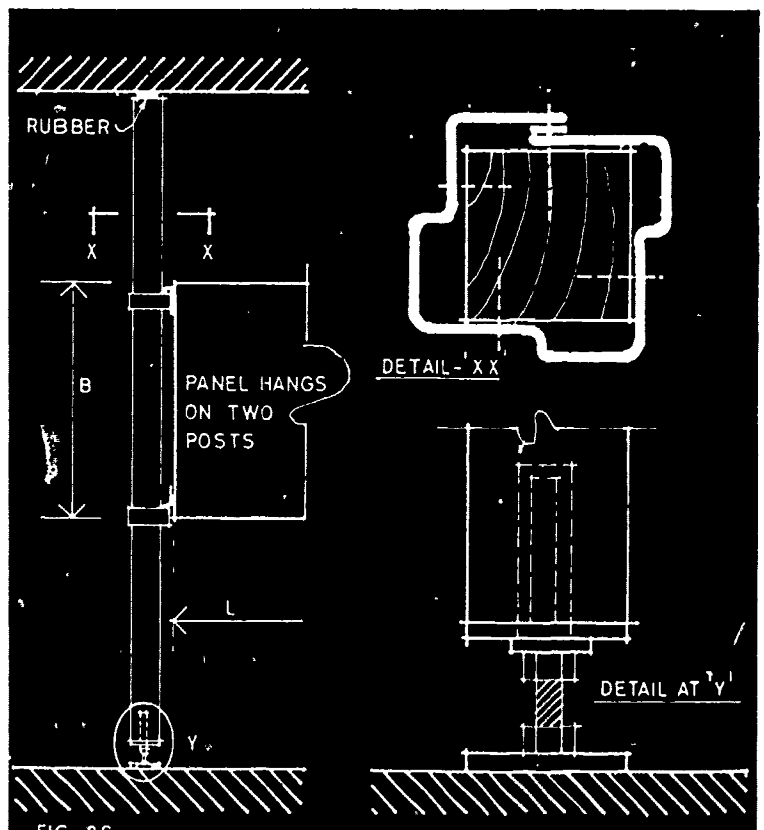


FIG. 86

Although it seems certain (7.23) that the main factors likely to influence change from the "classroom" concept to design for schools with open-spaces internally are the changing educational concepts and practices, there is a case for attempting to stimulate change and experiment through building design.

The Asian Regional Institute for School Building Research has been collaborating with the Government of Ceylon in the design of two new, open-plan, schools. These schools permit conventional methods of teaching but, because of the system of internal partitioning used (Figure 86), also permit the formation of any number of arrangements of sub-spaces within the large rectangular shelf of the buildings.

It is, of course, impossible to predict at this stage, the ways in which these buildings will facilitate change but the significance of a Government decision to invest in experiment is of considerable importance for the future.

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Chapter 8

SPECIAL CLASSROOMS

8.01 Definition

The term, "special classroom", which is commonly used in the Asian Region, describes a classroom which, whilst allocated for teaching of a variety of subjects, is used for a substantial proportion of the periods for which it is available for teaching of one particular subject. In recognition of this "special function", the classroom may be slightly larger than is usual, but will have normal classroom desks and chairs supplemented perhaps by a few special items of furniture and provision for the special aids that are needed for teaching and learning in the subject for which the room is designated, such as, geography, mathematics and social sciences * Examples of rooms that are *not* special classrooms are laboratories, workshops, art and handicraft rooms for, by definition, they are not furnished as normal classrooms.

Special classrooms will be justified when the total number of periods in the whole school for a single subject such as geography, is almost equal to or in excess of the number of periods in the week. Thus, if there are 40 periods in the week and, say, 32 periods or more of geography, one room could be programmed in such a way that all geography teaching in the school takes place in it. This criterion will, of course, have to be applied with regard to the size of the school. From the examples in para 3.02 of chapter 3, it will be recalled that, in the small school of only four groups, the total number of classrooms needed was 3. Clearly, the rotation of the four groups between three rooms for six different subjects, would be very difficult to programme in such a way that one subject could be taught exclusively in one room. On the other hand, if the second example of a school with eleven teaching groups and nine classrooms is considered, it would seem feasible to allocate one room specially for geography, one for mathematics and one for history and still leave sufficient uncommitted rooms for the principal to have a reasonable degree of flexibility in preparing the time table. In fact in this example from para 3.03, history, geography and mathematics require respectively 44, 44 and 55 space periods each, so that, if 36 periods of each subject were to be taught in special classrooms, there would still be a few periods left to be taught in ordinary classrooms.

Although special rooms are occasionally provided in new schools, it is quite common to find that a normal classroom has become a special classroom due to the enthusiasm of a particular subject teacher. This of course, is admirable, but it requires considerable determination and ingenuity to adapt classrooms as small as those shown in chapter 7 (Figures 81, 82 and 83) to any purpose other than that of formal teaching. It is thus better in designing a new school, to examine the space periods required for each subject and, in consultation with educationists, to obtain agreement on how many rooms could be reserved for "special" use and to make them a little larger than the regular classrooms. In this way, the enthusiastic subject teacher will be less likely to have enthusiasm dampened and the average subject teacher may be encouraged to use the additional space for educational offerings of a higher quality than would have been the case if only normal, minimum sized, classrooms had been available.

*Note *It is the practice in a few, richer, countries of the world to design rooms complete with furniture and fittings specially for subjects such as geography, mathematics etc. Such rooms then cease to be special classrooms in the sense defined here.*

The following sections deal with the sorts of sizes and facilities that are required for special rooms for various subjects.

8.02 Special Classrooms for Geography

The materials and aids used for teaching and learning in geography include the following (8.1), (8.2).

(a) Chalkboard – smooth surface is of critical importance for good draughting of maps. As maps are often complex, it will frequently be necessary for the teacher to prepare maps on the board *before* the lesson. This indicates the need either for a very large chalkboard with space for prepared maps, as well as space for incidental work on the board during the lesson. Often, part of the board may have a permanent outline of the country or state on it. In view of the critical importance of large areas of chalkboard for geography, the installation of reversible boards or hinged boards that can be swung out and are usable on both sides, should be considered.

(b) Globe – commonly two globes are used, 40 cm diameter and mounted on semi-meridian stands (ceiling hung globes, although available, are not in common use in the region). One of the globes is usually physical – political and the other slated for chalking, with continents in outline. There should be adequate space to stand these globes during lessons and, as they are expensive to buy, to store them under lock and key when not in use. (Appendix XVIII, shows that globes are in common use in 60% of the countries of the region).

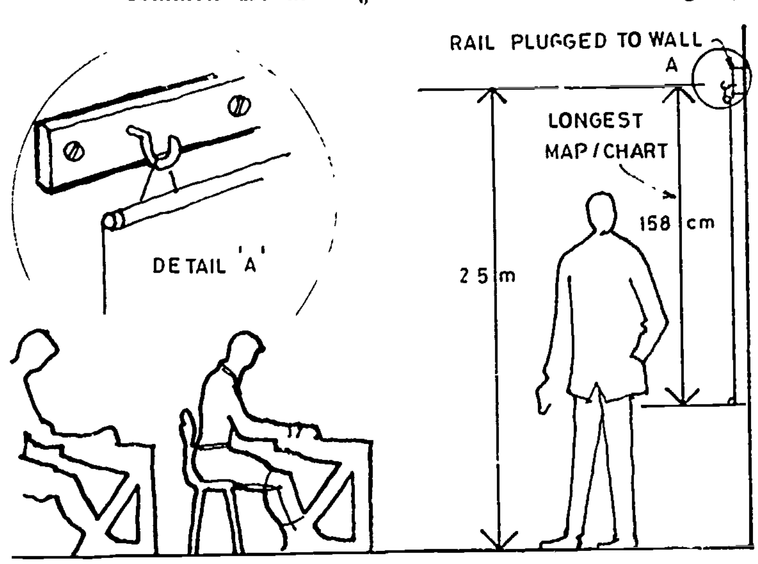


FIG 87

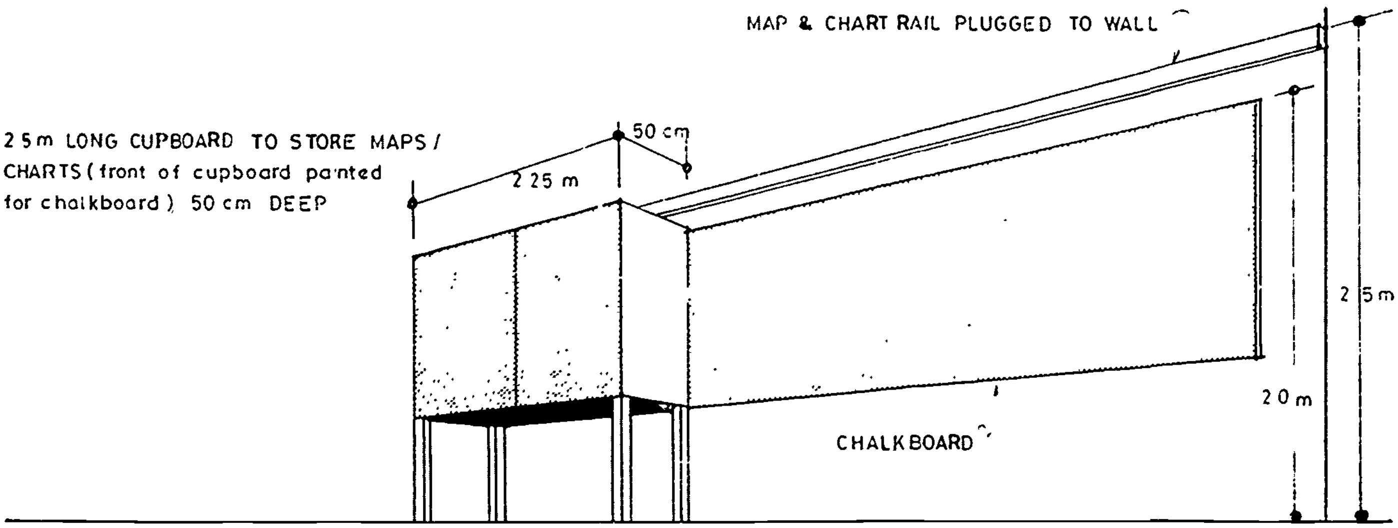

MAP & CHART RAIL PLUGGED TO WALL
2 5 m LONG CUPBOARD TO STORE MAPS / CHARTS (front of cupboard painted for chalkboard) 50 cm DEEP
50 cm
2 25 m
2 5 m
2 0 m
CHALKBOARD

FIG 88

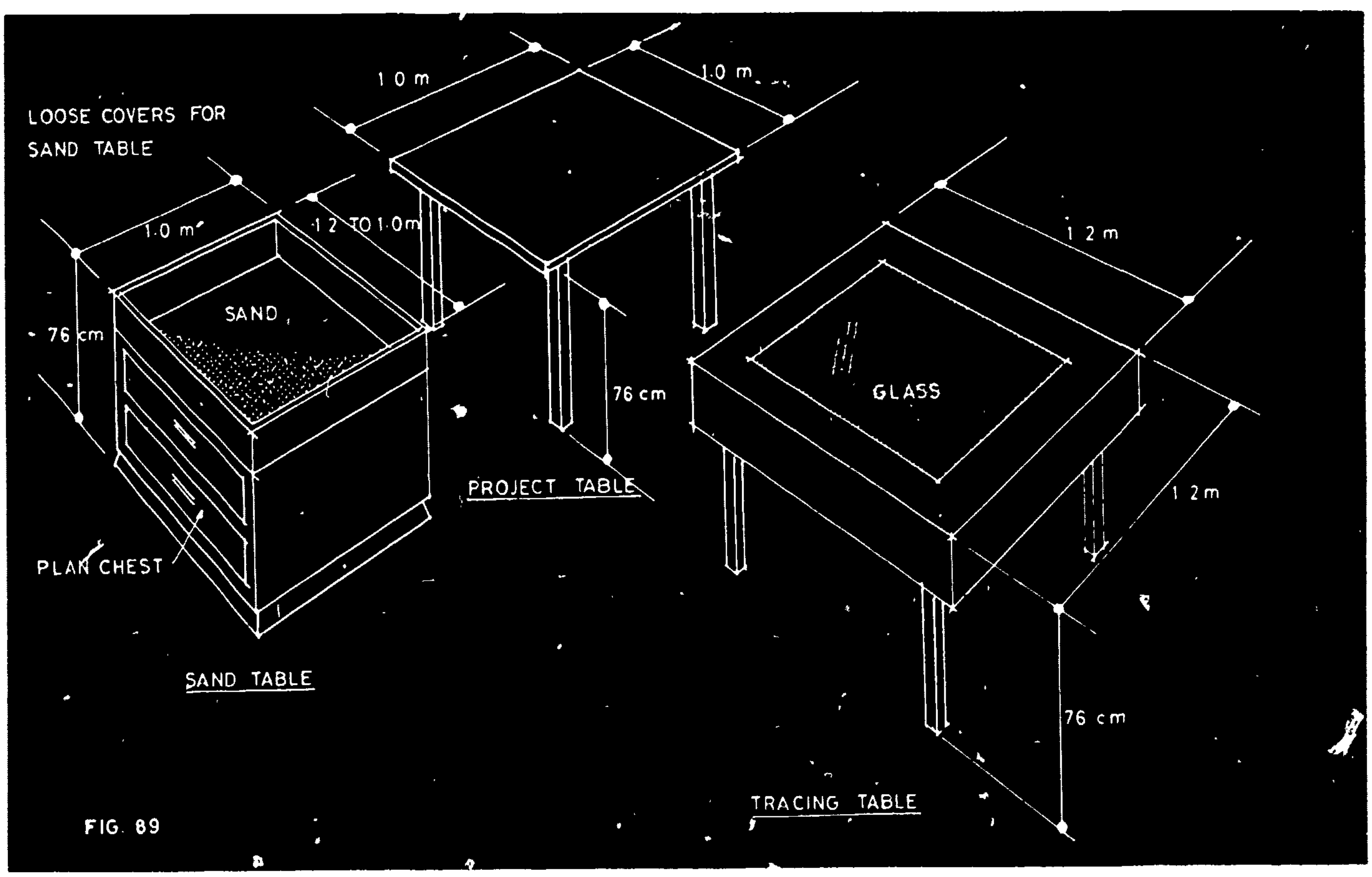

LOOSE COVERS FOR SAND TABLE
1 0 m
1.0 m
1.0 m
1 2 TO 1.0 m
SAND
76 cm
PLAN CHEST
SAND TABLE
76 cm
PROJECT TABLE
1 2 m
GLASS
1 2 m
76 cm
TRACING TABLE

FIG. 89

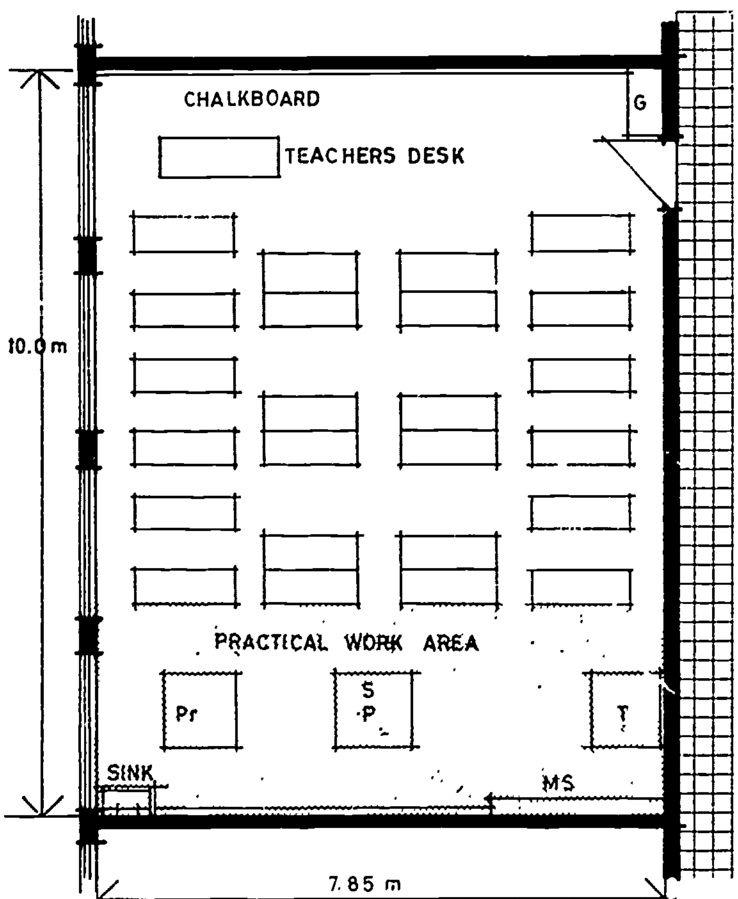
(c) Maps – wall maps mounted on cloth 125 cm wide x 158 cm long, and 200 cm wide and 125 cm long are also used in 87% of the countries of the region and require provision for hanging at the correct height (cup hooks should be fixed to a rail plugged to the wall for this purpose, Figure 87) and storage shelves or cupboards should be dimensioned such that the widest (200 cm) map can be rolled, and stored horizontally. Minimum storage should be provided for 10 maps. In addition to cloth mounted maps, many schools are supplied with 125 cm wide x 158 cm long, slated map outlines, blank for chalking. These require additional storage space and *have* to be hung against a wall as they are used as a form of special chalkboard.

(d) Charts – such as of the solar system, phases of the moon etc., are also in common use. 100 cm wide x 75 cm long, they require similar facilities for hanging and storage to those provided for maps.

(e) Other Equipment – may include an aneroid barometer, mariner's compass and specimens of minerals.

In addition to the items listed above, most teachers, especially in secondary schools, will build up a collection of pictures, photographs and ordinance survey maps which need to be kept flat in a plan chest.

Geography is essentially a descriptive subject and involves three dimensional concepts, learning about which is greatly helped by modelling in sand, plasticine etc. A sand tray, about 1 metre square or larger, fitted with covers, is useful in preparing three-dimensional models. A table of about the same size will provide a base for projects made of other materials. At the upper second level of education, a tracing table with glass surface and electric lamps is an essential item of equipment. The electrical socket outlet for the table can also be used for providing power where projected aids are used for geography teaching and learning. Figures 88 and 89 illustrate, in diagrammatic form, the physical facilities listed above.



PR = PROJECT TABLE
P = PLAN CHEST
S = SAND TABLE
T = TRACING TABLE
G = GLOBES & EQUIPMENT STORAGE

FIG. 90a

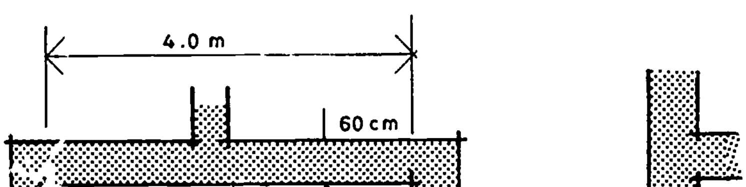
The space required for a geography room should be such as to provide, in addition to the special items shown in Figure 89, accommodation for the double desks which are needed to spread out maps, atlases and note books. When very large maps are used, then double desks can be pushed together to form a larger working surface. It is important, especially in working with maps, that the teacher can gain easy access to every student and thus gangways are needed, not only between desks, but also along both walls. From the selection of classroom furniture arrangements shown in Figure 82, it is apparent, if the furniture sizes shown in Figure 79 are used, that spaces of the dimensions shown in Figure 90a and 90b will be required for special rooms for geography. The two arrangements shown have furniture set out for formal teaching and for group work when tables are pushed together. In humid areas, only the short end walls can be used for chalkboards or displays of other material. In dry, upland or temperate zones, the short walls and the long wall opposite the window are available for this purpose.

The location of special rooms for geography should be either on the ground floor and adjacent to a small weather station that can be run by geography and physics students or, if the building is tall, on the uppermost floor where good views of the locality can be used in connection with some of the lessons. Finally, it is important to remember that it should be possible to lock all equipment away and cover the sand and tracing tables so that the room can be used as a regular classroom when necessary.

8.03 Special Classrooms for Mathematics

During recent years, profound changes have started to take place in mathematics education, in respect both of content and method (8.3; 8.4). Over 100 courses, seminars and workshops on mathematics teaching were held in the region in 1969 alone whilst 6 periodicals dealing specifically with mathematics teaching are published regularly in various Asian countries (8.5; 8.6) and articles on mathematics teaching appear regularly in a large number of other periodicals dealing with science education. Despite this activity little change has yet taken place in the physical facilities which should be provided to facilitate the new methods that are an essential feature of modern mathematics education.

From the view-point of the building designer, the most important aspects of the change in method are the emphasis on experiment as a group activity or as an individual effort (8.7) and the increasing use of a wide range of equipment by both teachers and children. In the late 1950's it was already evident that a special room was needed for the new methods of mathematics teaching and a number of publications appeared on the designing of mathematics classrooms (8.8; 8.9; 8.10). In the late 1960's the rate of change of method in some countries had begun to make it evident that even a special room for mathematics was unlikely to be adequate: "...we are suggesting that a mathematical laboratory is as essential to the appreciation of mathematics as a physics laboratory is to the learning of physics, a chemistry laboratory to the learning of chemistry or a biology laboratory is to the learning of biology. Theory goes with practice, experiment with progress and development." (8.7) and "... thought should be given to organising laboratories for mathematics in the same way as they are organised for physics and other natural sciences." (8.3). A few schools are now being built in various countries, – mainly the U.S.A. – in which science and mathematics facilities are arranged in clusters (8.11). From this it seems clear that there is an increasing recognition of the fact that mathematics requires facilities similar to those provided for the other natural sciences.



36 PLACES OR 1 18 m^2 / PLACE

BUILDINGS IN HIMALAYA & HINDU KUSH HAVE THICK WALLS & SMALL SPANS

FIG 90 b

In one or two countries in the Asian region, special rooms are sometimes designated for mathematics teaching and learning. The Daiichi Junior High School, Tokyo, built in 1960, provides a good example of two such mathematics rooms built en suite with a preparation room between (8.9).

In most countries of the region, however, the present situation is that mathematics is usually taught in an ordinary classroom. As mathematics teaching continues to develop in the region, it seems likely that, first, it will become an increasingly common practice to assign special rooms for the subject and that, eventually, mathematics laboratories will be required. Progress is likely to be rapid. "About half of the countries (in the region) anticipate that the course content presently in use will be replaced by modern mathematics within three to five years in some grades or in all grades of the elementary school" (8.10).

The designer, in designing a space for a special room for mathematics, would thus be wise to arrange it in such a way that it can, in future, be remodelled to form a proper mathematics laboratory.

As mathematics has such close links with the other natural sciences, the mathematics room can best be located close to the science laboratories and, in particular, the physics laboratory, some of the apparatus of which can be used in mathematics teaching. Figure 91 shows three such arrangements, two in conventional situations and one in an experimental urban school. The materials and aids that are likely to be used in mathematical education and that need the provision of physical facilities to use and store them, vary, depending on the level of education. They may include (8.11):–

(a) The chalkboard -- which should, as the board in the geography room, have a sufficiently fine finish to allow accurate draughtsmanship. Part of the board, which should extend almost the full width of the room, should be permanently lined for the drawing of graphs which form an important aspect of mathematics work at all educational levels. Another small section should be of peg board for hanging equipment.

It is convenient, apart from the main chalkboard at the teacher's station, to have a series of smaller chalkboards round the room to facilitate work with individual students near their desks. Doors, cupboards and the like can be painted for this purpose.

(b) A chart rail for charts and diagrams similar to that described for geography rooms and illustrated in Figures 88 and 89, is useful for hanging the charts that are either used by the teacher or produced by the students.

(c) Objects - This is an unsatisfactory term which, however, is convenient for use in explaining to the designer that there is a great range of aids that are used either by the teacher and/or by the children and which need space to use and space to store.

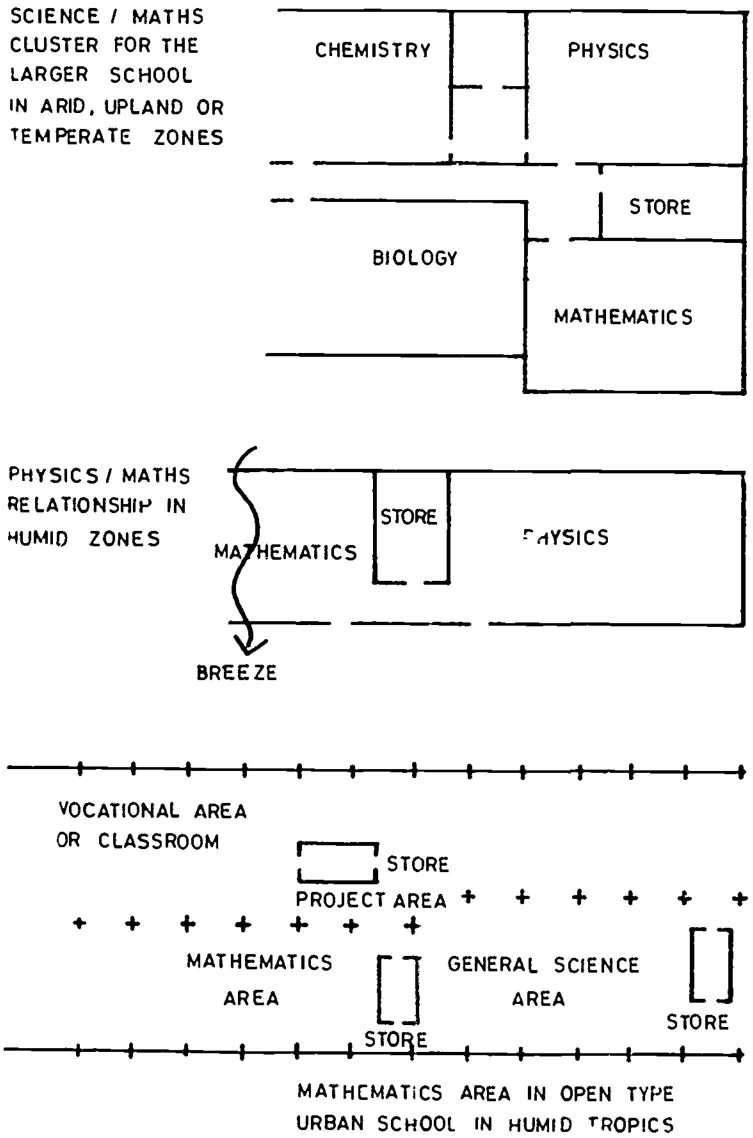


FIG 91

(i) *In primary schools,* although there will rarely be a special room for mathematics, the material for teaching and learning listed below will have to be stored in the classroom:-

(a) aids to counting - beads, shells, stones etc. and boxes or trays to store them in;

(b) measuring materials - scales, containers such as tins and bottles, rulers, tape measures:

(c) structural apparatus - small cubes, number bars, rods - all of which require keeping in sets in boxes:

(d) geometrical aids - geo-boards (30 x 30 cm), tiles, shapes in felt and paper, plasticine.

(ii) *In secondary schools* the aids are usually larger and many of them may be constructed by students or teachers. They may include:-

(a) geometrical solids - Often in sets of 12 - about 8x14 cm (8.2) these solids may often be made by teachers and children and a large collection may result, requiring shelving.

(b) models mounted on stands, often fixed to vertical boards, e.g. peg boards for graphical work, geometric models e.g. triangles, parallelogram, circle, fourier series.

(c) miscellaneous models often moving, e.g. simple surveying instruments constructed in the classroom, meccano models of linkages, space frames, mathematical toys.

The main elements of a mathematics room are shown in Figure 92. The special room for mathematics it will be seen, needs to be a room in which, not only it is possible to teach formally with access to a variety of aids near the teacher, but also a room in which the many aids, stored in shelves and cupboards, can be used by the students either at their desks as individuals or in groups or, where the aids are larger, at benches along the walls.

There is a need for a small workshop bench with tools to make and adjust models. New ideas, mathematical puzzles and the like are often displayed on a pin up board which is also an essential item to be located somewhere near the door.

It is noteworthy that there are not many good mathematical films strips/loops available (8.3) and thus the only projected aids are likely to be drawings prepared by the teacher and used with an overhead projector. Few countries, however, have such projectors in use at this time. Figure 93 shows some arrangements of special rooms for mathematics in the countries of the region where, it will be recalled, classes of 40 and over are very common.

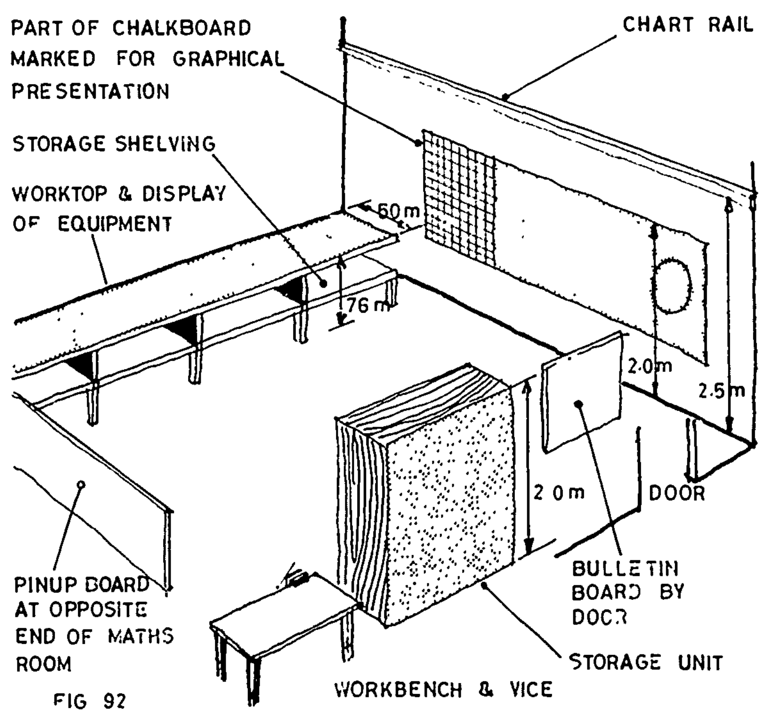


FIG 92

8.04 Special Classrooms for Other Subjects

Paragraphs 8.02 and 8.03 suggest that a special classroom is similar to a regular classroom except that it will require a slightly larger area and thus cost more per place. The additional area needed is, however, very small, amounting to about an extra one third of a classroom. The return in respect of improvements in the quality of education is not so easily measurable but it should be very high indeed.

Special rooms for geography and mathematics have been described in detail above with the purpose of showing that the design of a special room depends on some understanding of the content and methods of education that the room is required to house. Any special room can be designed, provided the designer familiarises him or herself with the activities which are to go on in it. A study of the second level curricula for the countries of the region (1.1) shows that in all but the smallest schools special rooms could be justified, in terms of high teaching load, for the following subjects:–

(a) Mathematics.

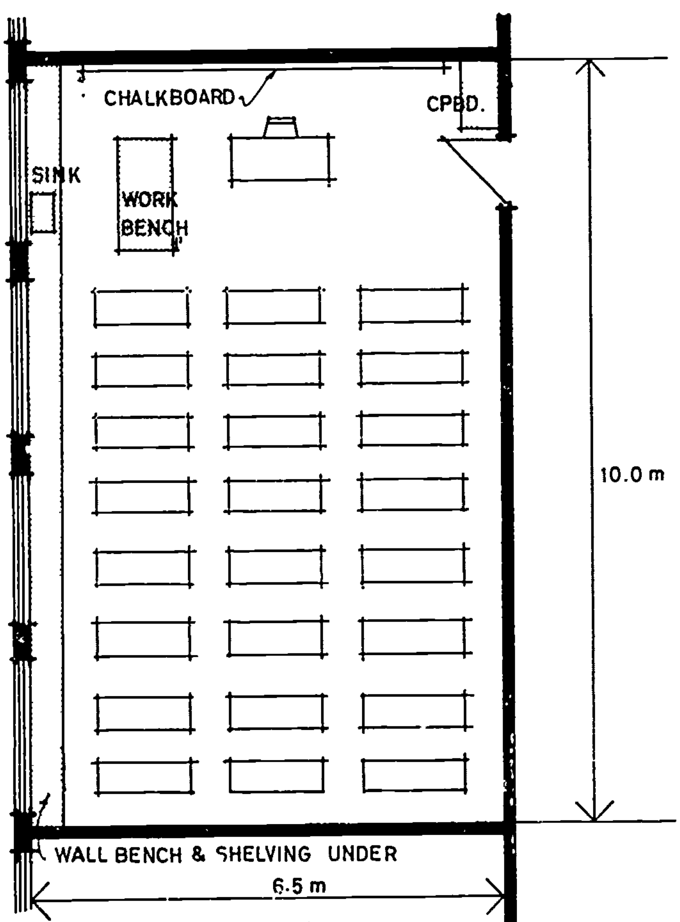
(b) Geography (not a heavy load but needs special equipment to teach effectively).

(c) Language (this usually provides the heaviest load).

(d) Social studies (where this includes history, geography and civics).

Another subject for which it might be worth providing a special room is science. Normally, of course, most of the science curriculum is taught in the laboratory. However, most curricula contain units that can be taught and learned in the regular classroom as for example statistical units in biology, the periodic table in chemistry and proportionality in physics. This is often reflected in timetables that allocate a double period of laboratory work and a single period in the classroom. Again, where laboratory accommodation is very limited, the classroom may be used for some of the work involving demonstration by the teacher. Where there is a heavy load of science in classrooms, then one or more classrooms may be designated as special rooms for science. They should, of course, be as close to the laboratories as possible so that equipment for demonstrations can be conveniently taken from the laboratory store to the special room for science.

It may be argued that this merely perpetuates the old laboratory – lecture room combination. It certainly does not as, unless there is a calculated space period requirement for a special room, no special room will be provided, whereas the lecture room is automatically provided with the science laboratory, without a calculation to demonstrate its necessity in terms of space periods.



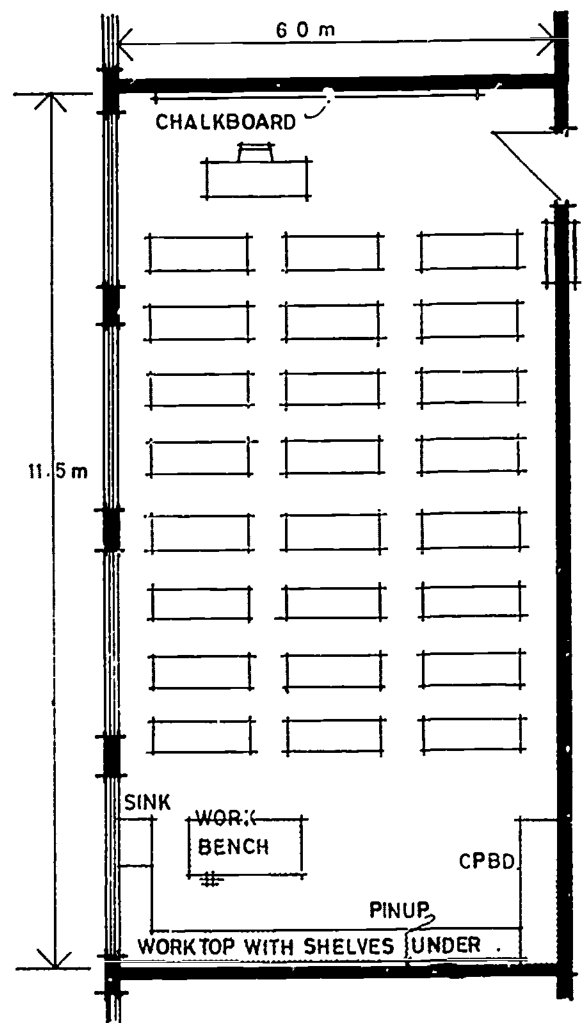


FIG. 93

48 PLACES OR 1 44 m^2/ PLACE

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Chapter 9

DESIGNING FOR SCIENCE

Plate 16

9.01 General

A thorough review of the status of science education in the Asian region is given in the Bulletin of the Unesco Regional Office for Education in Asia, volume IV, No. 1 of 1969 (9.1). Much of the material in 9.01 is drawn from this source.

The highest priority for curriculum reform in the countries of the Asian region has been given to science education The current widespread interest in science teaching reform began somewhat more than ten years ago and it is thus possible to take a much more positive attitude to the problems of designing for science than say designing for mathematics, where reform is of very recent origin in the region, or geography, where curriculum reform is limited to a very few countries indeed.

The movement for reform in science education is radical in character. It is no longer just concerned with improvement in the quality of teaching for the minority of school students who will go on to further studies in science and technology, vital though this minority is. The movement is also concerned with science for all, taught in a relevant and interesting way. It therefore embraces science at the first level as well as at the second level, although the former is only beginning to receive comprehensive attention.

In the past, the expense of adequate provision of laboratories has been an important constraint on the spread of effective science teaching throughout the region. This was due to the fact that laboratories were commonly designed like facilities for colleges and universities and were un-necessarily expensive (Plate 17).

The reform movement is based on the development of new attitudes on the part of the teacher and the students. The teacher can no longer depend on his position of authority, nor is he expected to place the same reliance on text books. In particular, new attitudes

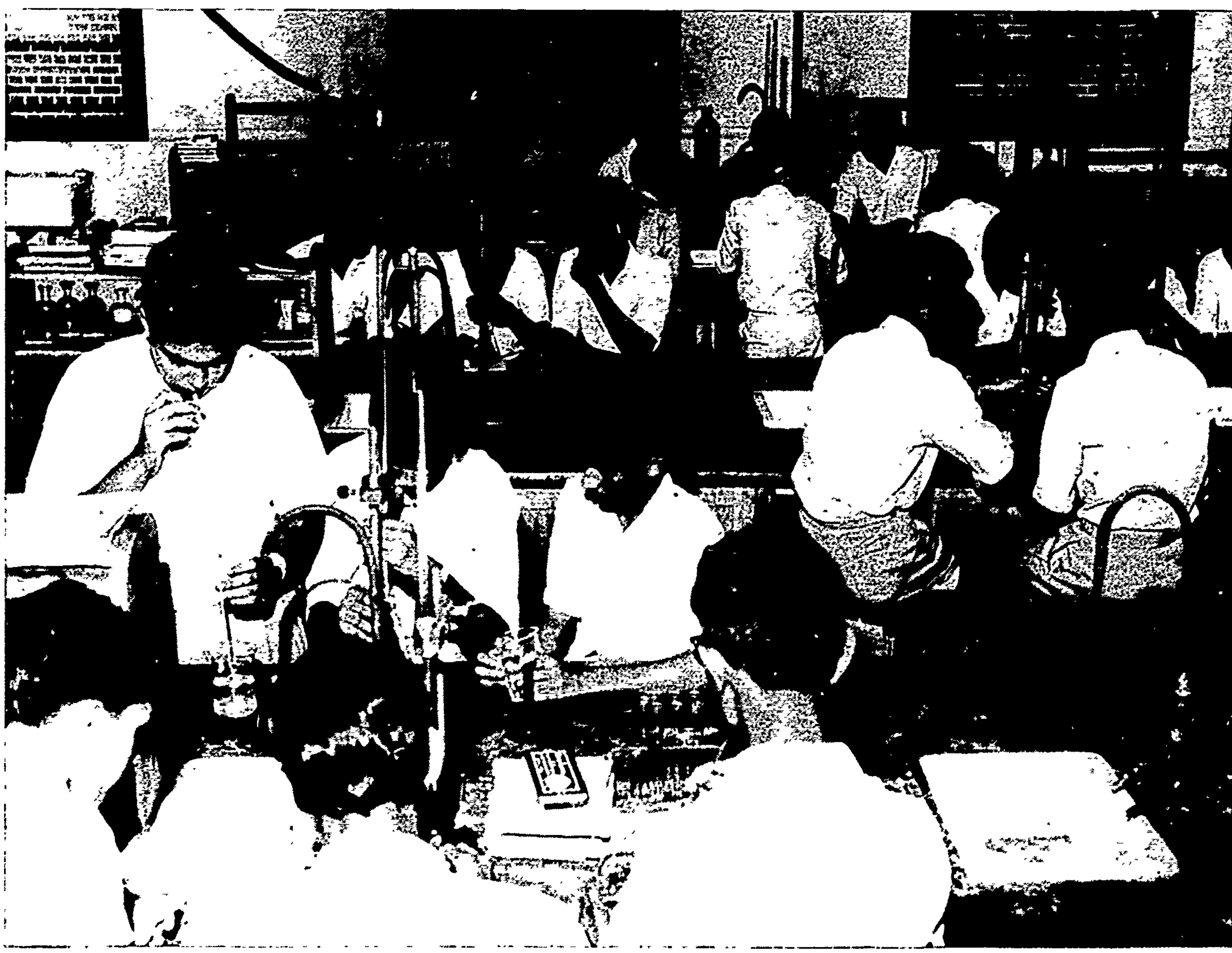
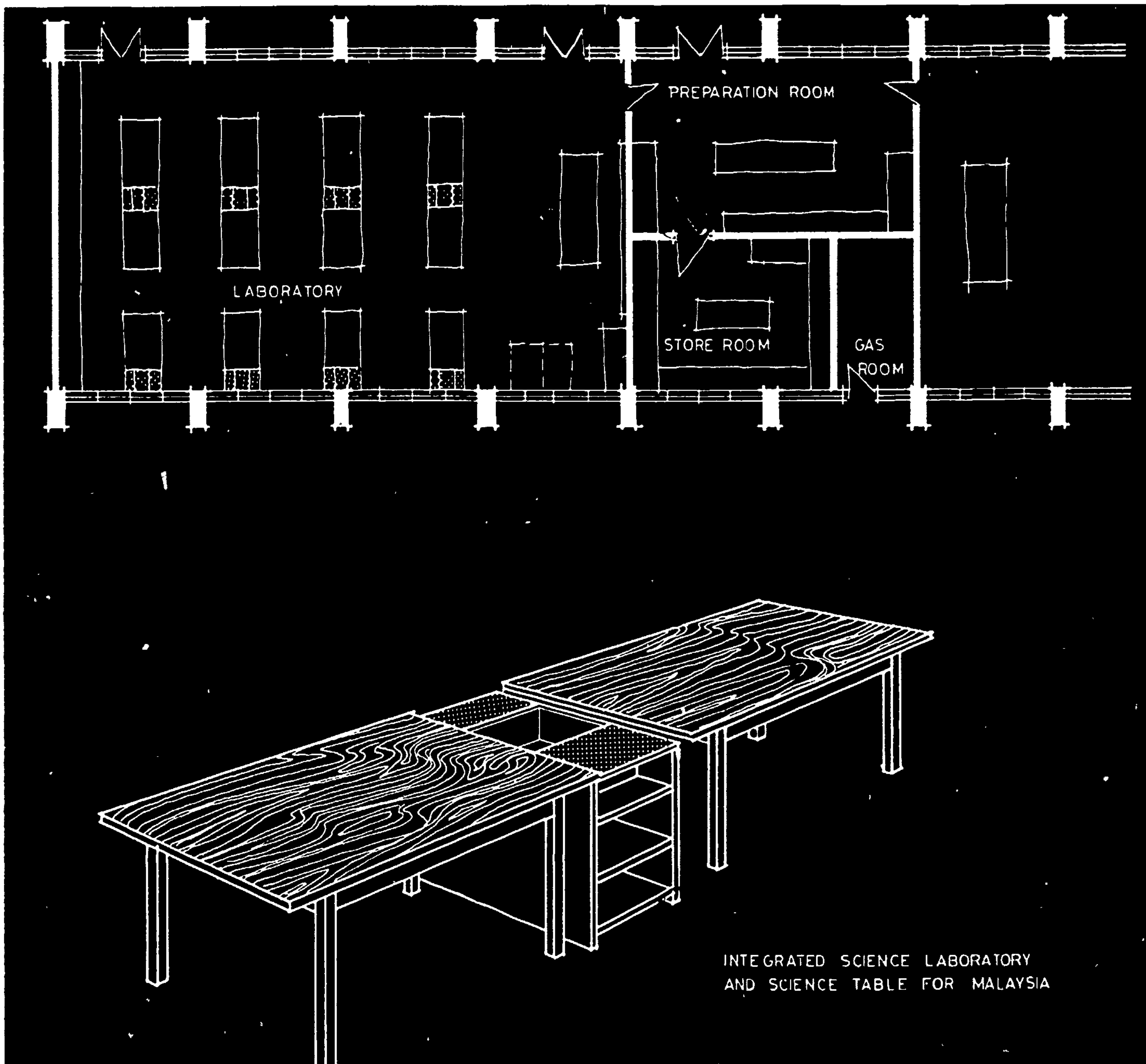


Plate 17

are sought to experiences in the classroom and the laboratory and new ways are sought of interpreting these experiences. The facts of observation and experience are relied upon, but the student is given to understand that the ideas and theories about these facts are subject to development and change.

Obviously, this requires that teachers do not adopt an authoritarian attitude in their work. In the laboratory this is reflected in planned sequences of learning by the students, singly or in groups instead of the methods of demonstration by the teacher, followed by repetition of the demonstration by the class. Demonstration of a particular phenomenon, of course, is still a useful method of teaching, but it is now only one of a wide variety of approaches to teaching and learning in the modern science laboratory. The teacher's platform and demonstration bench thus loose their significance in consonance with the abandonment of the copying of teacher-demonstrated experiments by the students.



INTEGRATED SCIENCE LABORATORY AND SCIENCE TABLE FOR MALAYSIA

FIG 94

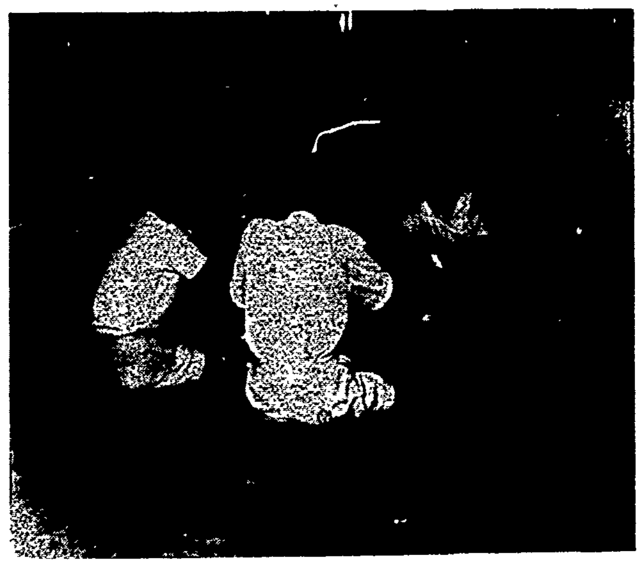


Plate 18

An analysis of schemes of work in science for many countries shows that the emphasis has changed from 'teaching' to 'learning' and, as a result, the focus of attention has switched from the platform and teacher's table to the students' benches.

The significance of the change will not be lost on the designer. Students, working in groups round an experiment, will not do so easily at the long traditional laboratory benches. Long fixed benches, in fact, ill accord with the development of new attitudes. Where there is student initiative in experimental work, benches should be easily movable to accommodate groups of various sizes for any desired experimental situation.

Other traditional features of laboratory design also come under closer scrutiny. The fixed benches of the past have been fitted, like university laboratories, with fixed ceramic sinks and waste water drains, fixed water supply outlets, gas and electricity points. A review of primary and lower secondary science schemes of work suggests the need for quite different and, as it so happens, much cheaper service facilities. Even at the upper second level of science education, the nature of the service facilities, traditionally provided, often makes little sense in relation to the teaching and learning need.

In short the radical changes of approach to science teaching and learning have to be matched by equally radical changes in the design of laboratories. The new play cannot be acted with the old scenery.

The situation is not as serious as might at first be thought. Although the countries of the region have a very large stock of existing classrooms, "...laboratories for primary schools are almost unknown, and in lower secondary schools, where a science laboratory exists, it is generally a combined laboratory designed mainly for demonstrations by the teacher. It is only at the upper secondary level that schools have separate laboratories for physics, chemistry and biology where experiments may be performed by the students..." (9.1).

Thus, the main thrust in laboratory design and construction is yet to come and, when it does, it is vital that the new facilities are such that, through the designer's understanding of science education reform, a built environment for science teaching and learning is provided which will positively contribute to the achievement of new attitudes in science education.

Work on new laboratory design is well under way in several countries of the region, notably in Ceylon, India, Malaysia and the Philippines and Plate 18 and Figure 94, both illustrate new teaching spaces for science in some of these countries. The total lack of similarity with the traditional laboratory of the past will be noted. The rationale for the designs is explained in the sections that follow.

9.02 Patterns of Science Education

In most of the countries of the region, science is taught in primary, lower secondary and upper secondary schools. Primary school science is described variously as nature study, basic general science, elementary science or just plain 'science'. Whatever the description, the content varies but slightly and is usually based on an "integration" of relevant material from physical and biological science and, occasionally, earth and space science. The approach is through concrete experiences of the child's environment, progressively structured as the child increases in age (9.1). For example, in Thailand the topics for study in grades 1 to 7 include:

Grades 1–4	Plants Animals Non-living things (soil, rocks and minerals)	Change Weather Natural phenomena Natural forces
Grades 5–7	Weight and measurement Living things	Matter and energy Natural forces Progress in science

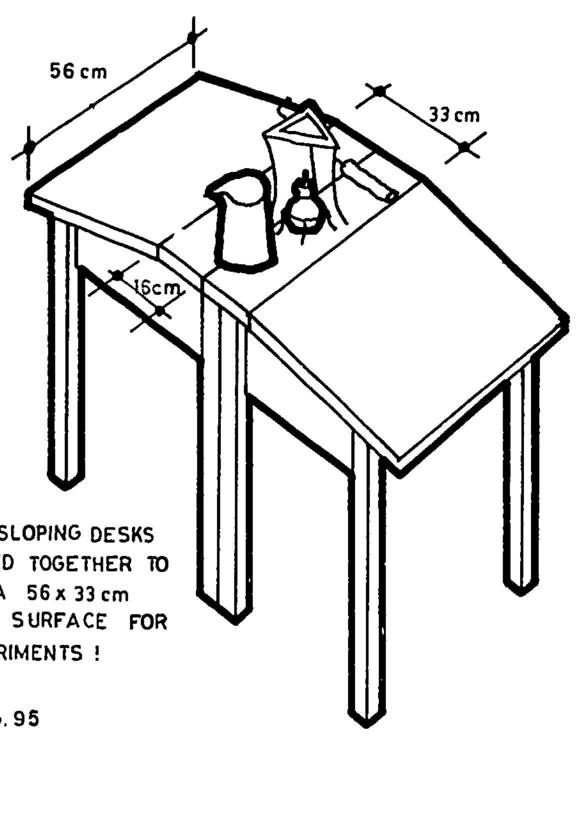
The general objectives are first to develop a basic understanding of nature and the forces of nature and, secondly, to develop habits of critical thinking and to draw inferences from observations.

As will be seen from Figure 4 (Chapter 1), for the majority of children in Asia, schooling at the first level is terminal. Many do not even complete their primary education. The period spent in the primary school is thus likely to be the only opportunity to learn about science that most children will have and the success of primary school science education is thus of critical importance.

At the second level of education, the pattern of science teaching and learning in the region is somewhat more complex. Most countries provide one, two or three years of general science but are moving towards greater integration of the separate major disciplines (physics, chemistry and biology). Malaysia, for example, is developing its lower second level curriculum in *Integrated Science*. With regard to the separate disciplines at the upper stage of the second level, two patterns are followed. In some cases, as for example in India, all three major disciplines (physics, chemistry and biology) are studied concurrently, while in others, as for example in Japan, the subjects are studied sequentially (9.1). Occasionally, general science is provided for arts or humanities students in upper secondary schools.

9.03 Designing for Science in the Primary School

The title for this section has been selected advisedly. There are very few laboratories for primary school science in the countries of the region and it seems unlikely that there is a need for laboratories for teaching and learning science at this level of education. It is, however, possible to design for science teaching in the primary school classroom if the curriculum content and methods to be used are well understood. One obvious design feature that is likely to occur immediately to the designer, is the need for horizontal rather than inclined tops to the children's desks so that they can perform very simple experiments on a level surface. In one country of the region, some years ago, the experiments for an entire scheme of work for primary school science had to be specially designed to fit on the narrow ledge at the top of an inclined table – a classic example of the physical facilities obstructing the educational process which it is thought worth illustrating in Figure 95. The country in question, it should be added, has recently adopted level desks in place of the old, sloping variety.



TWO SLOPING DESKS PUSHED TOGETHER TO GIVE A 56 x 33 cm LEVEL SURFACE FOR EXPERIMENTS !

FIG. 95

"What is needed (for primary school science) is a good sized classroom with adequate storage facilities, a sink and (running) water, some *level* desks or tables, ample wall space for the display of illustrative material and a sturdy table where children can undertake their individual or group investigations and leave their work in safety" (9.3). This, as has already been mentioned, poses problems in relation to the minimum size of primary school classrooms calculated in chapter 7. Providing an adequate classroom for science, handicrafts and other similar primary school activities will, in most countries of the region, be possible only in the future. Thus, the effort must now be made to design spaces that can be easily expanded as resources increase and more money becomes available for primary school building. This idea, as will be shown below, is easy to realise in the hot humid zones but it poses very difficult problems in the arid and higher latitude zones of the region where earthquakes and cyclones (or typhoons), coupled often with a very limited range of building materials, seriously restrict freedom in planning.

Before discussing the design of classrooms in relation to primary school science, it is necessary for the designer to understand the flavour of science teaching and learning at this level. The most important aspect of primary school science and one which is at the root of the movement for reform in science education is that science should start from the children's natural interests and normal activities. Science lessons in the primary school will, if this is accepted, be accompanied by a large measure of spontaneity intermingled with the work for the day that the teacher has loosely planned as part of the overall scheme of work for the term. Many of the science periods will be spent in allowing the children to find answers to questions that one or the other of them has asked. The question "why do flowers smell?" may give rise to a series of experiments and observations during which the teacher will act as a discreet and unobtrusive assistant, proposing, perhaps, as various ideas are put forward by the children, that they divide into groups and investigate the different aspects of the problem. Not only is such a question as that concerning the smell of flowers, unpredictable, but, equally, it is impossible to predict the ways in which the children may attempt to find the answer to it, the equipment they will need and the physical facilities they will require. For this, as well as for the more formal periods in which the teacher may start a set lesson, only to depart from it to allow the child to follow some special interest that he/she may have stimulated, the physical needs cannot be precisely defined. As has been mentioned above, the best that can be provided is as much space as can be afforded, level tables that can be moved about, a supply of water and space for storage and display.

Figure 96 illustrates the elements of a primary school classroom designed, amongst other things, for science teaching and learning in the humid zones and shows the possibility of enlarging the classroom as time passes. It is clear also that in any other part of the region in which steel or reinforced concrete is commonly used to

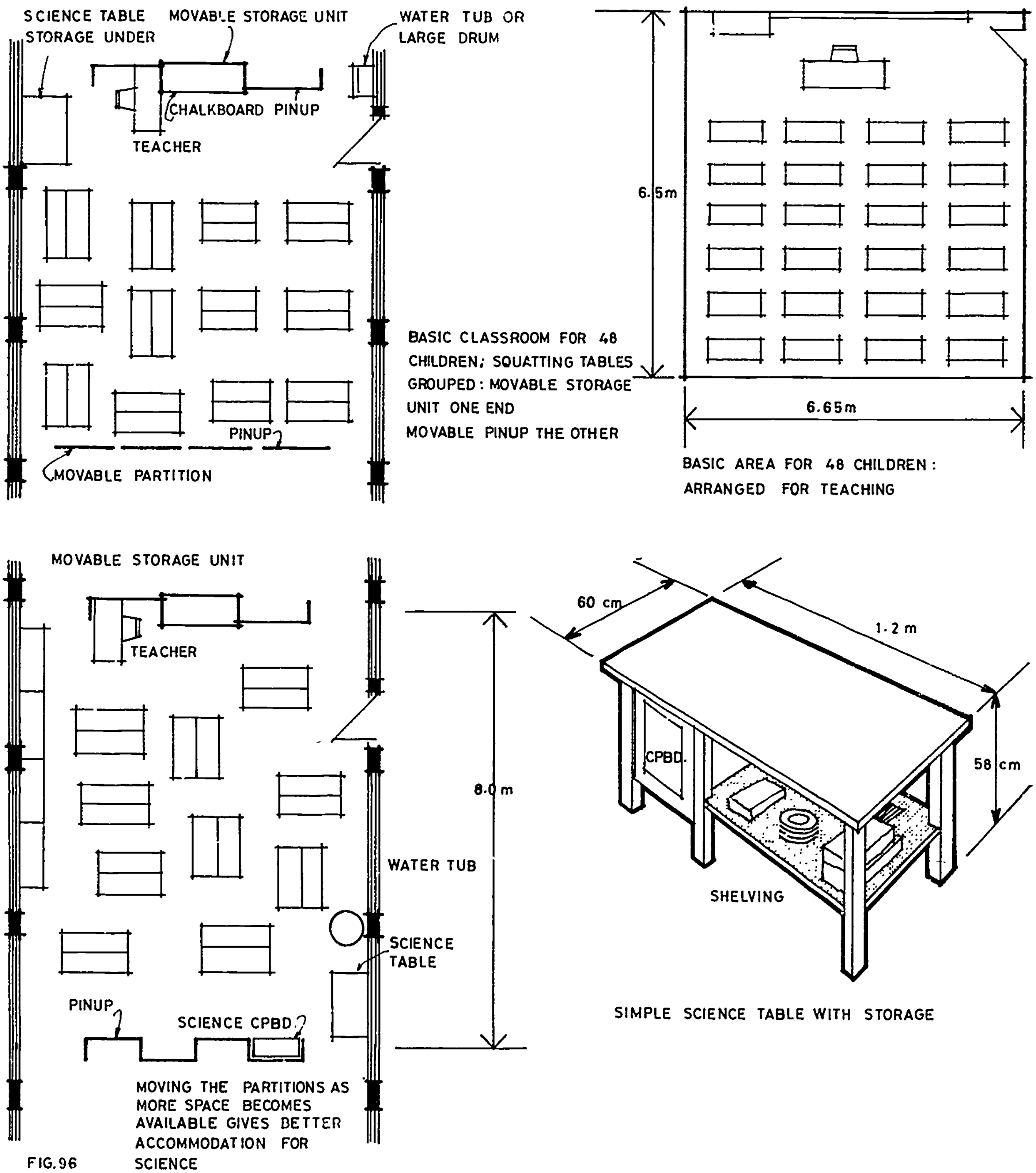


FIG. 96

frame buildings and to construct floors and roofs, this concept of extendibility can be applied. In the rural areas of the arid zone and upland zones of the Himalayas and Hindu Kush, however, it is the practice to build with thick rubble stone walls in either mud, or mud and lime, mortar. Flat roofs in these areas are supported on timber poles cut from stunted trees and, for this reason, spans rarely exceed 5 metres. Commonly, 3 or 4 metres is the maximum width of a teaching space. Window and door openings are small and the ultimate expansion of smaller classrooms into the larger spaces that are needed if the quality of education is to be improved, poses considerable problems. In the chapter on special rooms, the use of the central corridor was suggested. For primary school science it would seem that the best that can be done without forming so many openings that the structure is weakened, is to develop slightly wider adjacent spaces and to link them together as is shown in Figure 97.

9.04 Designing for Science in the Lower Secondary School

Science education in the lower secondary school follows two patterns. In some countries, as for example Afghanistan, physics, chemistry and biology are offered as separate subjects. In other countries they are combined in various ways. Malaysia describes the combination as "integrated science," Laos and the Republics of Viet-Nam and Korea, provide physics or chemistry combined with biology or natural science as a separate subject. Nepal, Pakistan and Singapore describe the subject as science.

It is, as has been mentioned above, at the lower second level of education that curriculum reform has made the biggest impact on science education in the region and it is thus in the lower secondary schools that the changes in laboratory design to match the educational reforms are first to be expected.

At this level, whilst the content is much more tightly structured than at the first level of education, the same theme of the reform movement is clearly expressed, namely, the development of new attitudes, new ways of interpretation and adaptability, all of which are summed up in the phrase, "learning to learn". Designing for science requires, as has already been said several times before in this book, a broad understanding of the activities that are involved, in this case, at the lower second level of education.

In most countries of the region the subject is allocated between 2 and 4 periods a week if general science is offered or 6 periods – 2 for each subject – when physics, chemistry and biology are offered separately.

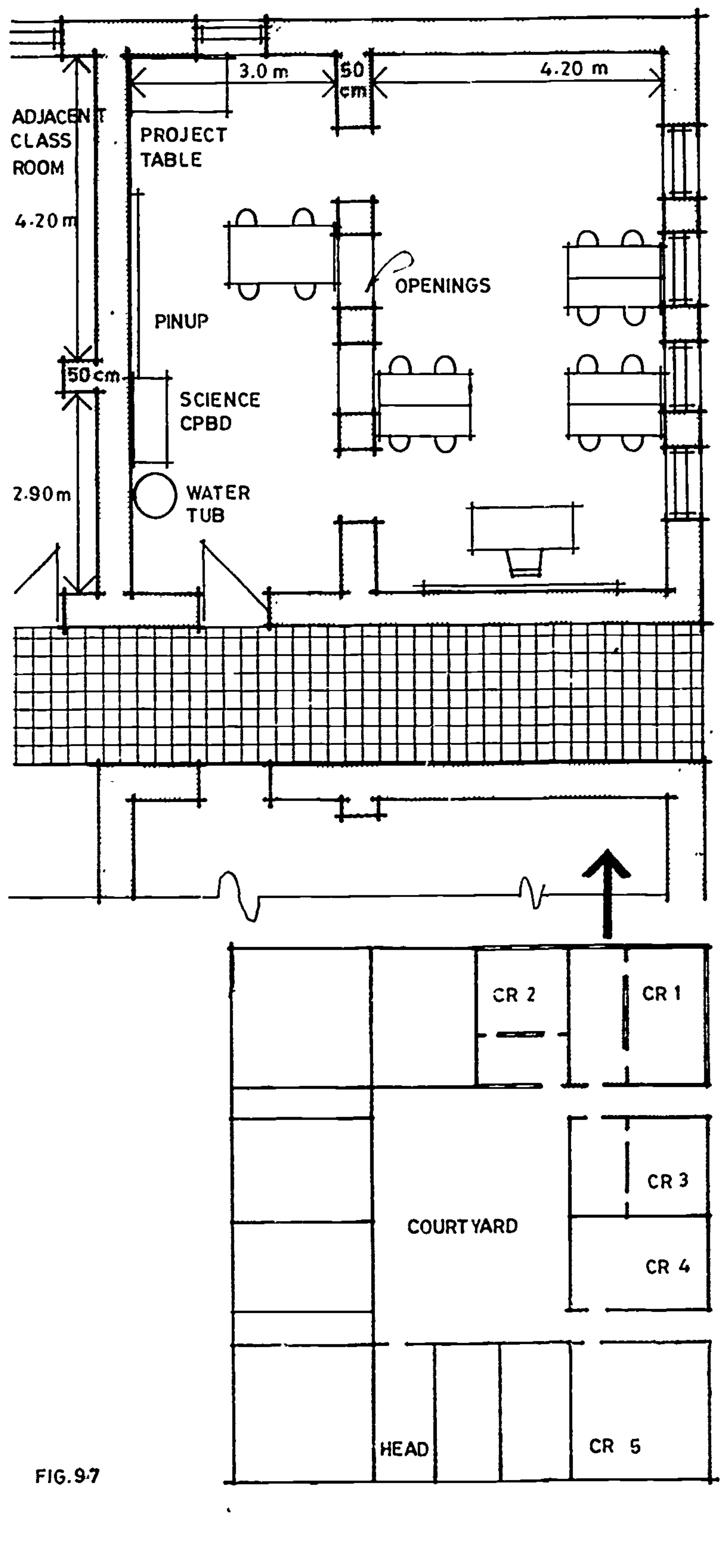


FIG. 9.7

Curricula vary somewhat in their content and that of Thailand (9.1) shows vividly the extent of the change:–

Grade 8

Earth	Electricity in the atmosphere
Water	Magnetic force
Air	Weight and mass
Sun	Preservation free sources
Living Things	History of science

Grade 9

Natural food resources	Nature of water
Relations between living things	Atmosphere
Mineral resources	Light
Combustion and fuel	The milky way
Heat in daily life	Nature of electricity

Grade 10

Fertilization and reproduction	Sound and hearing
	Lighting at home
Weather	Simple visual instruments
Machines	Communications and transportation by electricity
Chemical substances	

It will be patently obvious that teaching and learning of curriculum content such as this cannot satisfactorily proceed on the basis of a series of predetermined, neat, standard experiments as was the case years ago with the traditional science curriculum. More tightly structured though the lessons may be than those in the primary school, there is obviously an opportunity for considerable initiative by the students to question, experiment and observe in a way which they, themselves, will determine, guided, of course, by the teacher. The first design outcome of this understanding of activity is that of the need for optimum flexibility of environment in the teaching space, be it a classroom, multi-purpose laboratory or a laboratory for physics, chemistry or biology.

Flexibility in this context may be taken to mean flexibility of location – both inside and outside the laboratory where there may be a small meteorological station, a few animals or a science garden. Inside, the students must be able to work as a whole group (in watching a demonstration by the teacher), in smaller groups of four or five (perhaps studying the living things in a sample of water drawn from a pond) or individually (perhaps at a microscope). The furniture – that is the tables and stools – will thus not only need to be easy to move about, but also of different shapes so that they facilitate different sorts of work. Long, narrow tables are useful for students to work closely together opposite each other on perhaps a simple dissection. More square and somewhat heavier tables are useful for experiments that may involve weights, pulleys and the like. Some hexagonal tables of arm length radius around which students can work in groups of five or six, perhaps heating something and observing a reaction or a change in colour will also be useful. The possibilities are illustrated in Plates 19, 20 and 21 and the corresponding Figures, 98, 99 and 100.

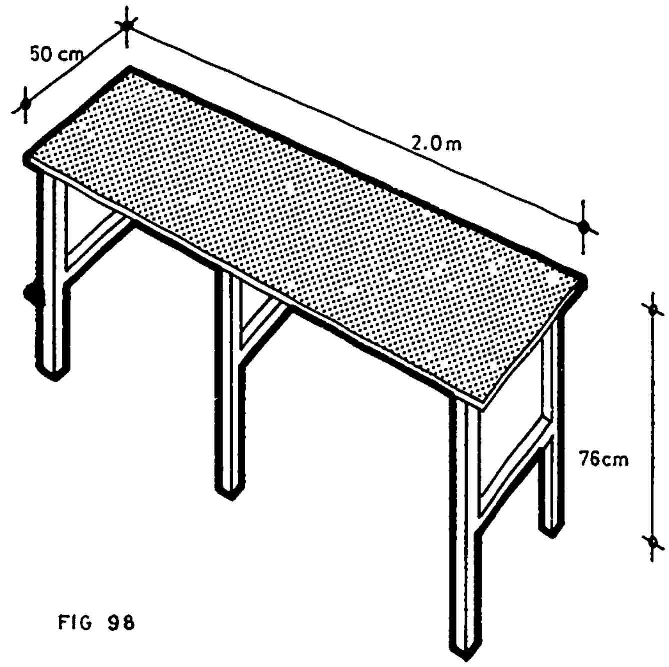


FIG 98


Plate 19

Plate 20

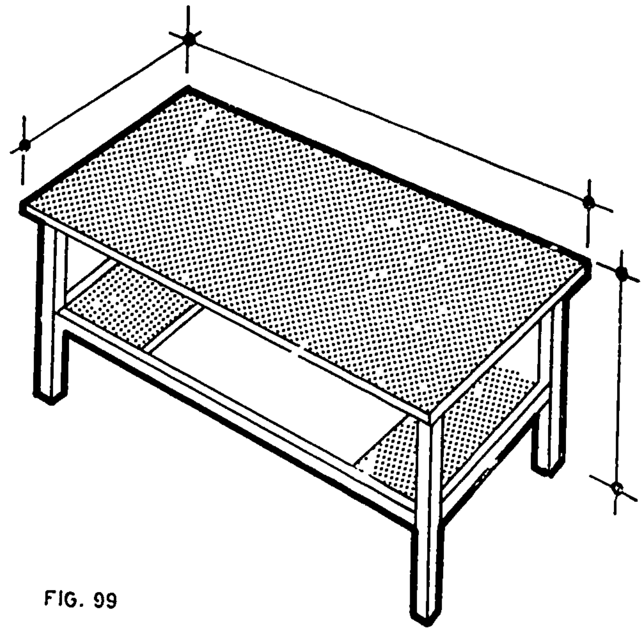


FIG. 99

All three types of tables, it will be noticed, are of a height suitable for both sitting and standing work. A tradition has grown up in science education of standing when experimenting. When working with hot liquids or concentrated acids and alkalies, standing is, no doubt, wise as it enables the student to move away more rapidly in case of an accident. For other experimental situations the student should be as comfortable as possible and thus stools should be provided which are correctly sized for sitting at the 76 cm high tables. (Figure 55).

The services in the laboratory should also match in flexibility the tables at which they will be used. Traditionally, it was the practice to provide running water, mains electricity and piped gas at the laboratory bench. If, however, the needs are studied they will be found to be:–

(i) Water

In quite small quantities (processes requiring running water such as distillation are unlikely to be used in lower second level science). One tap in a room is enough where piped water is available – if it is not, then a few buckets drawn from a nearby well will suffice.

(ii) Heat

Used for test tubes or beakers – where bottled gas is available, three or four bottles can be placed in the lab with a Bunsen burner and taken to the bench where needed (Plate 22). However, a spirit lamp will heat a test tube (Plate 18) and a primus stove, using kerosene obtainable in most rural areas, a beaker.

Plate 21

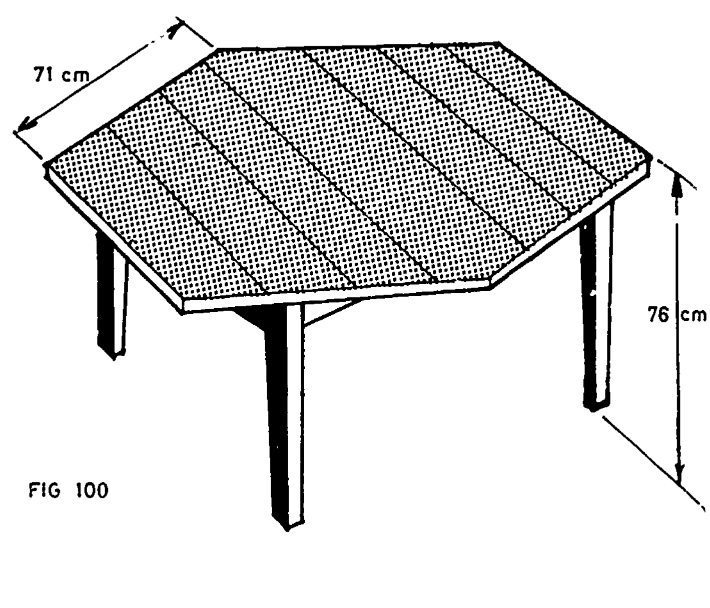


FIG 100

(iii) Electricity

The main need is for low voltage direct current which can be obtained from lead or nickel iron accumulators (easily rechargeable in some rural areas at a local garage), or from dry cells which have a long life but, of course, cannot be re-used.

There are those who oppose the approach to the provision of flexible and limited services in modern laboratories with the argument that the new ideas may be all right (for others) but that the traditional services are "more convenient". Convenience, however, is not the only criterion in selecting the type of services to be used; not only may it be dangerous and expensive to provide mains electricity in laboratories at this level of education, but the current, which is alternating, has to be transformed to direct current and its voltage reduced. Wet and dry cells "...have one great advantage for elementary science teaching: there is a constant need to decide how many cells are required for any experiment, and how best they should be connected. To provide a greater voltage, cells have to be connected in series; to increase current, more cells must be added in parallel. Experience in the use of cells, therefore, emphasizes the meaning of fundamental characteristics of an electric current. This emphasis cannot be gained from the uncritical use of a 'laid-on' low-tension supply" (9.4).

Thus, a tap or a bucket of water, a plastic bowl for waste liquids, a spirit lamp, primus stove and some accumulators or dry cells are all the services that are needed in a science laboratory for lower second level education.

Another important element required as part of the facility for science at the lower second level of education is space for storage and preparation. The precise space required will vary, depending on the amount of equipment and material normally provided for science.

The storage arrangements will depend very much on the administrative system under which the equipment and materials are issued to schools. Unfortunately, in many countries, science equipment is in very short supply and also is issued personally to the teacher who is made financially responsible for loss or breakage of all but the smallest items. This encourages teachers to keep all aids for science teaching and learning under lock and key and also encourages reluctance to issue the equipment and material to the children. a reluctance which is understandable if no replacements are available or if breakage or theft results in a deduction from the teacher's salary. Where this sort of situation cannot be altered then lockable storage in the form of cupboards and a store room will have to be provided.

In easier circumstances, materials and equipment of a more expensive nature can be kept in a store-cum preparation room and items of very common use, such as spirit lamps, test tubes, cylinders, beakers, clamps etc., can be kept in cupboards or on open shelving around the laboratory in positions convenient for instant use (9.5; 9.6; 9.7; 9.8).

Plate 22

Mention should also be made here of the various science kits that are now being developed and produced in some of the countries of the region; for example the National Council for Educational Research and Training, India (9.9) has designed, tried and evaluated kits for learning in chemistry, physics and biology and the use of these kits in the various states of the Union of India is now increasing rapidly. Development of kits for chemistry has been undertaken by the Unesco Pilot Project for chemistry teaching in Asia in Bangkok, whilst kits for science are also being developed at the Science Education Centre in Quezon City in the Philippines. Other examples could be added.

The use of kits, apart from their educational merits, makes storage requirements in the laboratory not only easier but also quantifiable.

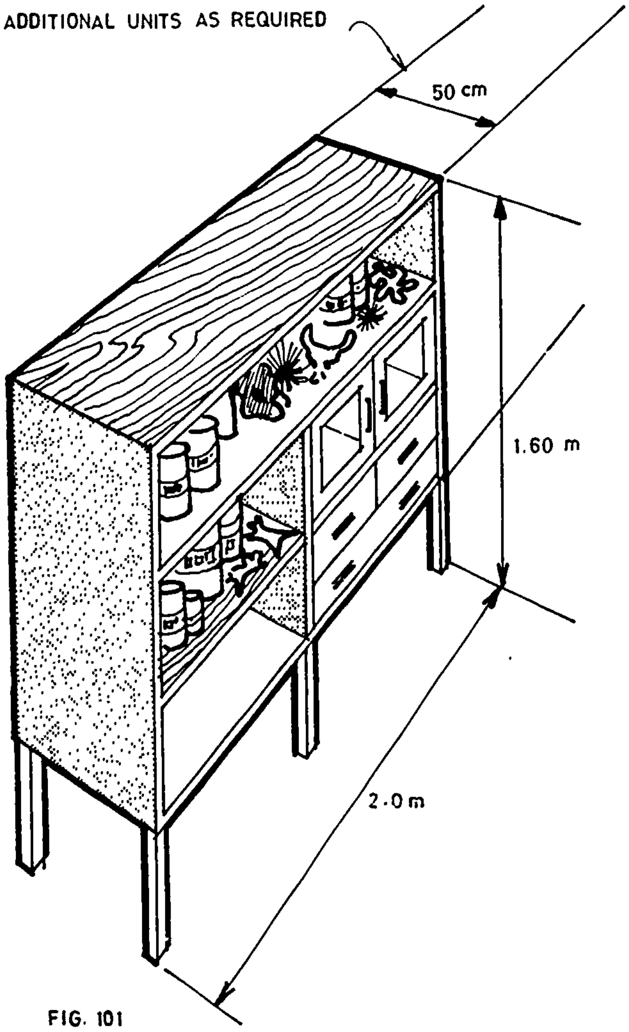


FIG. 101

9.05 Biology in the Lower Secondary School (9.6)

The important activities in the biology laboratory are:–

(a) Work with microscope/magnifying glass which requires high illumination levels and thus location near a window.

(b) Dissection of plants and animals – also requires a high level of illumination.

(c) Miscellaneous experiments of a duration of not more than one laboratory session and requiring a stable bench and often some water.

(d) Standing experiments that last for several weeks such as on plant growth. These require safe. undisturbed bench space.

There are also a range of statistical and field activities having no direct impact on laboratory design. The most suitable bench for all these activities is narrow, 50 cm wide and having its surface 76 cm above floor level (see Figure 98). As this bench is easily movable. it can be pushed near a window when high illumination levels are required or benches can be pushed together for larger group experiments. Sufficient surplus benches should be provided for experiments that are to stand for several weeks.

A unique requirement of biology work is a museum from which specimens, collected over the years by a succession of teachers and children, can be drawn for study. These specimens are usually small in scale although, when enthusiasm knows no bounds, as it did in one Asian school. specimens such as the skeleton of a dead camel that was found, might have to be accommodated. Figure 101 suggests the dimensions of a useful museum storage unit that provides open shelves, a lockable, glazed cupboard and a few drawers. Figure 102 shows alternative arrangements for 40-place biology laboratories for lower second level schools.

9.06 Chemistry in Lower Secondary Schools (9.8)

Chemistry teaching and learning includes conducting of enquiries (9.8), involving:–

(a) getting new materials from those already available;

(b) looking for a pattern in the behaviour of substances;

(c) the use of explanatory concepts and knowing how to check theory by observation;

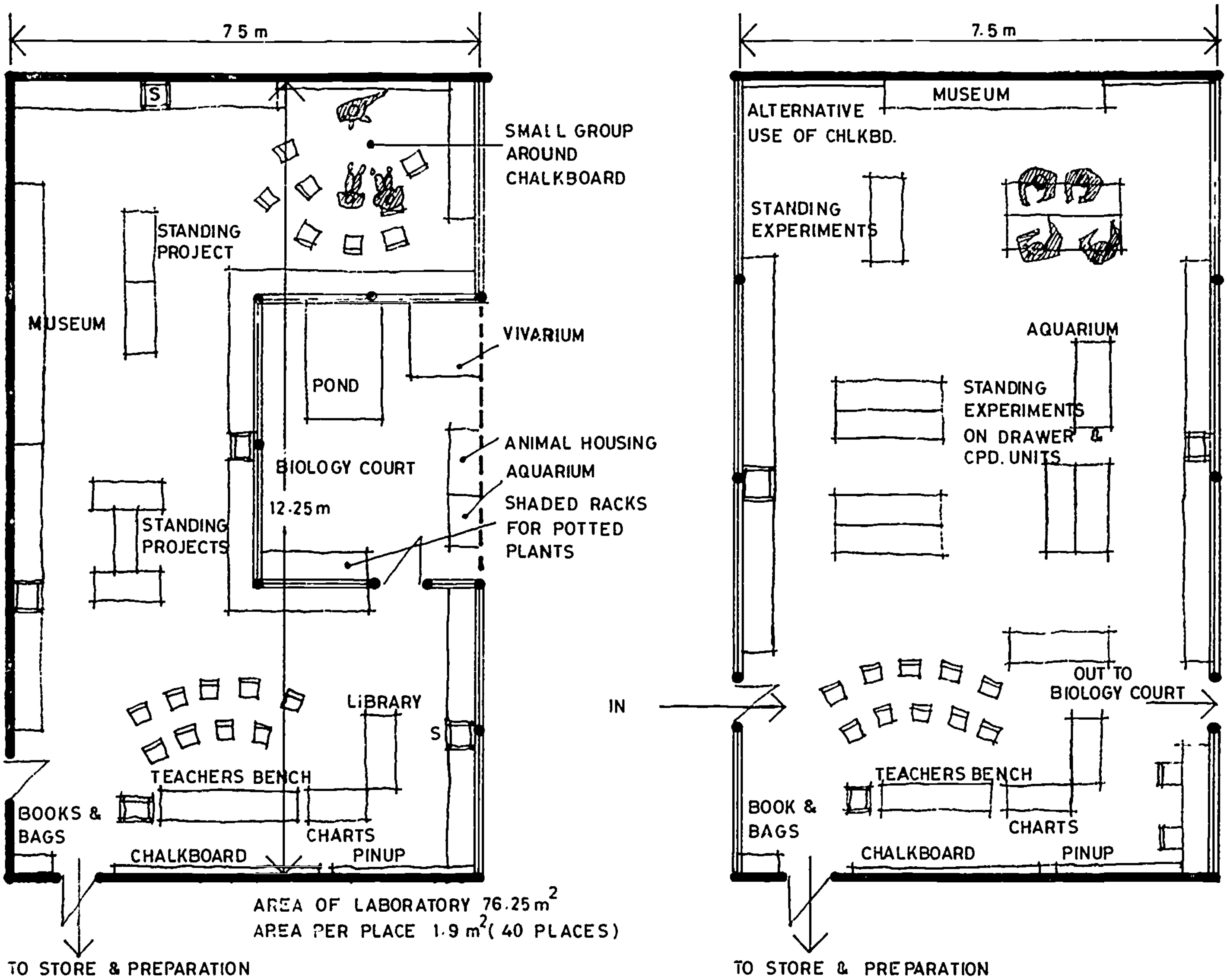
(d) associating energy changes with material changes.

Dissolving, heating, filtering, mixing, simple distillation and measuring (weight, volume, temperature etc.) are the main activities. The number of students working on a particular enquiry or experiment will depend on the equipment available. If there are 40 students and 8 spirit heaters for heating test tubes, then groups of 5 will work together; if there are 10 heaters then groups of 4 can be formed.

This suggests the need for rectangular, polygonal or circular benches in the chemistry laboratory, the plan dimensions of the benches being fixed by the comfortable arm reach of the children using them. In Ceylon, for example. as is shown in Plates 18 and 21. polygonal tables have been used. In other countries, such as Canada (Ontario) (9.11), rectangular benches are provided for students working in groups of 2.

As in biology, there is a need for the benches to be movable to meet, whatever experimental situation arises. Movement of benches for chemistry is, however, likely to be somewhat less than for biology and physics learning and teaching. The designer should remember that, at this level of education, very little, if any, use is made of strong alkalies or acids and thus no case can be made for heavy expenditure on an acid resisting finish to working surfaces, or the use of traditional and very expensive timbers such as teak (Tectona grandis). What is required is a stable, level bench top of the cheapest local timber which is suitable for joinery, that is timber that takes a reasonable finish and is not subject to excessive moisture movement. In one laboratory, for example, cypress (Cupressus macrocarpa) was used for benches some years ago. Although now, somewhat stained (see Plate 21), this cheap wood continues to provide a thoroughly satisfactory working surface and will do so for years to come.

That other traditional laboratory fitting, the fume cupboard, can also be swept away along with the teak benches, expensive fixed water supply, ceramic sinks and acid resistant drains. All the various acidic gases produced in lower second level chemistry can much more safely and cheaply be absorbed by solid alkaline reagents at the bench rather than dispersed from an expensive cupboard up lengthy flue pipes, often only to blow into a nearby classroom.



FURNITURE ARRANGED FOR DEMONSTRATION

FIG 102

Storage is an especially important facility needed for chemistry. Stocks of chemicals need to be safely locked up and in addition to a minimum of about 4 square metres of shelving for bottles, sand trays should be designed in which to stand the larger containers of acid which will be subsequently diluted before use by the students.

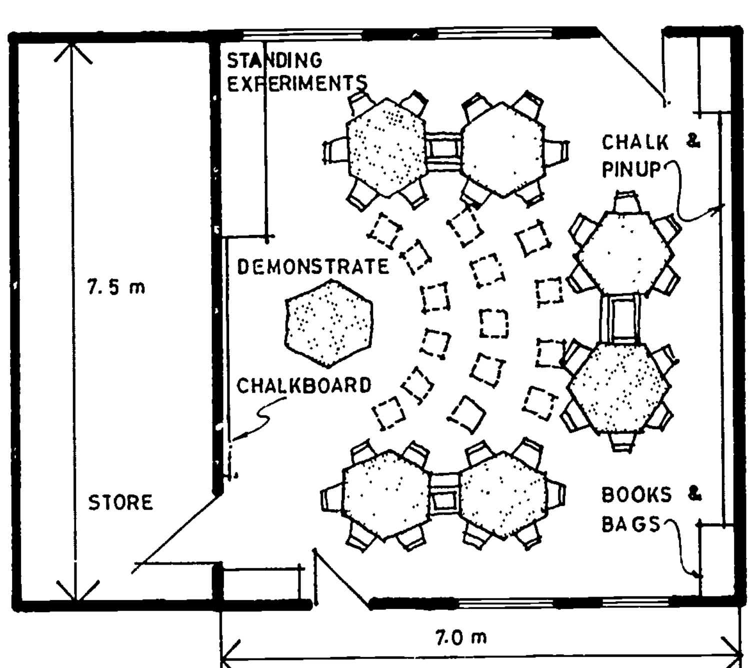
Figures 103 (a) and (b) show a minimum laboratory for lower second level chemistry as well as a somewhat larger laboratory in which more space is available.

9.07 Physics in lower secondary schools (9.7)

Traditionally, the physics syllabus includes heat, light, sound, electricity and magnetism and mechanics. The modern physics curriculum is concerned with these same topics but conceived in a very different way. (see 9.01, General). From the designer's view-point, physics involves a very much greater *variety* of equipment than do biology and chemistry at the lower second level of education. In chemistry, for example, many of the experiments involve the repeated use of similar containers such as test tubes, beakers, cylinders and flasks, whilst many operations such as heating, dissolving, mixing and evaporating are repeated again and again (with, of course, different materials and different objectives).

In physics, however, different experiments more frequently require very different sorts of apparatus ranging from, for example, a small plane mirror for investigations into light to Boyle's Law apparatus with foot pump for work on pressure. Very much more storage space is thus required for physics than for biology or chemistry. The storage facility, moreover, requires a wide variety of shelf heights and widths as well as cupboards and drawers of different sizes.

The varied nature of this equipment needs also to be reflected in the provision made for its use. In general, tables for physics learning and teaching need to be larger than those for the other sciences. Long enough for an optical experiment, wide enough to accommodate assemblies of batteries, generators, meters and transformers and with overhanging edges designed for cramps and strong enough to support hanging weights, the physics table should be designed to be movable but robust. Plate 20 illustrates a 75cm x 150cm table that meets this specification. Essential services in the physics laboratory comprise, a sink and tap or a bucket of water drawn from a nearby well. The most important aspect of the laboratory design is its capacity for adaptability to a variety of experimental situations. Figure 104 illustrates the essential features of a physics laboratory for 40 children.



TOTAL AREA 50 m^2

AREA PER PLACE 1.7 m^2

FIG 103 a

9.08 The Multi-purpose Laboratory (9.5)

As was mentioned in 9.01. (General), in lower secondary schools, where a science laboratory exists, it is usually a combined laboratory. The provision of a combined or multi-purpose laboratory is not necessarily the result of a lack of money for building separate laboratories where biology, physics and chemistry are separate subjects in the curriculum. If the curriculum includes 2 periods per week for each of these separate subjects and the duration of education at this level is 3 years, then the space periods required for a single stream school are as follows:–

Biology	2 x 3	=	6
Chemistry	2 x 3	=	6
Physics	2 x 3	=	6
	Total		18 space periods

In a 40 period week, the laboratory could be used for about 75% of the time (allowing periods for clearing up and preparation), that is for 30 periods. Thus, even one combined laboratory in a single stream rural school would be somewhat under-utilised.

To utilise separate laboratories for each science subject to the full would require a school of $\frac{30}{6}$=5 streams. A school of this size would normally, of course, only be found in an urban situation. As roughly 80% of the population of Asia lives in rural areas, the multi-purpose laboratory assumes considerable significance as an accommodation element.

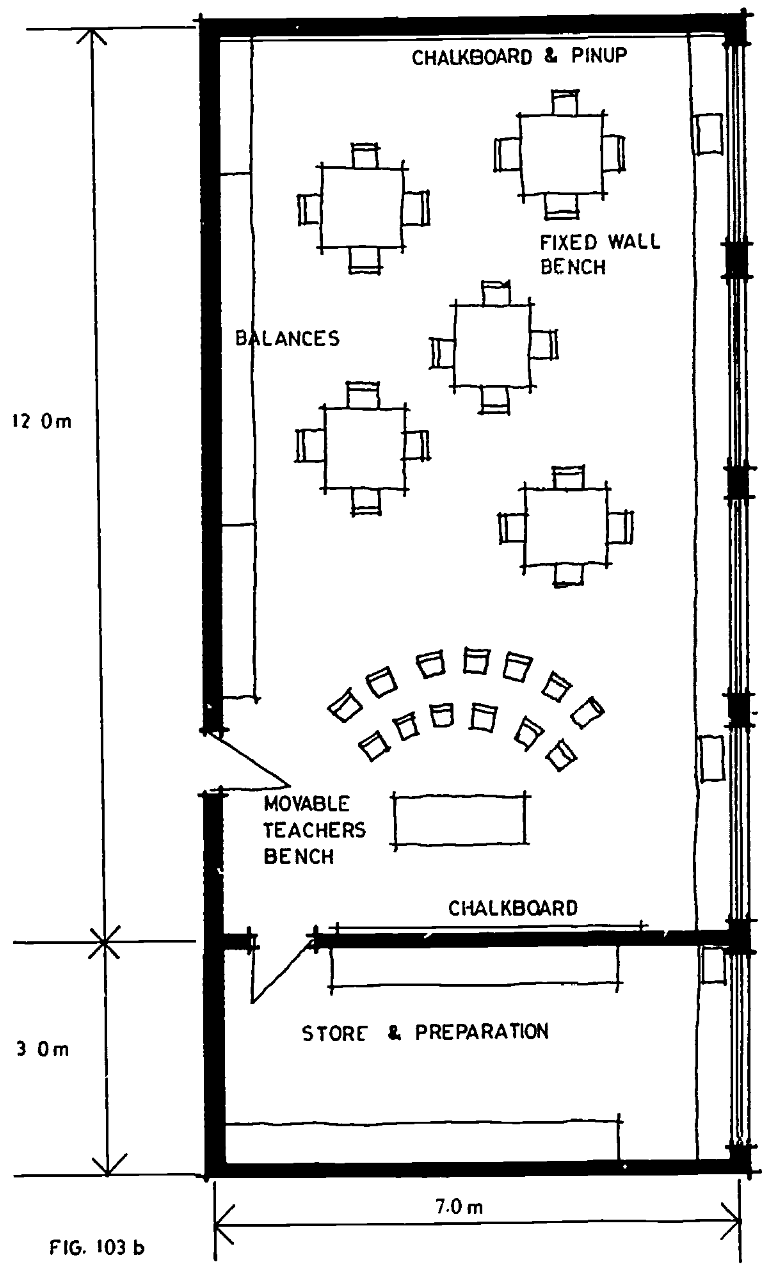


FIG. 103 b

There are, of course, also a number of countries in which science is taught as one combined subject and this approach to lower second level science is spreading (sec 9.02, Patterns of Science Education). In such countries, multi-purpose laboratories are required in both rural and urban areas, and irrespective of the numbers of children in the school.

"Integrated" science learning and teaching (9.2), whilst naturally reflecting the reforms referred to earlier in this chapter, is based upon the concept of science as a total subject area unified in substance and content and in which all natural events are understandable in terms of physical theory. The concept may perhaps best be understood by reference to an example. Yeast, mixed with a sugar solution produces a chemical change resulting, *inter alia*, in the production of gas, and the growth of the yeast cells. The rate of change is affected by temperature. Thus, in one experiment, children can become interested in biological, chemical and physical phenomena unified in both substance and content.

In practice, the subject of integrated science would be approached not through separate experiments of the sort described above but through the experimental study of selected themes such as, for example, "support and movement".

The students might perhaps study the ideas of force and of worked energy and examine them in relation to support in plants and animals, leading on to an investigation of muscles.

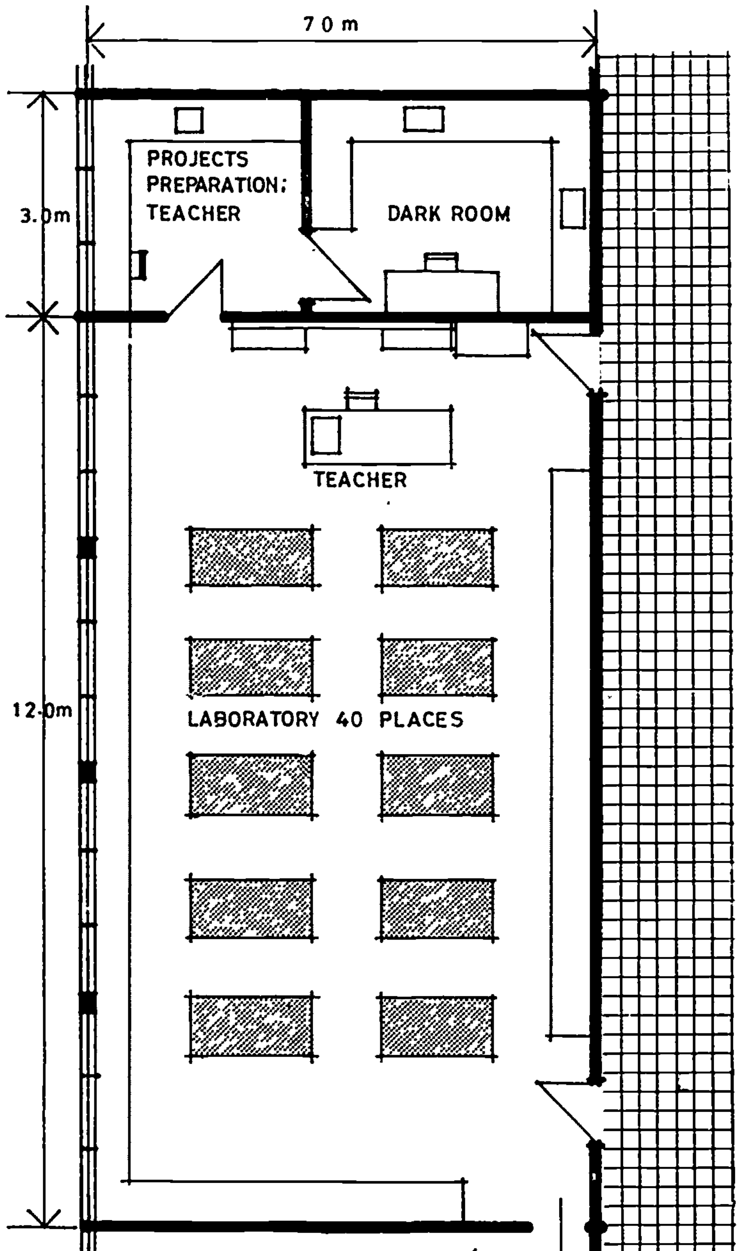


FIG. 104

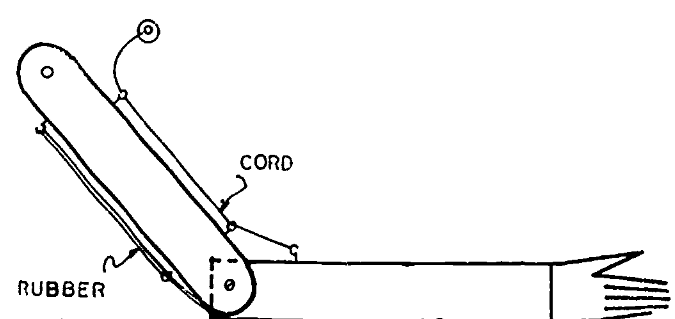


FIG. 105

A theme of this sort might result in the need to weigh, to push, to study trees near the school, to cut and to make models simulating supporting systems. The range of activities will be seen to vary from use of more conventional laboratory techniques such as use of a balance for weighing to techniques more commonly associated with a workshop such as would be used in making the model muscle (9.3) shown in Figure 105.

The multi-purpose laboratory thus needs to be furnished with a variety of tables and a few sturdy workshop type benches. There should be storage for tools, and for a small amount of wood and sheet metal in addition to the more conventional science equipment mentioned above. Figure 106 illustrates some of the features of such a laboratory.

Of course, it is not possible to construct multi-purpose laboratories of the size shown in Figure 106 in mountainous areas where materials only permit of roofing over 4 or 5 metre spaces and Figure 107 shows a multi-purpose laboratory designed for rural areas of Afghanistan. The space is small but a high level of flexibility is achieved through the use, not only of movable tables, but also of simple, wheeled trollies. Storage is arranged along one cross wall.

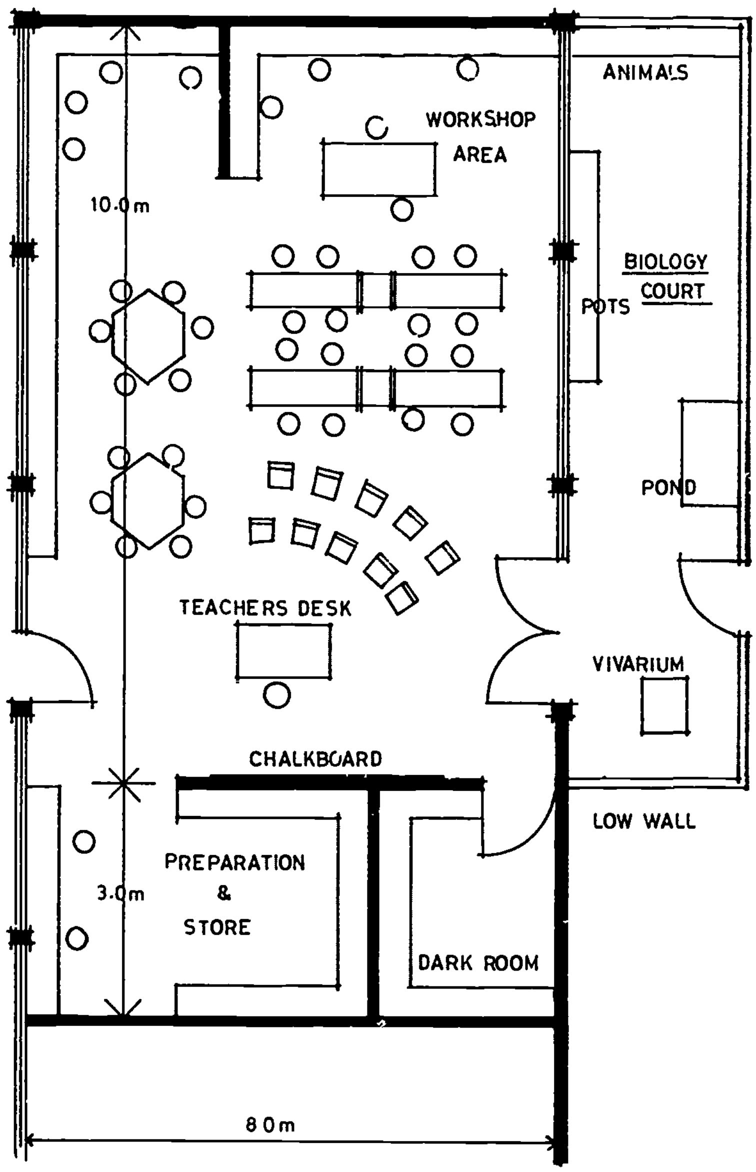


FIG 106

9.09 Designing for Science in the upper secondary school

Chemistry (organic, inorganic and physical), physics, botany, zoology and, sometimes geology continue to be taught at the second level of education in the region. in a traditional manner, to students preparing for university entrance; in some countries, as, for example Indonesia and Thailand, general science is taught to arts students at the upper second level of education.

Reforms in science education at this level are slowly being introduced in a few countries outside the region and, no doubt, in years to come, the move to reforms in science learning and teaching, now evident in most Asian countries, will result in changes in pre-university science education. The designer has thus to keep an eye cocked to the future but, at the same time, to provide for traditional science teaching in designing upper secondary schools. In so doing, opportunity can at least be taken to avoid some of the design defects that are to be found in many traditional laboratories. Particular attention should be paid to:–

(a) Benches and stools designed at the correct height for students who will be probably 16 to 18 years of age. Figure 108 suggests suitable heights;

(b) Widths of working surfaces such that they are within easy reach of a seated student (Figure 108);

(c) Storage within zones of convenience which differ in height from those for younger children (Figure 57).

Several other features distinguish science laboratories at the upper second level from laboratories at the other levels of education. It will be recalled that in lower secondary schools, the number of periods allocated to science is small and also that there is no need for elaborate water, gas or electricity services. In consequence, laboratories can be located in positions which result in minimum movement of the children about

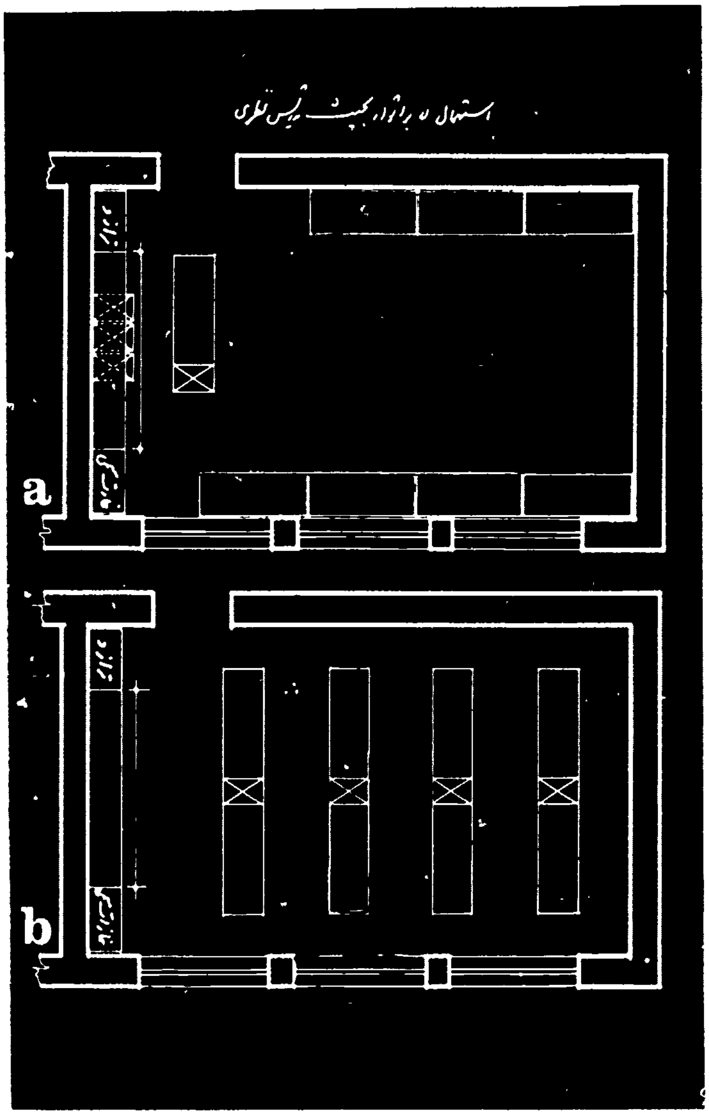


FIG 107

the school building. Figure 73 illustrates this point. Upper secondary school laboratory requirements, on the other hand, are such that their location adjacent to each other is essential. In the first place, science students spend substantially more time in laboratories with consequently much less movement between the laboratory and other elements of accommodation (1.1) and, secondly, the need for services such as gas, water and electricity are such that building costs are likely to be substantially less if laboratories are grouped together rather than arranged at random throughout the building. In many countries, both in and outside the region, the practice of providing the science department of the upper secondary school with its own building is common. The Oxford School Development Project from outside the region (9.14) and the science laboratories for Malaysia's upper secondary schools are good examples of this trend. Both are illustrated in Figure 109.

In Iran, this idea has been carried even further with the construction of a laboratory building in the centre of Teheran serving a number of surrounding schools, the students of each of which spend half a day a week in the central science laboratory. This idea is extremely attractive from several points of view. It ensures that maximum use is made of the laboratories. Only one set of equipment is needed for each of the biology, physics and chemistry laboratories instead of a number of separate sets that would otherwise be provided in the feeder schools. Finally, and perhaps most important of all, full use can be made of skilled science teachers. Arrangements have been made for industrial arts learning and teaching at central workshops in Singapore with the same object of achieving both greater economy and greater efficiency through concentration of resources in one place.

The size of upper secondary science laboratories ranges from 3.0 to 3.9 m² per place, the larger per place areas being required for smaller laboratories. 1.0 to 1.5 m² per place are required for lecture or demonstration rooms, separate from the laboratory. Preparation and work rooms are always required but often one such room can serve two laboratories. Balance rooms, dark rooms and stores are essential and for biology, a specimen room or small museum is required. A small workshop is also extremely useful for science at this level of education.

In view of probable future changes in upper secondary school science curricula, the laboratory should be provided with as few fixed elements of furniture as possible. Benches along the window wall can be fixed and provided with water, gas and electricity outlets but in the centre of the room flexibility for

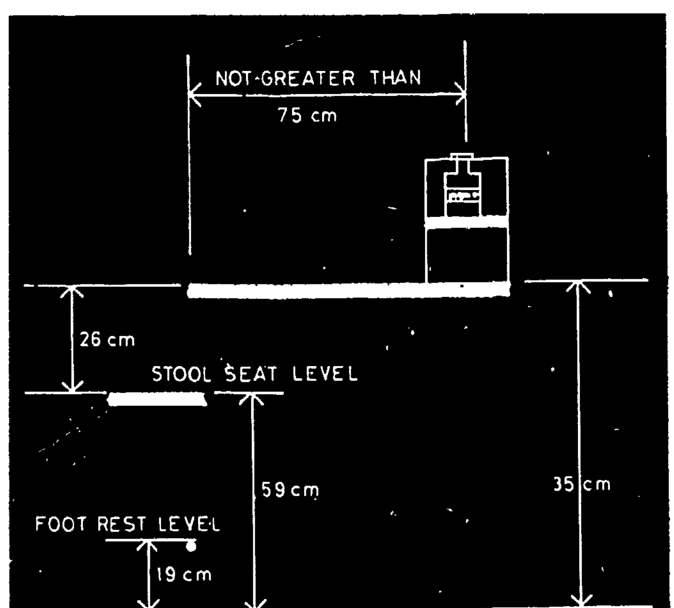
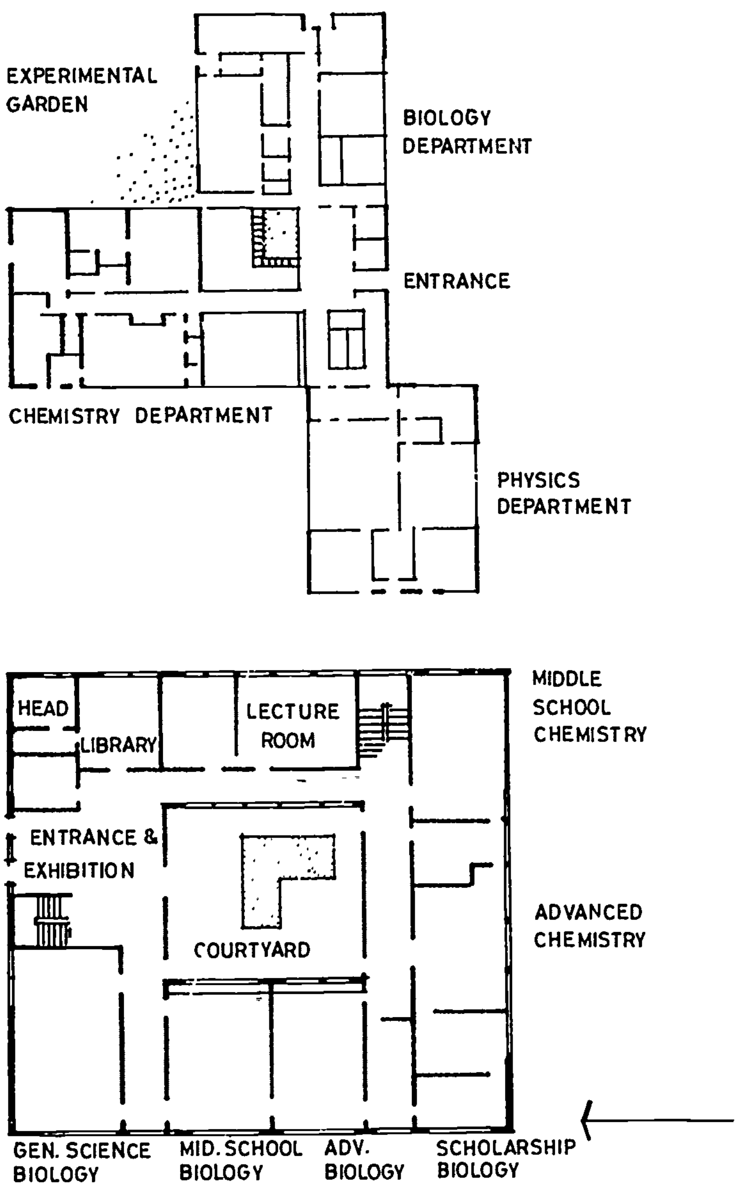
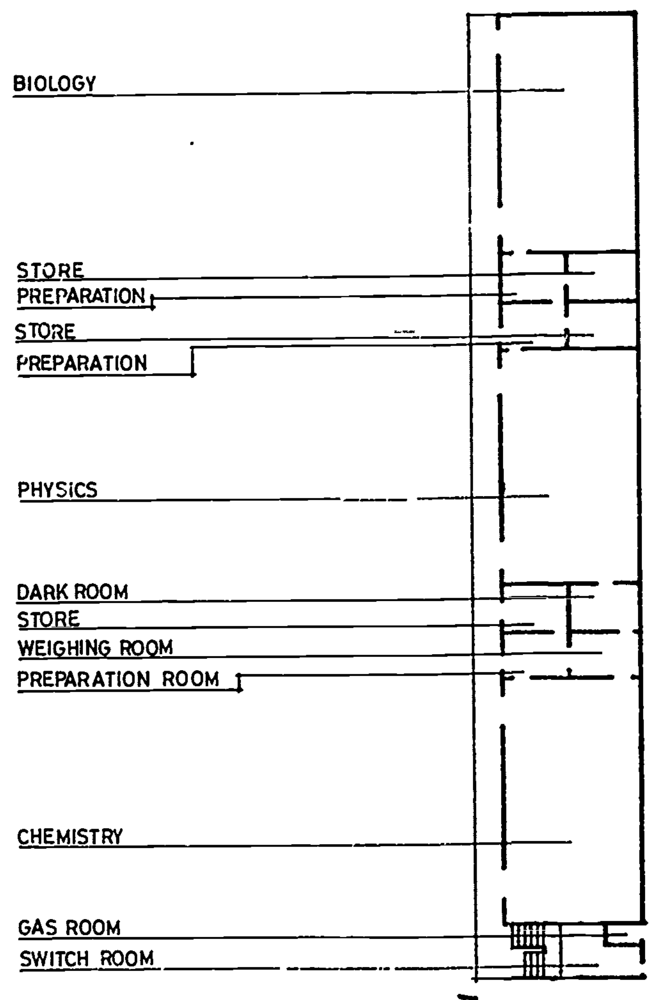


FIG. 108

change can be partially ensured by providing somewhat heavier and more stable benches than those suggested earlier in this chapter for lower secondary schools and arranged near service islands, strategically located in the laboratory. Figure 110 illustrates some alternative types of service islands. Two points may be made concerning the details of their arrangement. First, it will be noticed that all services pipes and lines are exposed. This is because they are easier of access for repair but, far more important, the chance of white ant using either the inside or outside of the pipes to gain access to the laboratory is much reduced if the access paths can be seen. Services, when carefully concealed behind cupboards not uncommonly result in the destruction of furniture by providing easy, hidden access for wood eating termites. Secondly, where laboratories are arranged on separate floors, one above the other, economies can be made in piping and electric wiring by arranging the islands above each other with vertical runs for the service inlets and waste outlets. Further reading on the design of laboratories is provided in (9.14; 9.15; 9.16; 9.17).

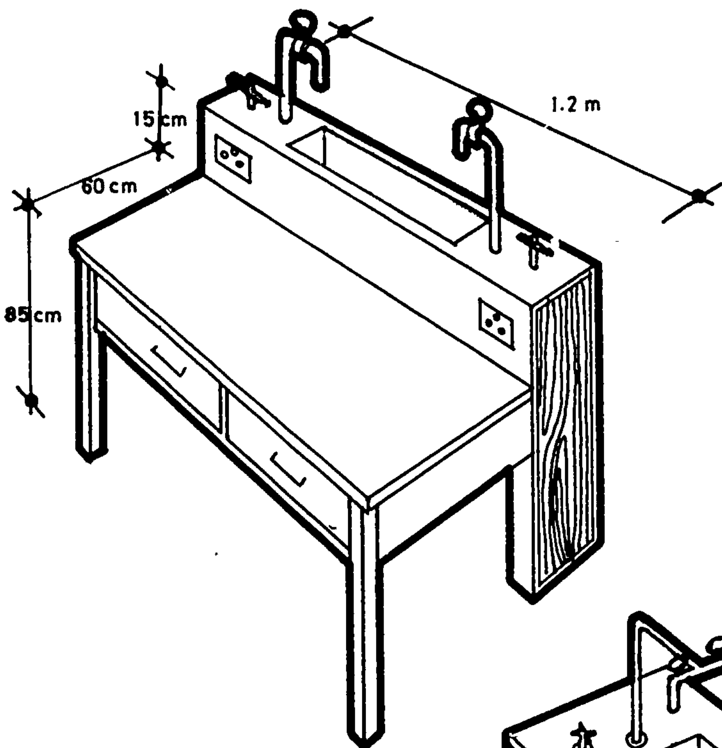


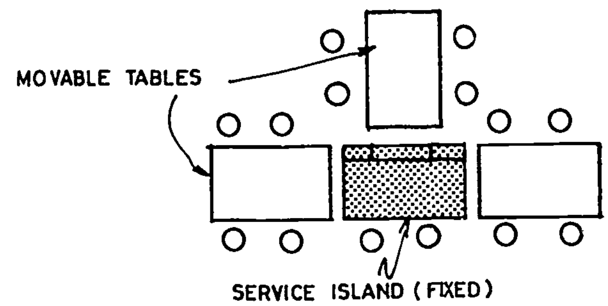


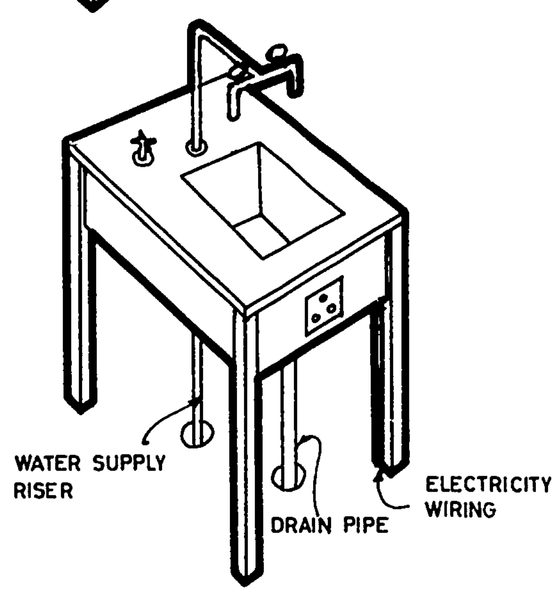
SCIENCE LABORATORY FOR MALAYSIA

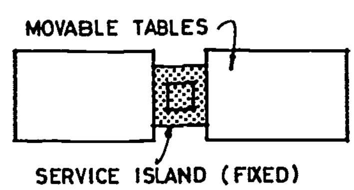
OXFORD SCHOOL DEVELOPMENT PROJECT

FIG. 109


15 cm
60 cm
85 cm
1.2 m


MOVABLE TABLES
SERVICE ISLAND (FIXED)


WATER SUPPLY RISER
DRAIN PIPE
ELECTRICITY WIRING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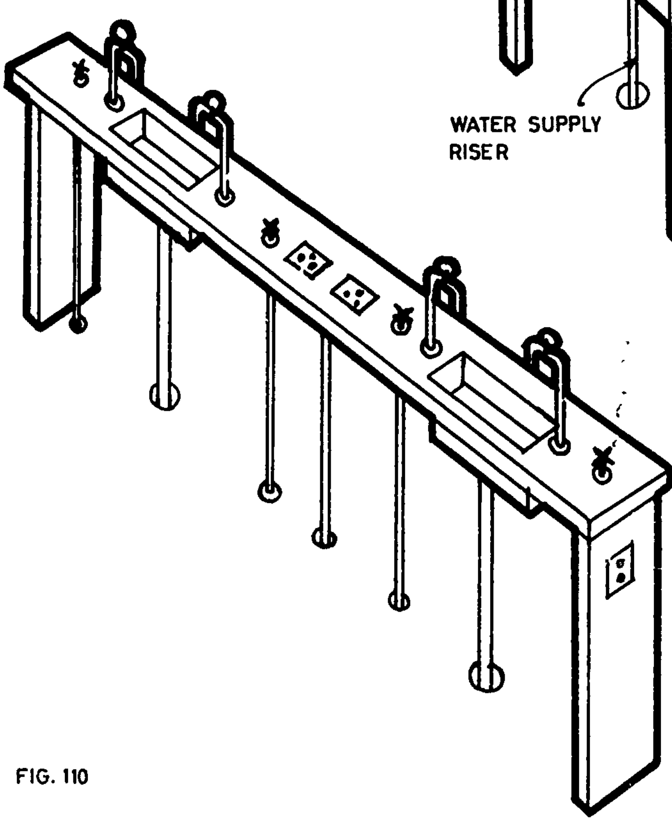

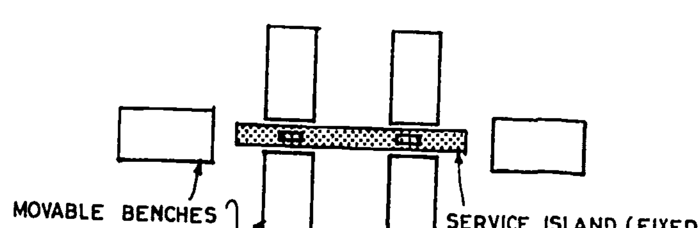
MOVABLE BENCHES
SERVICE ISLAND (FIXED)

FIG. 110

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Chapter 10

HOME SCIENCE LABORATORIES

10.01 General

The subject matter pertaining to education for home and family living at the second level of education (it is rarely included in first level curricula) is known by several names in the countries of the Asian region. These names include home science (used in this chapter), home economics, domestic science and home making.

A review of the curricula of the countries of the region, suggests that home science is commonly regarded as part of the general education of the adolescent girl and is usually terminal in nature. There is much emphasis on practical and manipulative skills and on the production of goods, rather than on their intelligent consumption. Science, particularly chemistry and physics, often plays an important part in home science teaching and learning.

In Asia, the following usually comprise, in one form or another, the main components of a home science course:–

- Foods and nutrition
- Textiles and clothing construction
- Child care, home nursing and family living
- Laundering.

Arts and crafts occasionally forms part of the course but, in most countries this topic is included in the industrial arts curriculum.

There are very few laboratories for home science in the Asian region as a whole. This is due, in part to lack of teachers, to the fact that home science is often an optional or elective subject and is less preferred than the more academic subjects required for university entrance and, finally, to the belief that home science laboratories are expensive to construct as indeed they are, if modelled on university facilities or the facilities of the richer countries of the world.

Thus, with a very small stock of laboratories, most of which are quite modern, attention can be fairly and squarely focussed on the provision of the new facilities needed for secondary schools.

Curriculum reforms of the sort already described for the physical sciences and mathematics, have not yet begun to take place in respect of home science. Teaching, by and large, if there is no provision of laboratories, is didactic, with demonstrations by the teacher copied by the class. Perhaps the main difference between learning in home science (if adequate facilities are provided) and learning in other subject areas is the practice of evaluation which has some implications for design.

The children may not only cook a rice meal, but also sit down and eat it. Dressmaking is followed by fitting of the completed garment and laundering by wearing or using of the item that has been repaired washed, starched and ironed. Home science, if it is to be learned successfully, involves more activity by the children than by the teacher. Some of these activities, an understanding of which is essential to the designer, are shown diagrammatically in Figures 111, 112, and 113 (10.1).

The other activities, child care, home nursing and family living do not lend themselves to diagrammatic representation. They also, however, involve much practical work in which students learn to make value

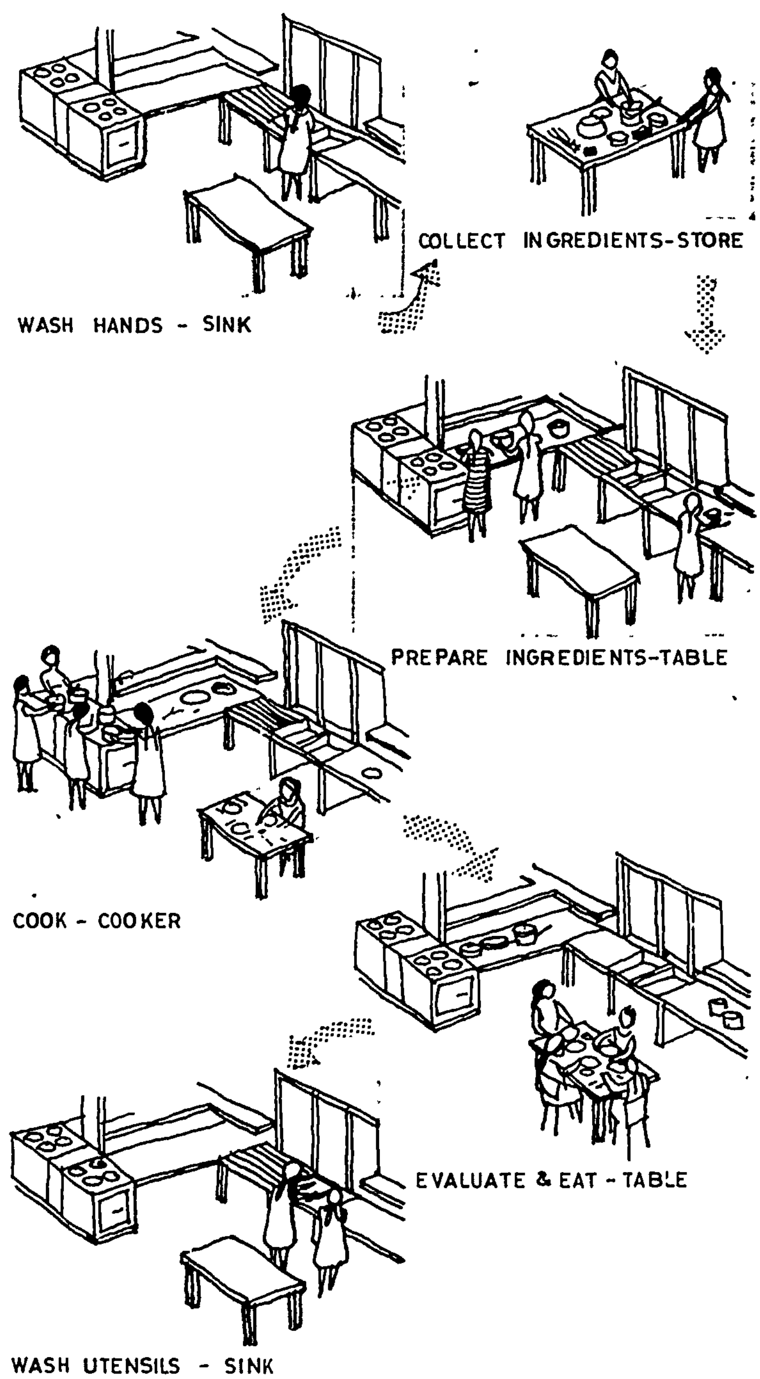


FIG. 111 FOOD PREPARATION - THE PROCESS

judgements in the choice of colours, textures, fabrics, equipment, methods of work and in the use of money, time and energy, and also to acquire some measure of skill in caring for a sick member of the family. They are, if they are girls, guided in understanding their role of helping their mothers with babies and other young members of the family: they are taught to prepare a baby's food and ways of keeping a younger brother or sister occupied while parents are at work.

A good idea of the teaching implications of the family living course is provided by the National Council of Educational Research and Training, India, in its plan and courses of study for higher secondary schools (10.2).

The facilities required include a bed, cot, chairs, arm chairs, tables, pictures and cupboards; in fact the elements of furniture in a normal home appropriate to the country in which the subject is being studied.

This concept of "the home" as a place in which to learn about home science is of considerable interest in the context of school building design as it represents one of the two basic solutions to the design problem, a solution which has been adopted by many schools in the Philippines where, instead of providing a conventional laboratory for home science, as is the common practice in the region, a house is designed for teaching and learning which forms part of the complex of buildings on the school site. Figure 114 illustrates a Philippines, home science house of a type built for schools in Laguna Province.

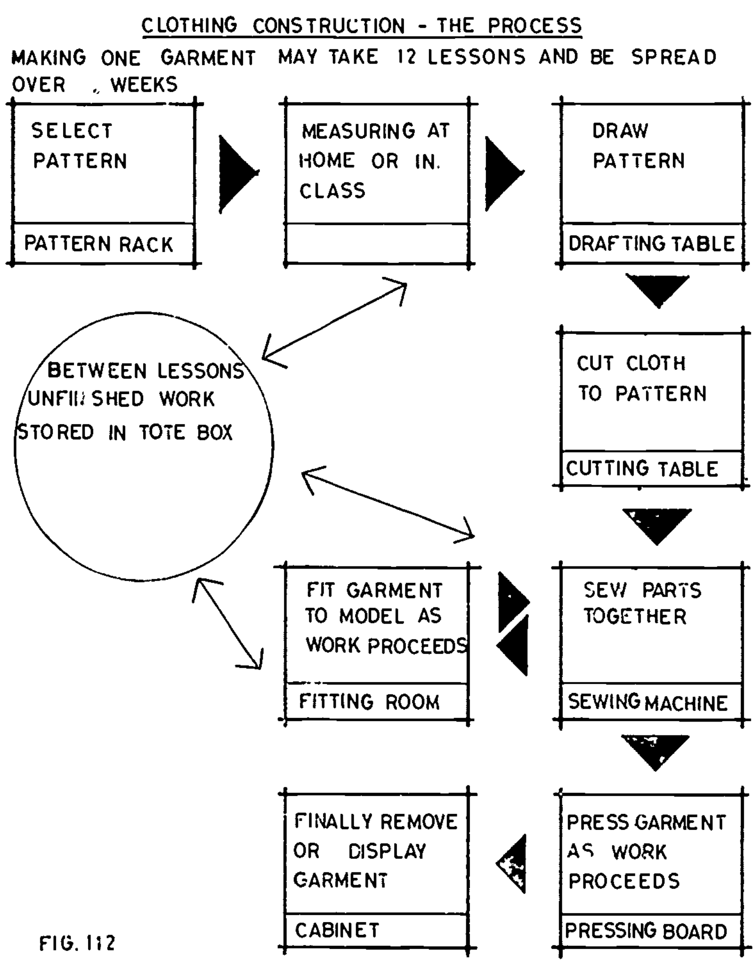


FIG. 112

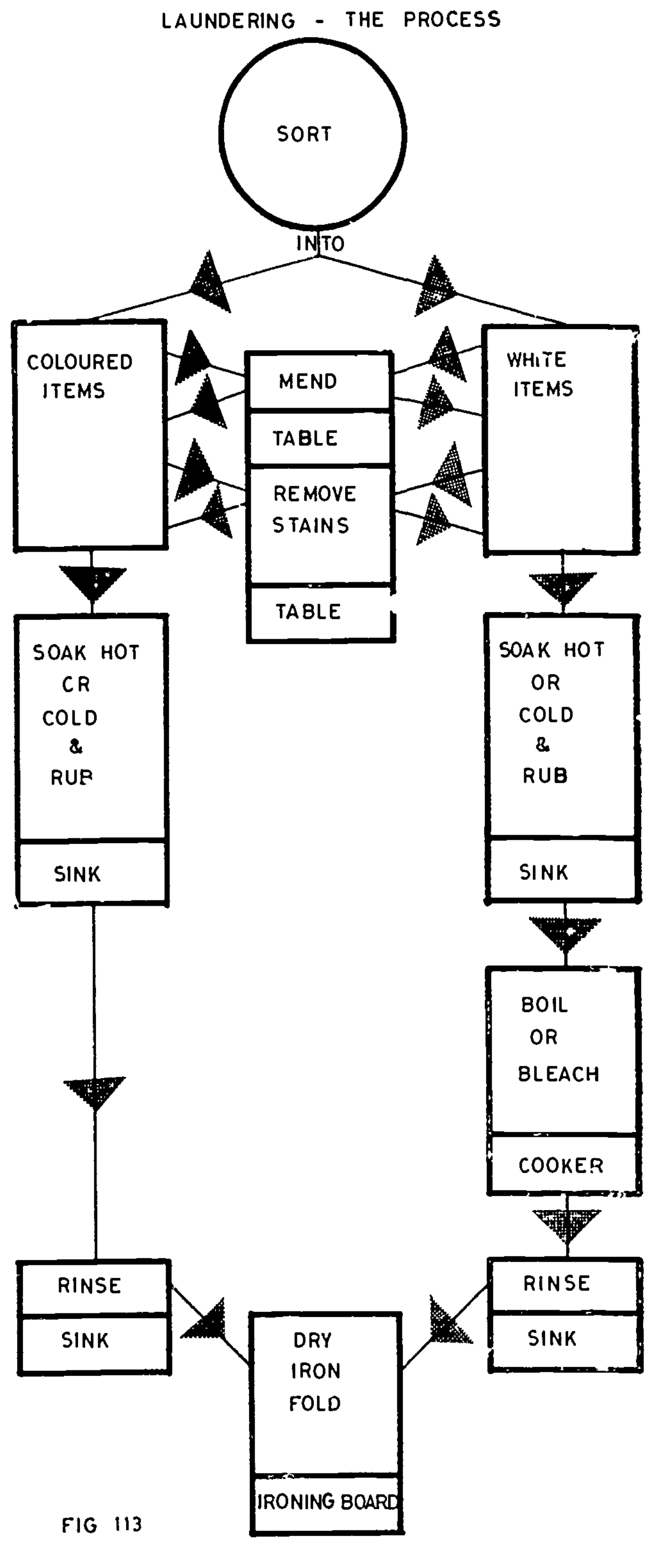


FIG 113

The more common home science laboratory comprises a single space designed for all fields in the area of study – that is foods and nutrition, clothing etc. This is a practical solution in schools where either mixed classes of 40 boys and girls are divided, approximately into two groups of 20 children, each group concurrently studying either industrial arts or home science. A single space is also practicable where home science is an elective subject and the numbers in the class are small.

In a girls' school, however, where classes of 40 remain undivided for home science, it is very difficult to provide one space to serve all activities. Figure 115 shows such a laboratory arranged for teaching and learning in clothing and textiles, laundering, foods and nutrition and family living. It might be wondered why it is necessary to rearrange the laboratory for simultaneous activities by all children in one area of activity at a time. The reason is that there are very few trained home science teachers in the region and certainly not enough either now, or in the forseeable future, to allocate more than one teacher per class. To teach 40 girls at a time – sometimes as many as 50 – is an herculean task and certainly one which there is no point in making even more difficult by conc[illegible]y, attempting to allow them to study four di[illegible]reas in the field, in 4 groups of 10.

If the curriculum allows for courses in the four subjects mentioned above in rotation, allocating one term for a subject, one multi-purpose laboratory needs to be re-arranged only every 8–9 weeks. The large multi-purpose laboratory of the type illustrated in Figure 115 requires about 3.19 m^2 per student place. It is obviously preferable to have separate laboratories for each area of activity in order to avoid the movement of furniture and storage problems associated with very large, multi-purpose laboratories. The feasibility of this will depend on the space periods requirements for home science teaching in the school.

In a lower secondary school, grades VII, VIII and IX with 2 periods per week of home science, for a single stream school – that is, a school with one class in each grade – the space periods required would be:-

2 x 3 = 6 periods

One laboratory would be available for 75% of the 40 period week, that is for 30 periods. As only 6 periods are required, a separate laboratory could hardly be justified and the subject would have to be taught in the classroom. Ways of arranging this for home science, science, industrial arts etc. are fully discussed in chapter 12.

Five or 6 stream schools would be needed to justify one multi-purpose laboratory for home science when the periods per week allocated for this topic are of the order of 2 or 3.

It can be said generally that:-

(a) Where the number of periods allocated per week for home science is of the order of 2 or 3, then, in rural areas, one multi-purpose laboratory will be needed and in large urban schools, one (or more) specialist laboratories for each of the 4 main subject components of home science can be fully utilised.

(b) Where the number of periods allocated ranges from 5 to 10 or more, then in all but the very smallest schools, separate specialist laboratories for the 4 main subject components can be fully utilised.

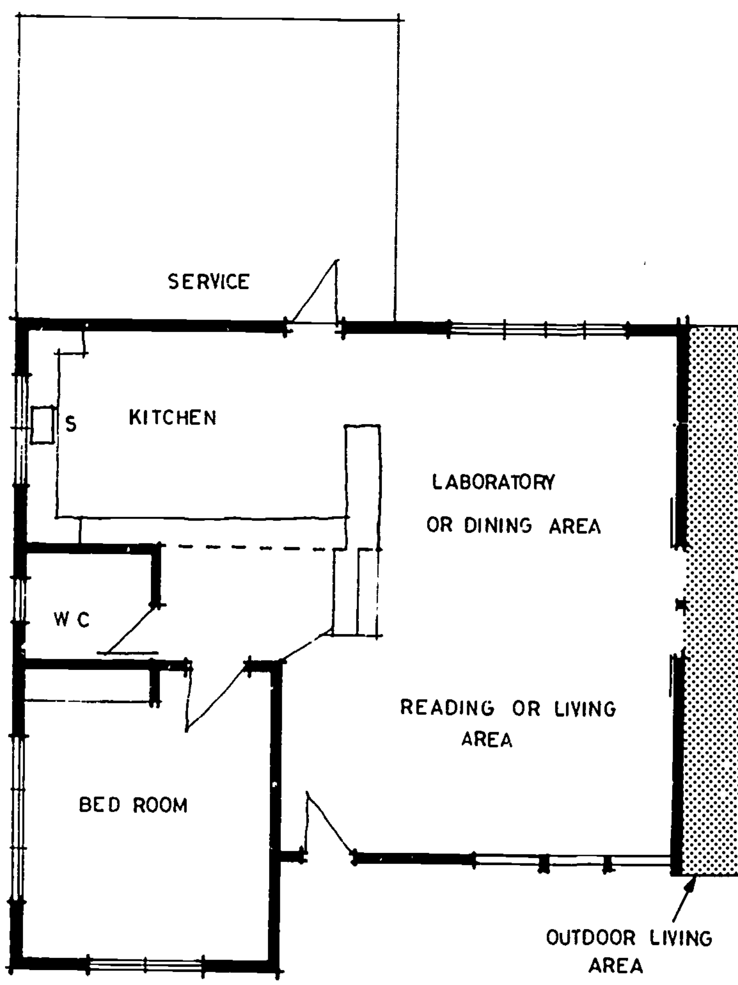
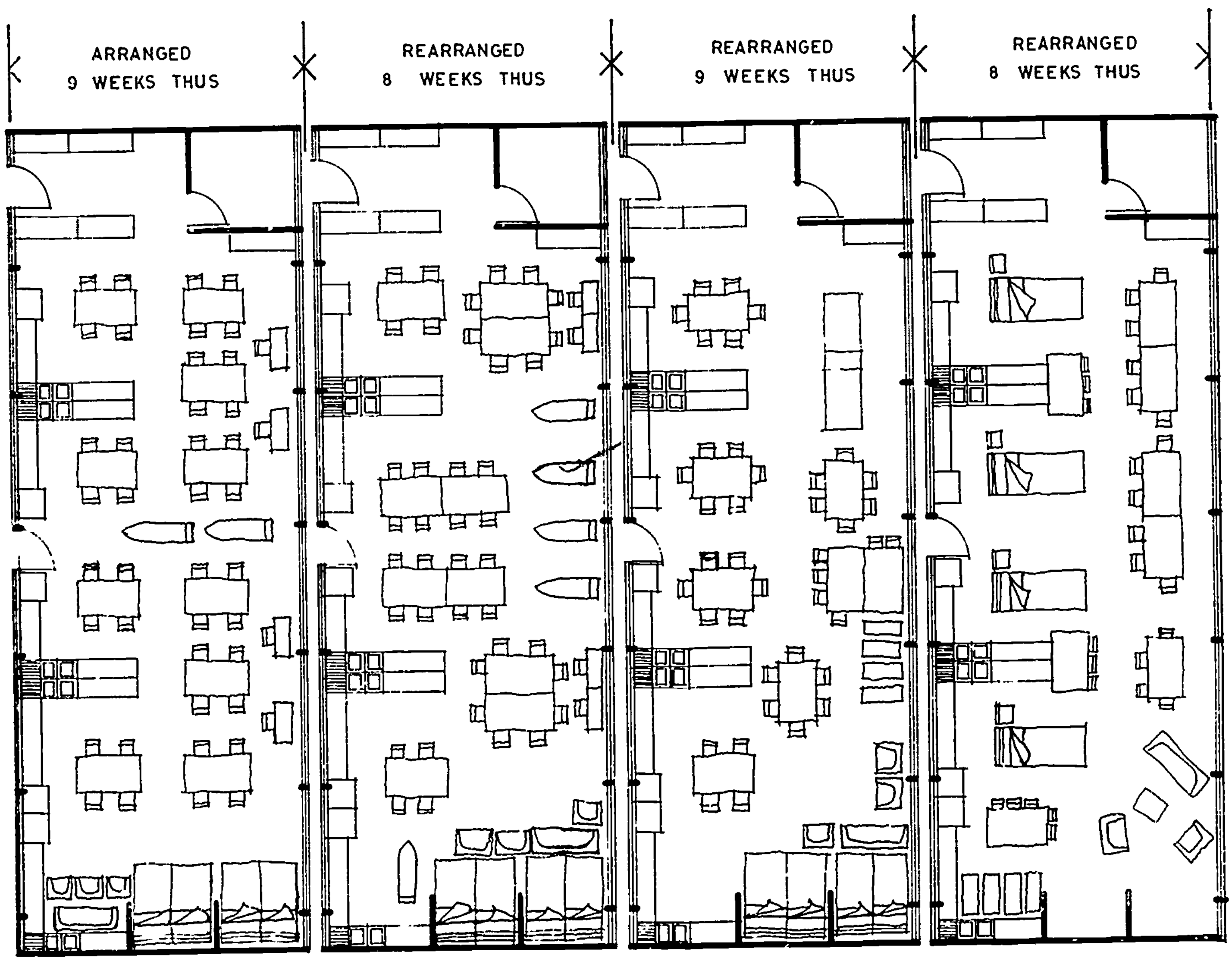


FIG 114



ARRANGED FOR :-
CLOTHING & TEXTILES — LAUNDERING — FOODS & NUTRITION — FAMILY LIVING

FIG 115

Plate 23

10.02 Laboratories for Clothing Construction and Textiles

The term "clothing laboratory" refers to a space used for teaching subjects, variously described in the Asian Region as needlework, sewing and dressmaking or clothing. This section deals with the furnishing and design of a laboratory in which these subjects can be taught.

The laboratory and its furniture provide facilities in which a course in clothing can be conducted according to a specific syllabus. A number of syllabuses used in the Asian region for this subject have been studied and their main elements incorporated in the following sample which will serve as a guide to designers of textiles and clothing laboratories:–

- The need for clothing; classification and manufacture of fibres; processing of yarns; knowledge of fabric finishes; suitability of materials for clothing;
- Choice of clothes, colour, style, occasion; selection and purchase of materials;
- Seams and stitching; design of embroidery in needlework; body measurements; pattern drafting for simple garments; use and care of equipment including sewing machine; construction of simple garments (night-dress, petticoat, boy's trousers, child's frock, woman's jacket, simple frock, knitting, making cushions and chairbacks);
- Renovation of old clothes; storage of clothes and fabrics.

The activities in this laboratory will, as seen from the foregoing, include the complete manufacture of clothes by machine or hand from the initial stages of the measurement of a person to the final pressing of the finished garment. Some laboratories will also include provision for the simple study of textiles. Plate 23 shows a clothing laboratory in Singapore. The complete range of activities, connected with the manufacture of clothes is shown diagrammatically in Figure 112.

As these activities will be spread over several lessons, it will be necessary to provide storage space for paper patterns, material, partly finished and finished garments.

The minimum equipment for a clothing laboratory will probably include the following items:–

Article	*Description*	*Quantity*
Stored in Storage Unit		
Skeins or spools of thread	assorted	variable
Needles, pins, fasteners, thimbles	assorted	variable variable
Pin cushions	variable	20
Tape measure		4
Measuring stick	length 1m	4
Tracing wheel or tailor's chalk	17cm x 2.5cm (tracing wheel)	4
Dressmaking shears	28cm x 10cm	4
Embroidery scissors	stainless steel, 7cm	20
Located in Laboratory		
Sewing machines	hand-operated	4
Sewing machines	treadle type or electric	
Ironing board	with pad and cover	2
Iron	charcoal or electric	1 per ironing board
Sleeve board	with cover	2

More fully equipped laboratories may also have:–

Folding rules	Curved rules
Embroidery frames	Neck and arm hole guide
Full-size dressmakers forms	Triple mirror
	Dress stand
Sleeve ironing boards	Pattern books and magazines
Seamboards	Visual, aids - flip charts
Water bowls	Loose charts, cards

These items are such as to require small drawers for storage (chalk, scissors, pins, cotton and the like), shelves (books, magazines) and larger drawers (visual aids). The remaining larger items requiring much more space are sewing machines, ironing boards, mirrors and dressmakers' forms. Of these, the largest space is required by sewing machines, and the number of machines provided will greatly influence the final size of the laboratory. Ideally there should be a machine for each student but at present and indeed, in the immediate future, provision on this scale in Asia is most unlikely. In one Asian country most clothing laboratories have one machine per two students but in most countries there are unlikely to be more than two to four machines for a class of forty.

It is clear that, as the study of home science develops, more machines will be used and provision should be made for one machine for four students with space for more machines if needed.

Furniture

The furniture required in the laboratory can best be considered in the order in which it is used

...for drafting and cutting

The size of the drafting and cutting space required by each student will depend on the size of the garment being made. Flexibility is required and this can be achieved by grouping four students at one table so that a piece of material may overlap from one student's working area to the next. The tables are so made as to hold the tote boxes of the four students using the table. (see below).

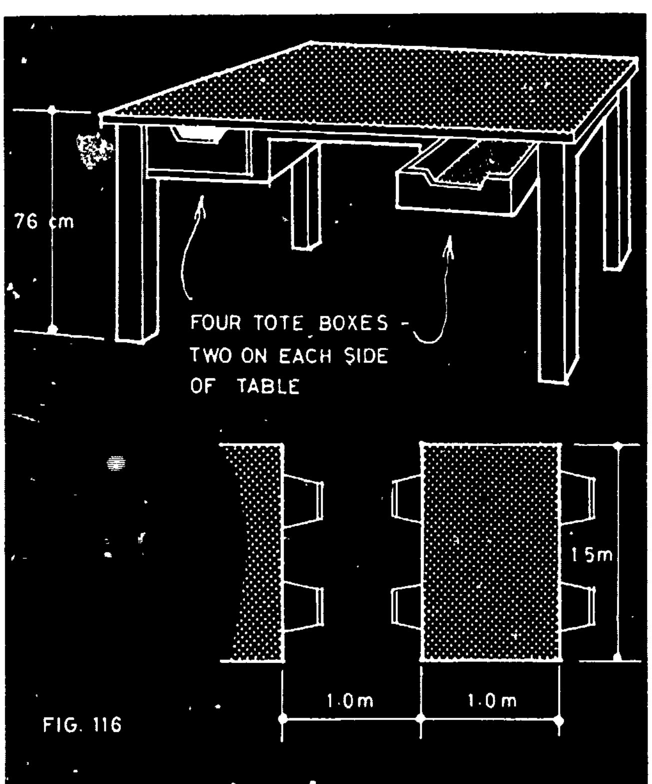


FIG. 116

The basic working area recommended for four students is 1.50m² provided by a table 1.0m x 1.50m (Figure 116). There should be not less than 1.0m between the tables. The height of the table should be 0.76m to allow for standing and sitting work.

As it will take several periods to complete a garment there is thus a need between one period and the next, for each student, to store paper patterns, cloth, personal needles, thread and record cards.

For this purpose each student is provided with an open wooden box or plastic tray in the form of a drawer called a "tote box".

On coming into the laboratory, the box, which is stored in an open storage unit (Fig. 117) is carried to the drafting and cutting table where it is slid into a recess provided for it. At the conclusion of the period it is taken back to the tote box storage unit where it is kept until the next period.

The number of tote boxes will thus equal the total number of students using the laboratory during the week, while the number of table recesses will be equal to the number of students using the laboratory during any one period.

As a tote box is a portable drawer fitting into both a storage unit and a table, if made of timber, it will possibly wrap or twist if not carefully seasoned; thus care should be taken to make the recesses, into which it will fit, slightly larger than would normally be the practice in constructing drawers and recesses. On the other hand, a plastic tray which, because of its light weight and dimensional stability forms a useful tote box, should fit into any recess made for it.

...for sewing

Sewing may be done by machine or by hand. If by hand, the student could sew at the drafting and cutting table. Sewing by machine may involve the use of either a hand, treadle or electric model. The treadle machine is usually built into a separate table. Hand and electric machines are more commonly portable and can thus be used at any convenient place in the laboratory. However, as a number of special accessories are required with the machines, it is more common to locate each machine, whether a portable, electric or hand model at a special table.

The area requ'-ed for a machine located on such a table will be very approximately 50cm x 80cm when the machine is not in use and when in use this may increase in the case of a treadle machine, depending on the design of the table, to 0.50m x 1.13m (Figure 118). In positioning the sewing machines, care should be taken to arrange them near the window to give the high level of illumination needed for fine work and at right angles to the window so that when the student looks up, she does not look straight out of the window and experience glare from the sky (Figure 118).

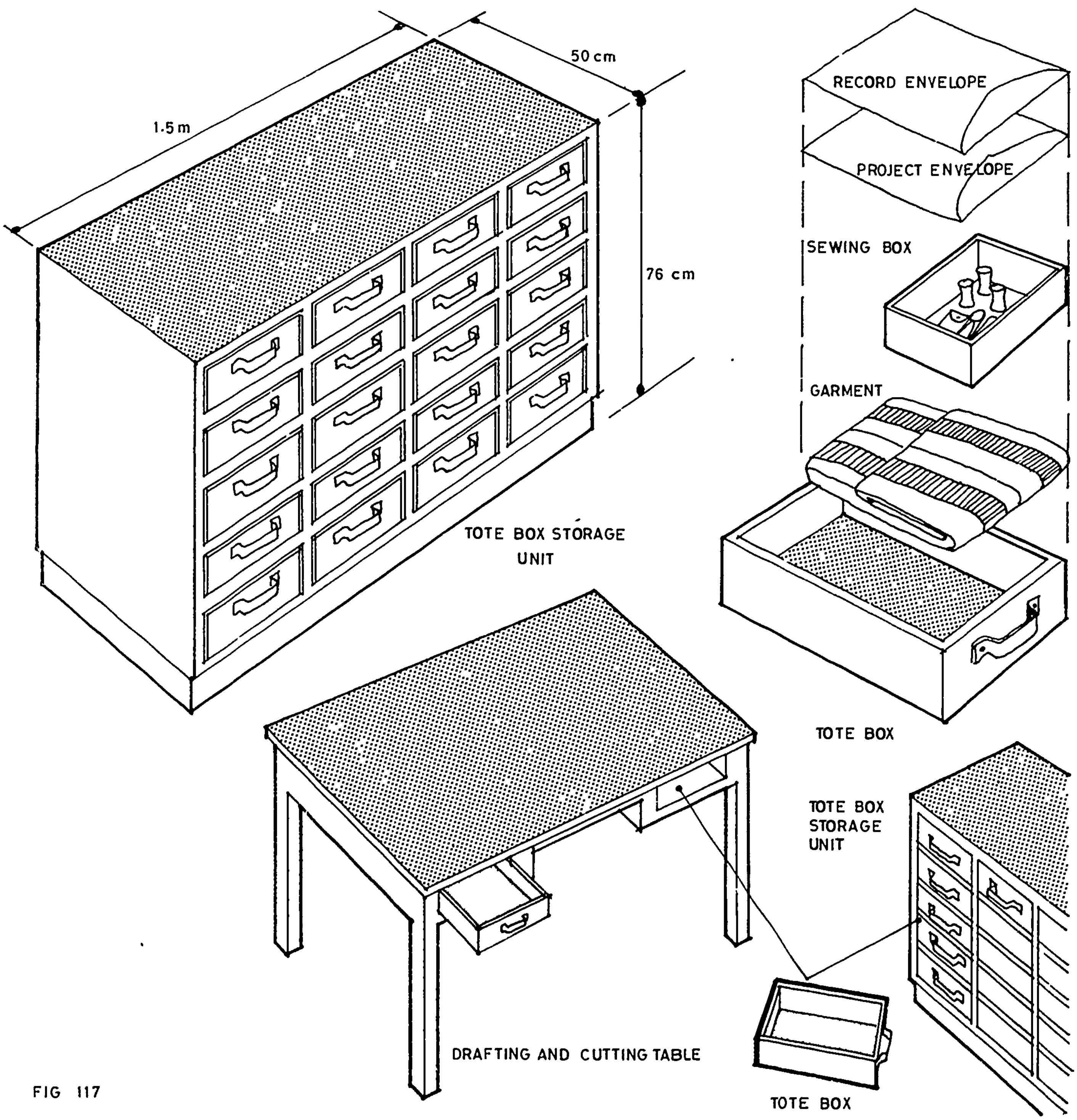

1.5 m
50 cm
76 cm
RECORD ENVELOPE
PROJECT ENVELOPE
SEWING BOX
GARMENT
TOTE BOX STORAGE UNIT
TOTE BOX
TOTE BOX STORAGE UNIT
DRAFTING AND CUTTING TABLE
TOTE BOX

FIG 117

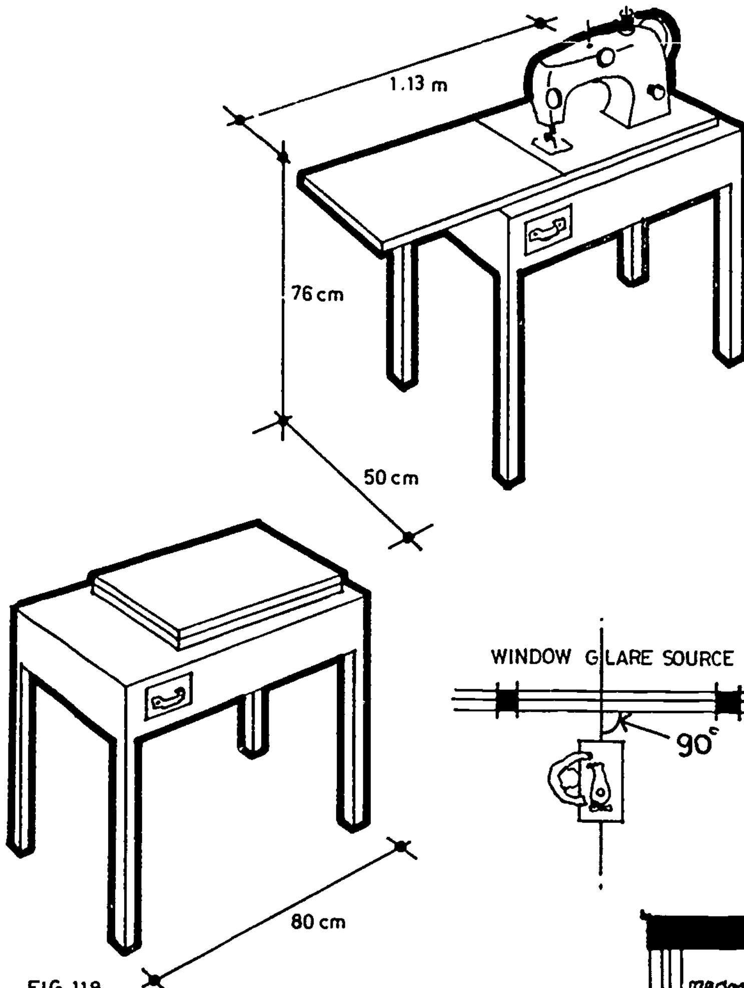


FIG 118

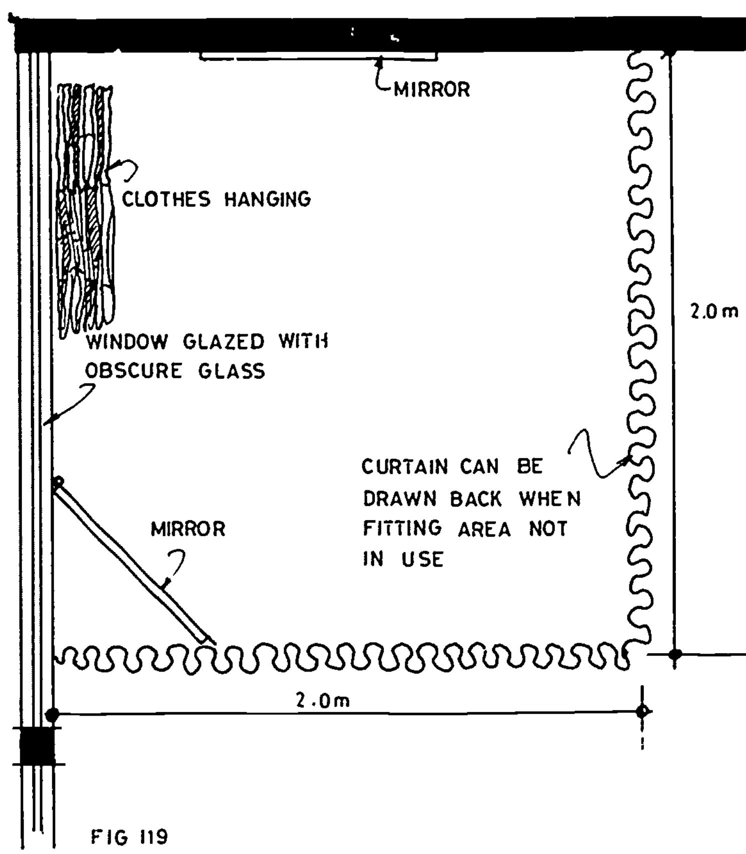


FIG 119

...for fitting and hanging

When the garment is in the final stages of construction, it is fitted to the student. A small screened and private area is required for this. At least two full-length mirrors should be provided and arranged so that a three dimensional view of the garment can be given.

Facilities should also be provided for hanging a few complete garments in the fitting space. The space itself need not be enclosed by fixed walling. Portable screens or curtaining are quite adequate as well as less costly and permit more flexible use of space (Fig. 119).

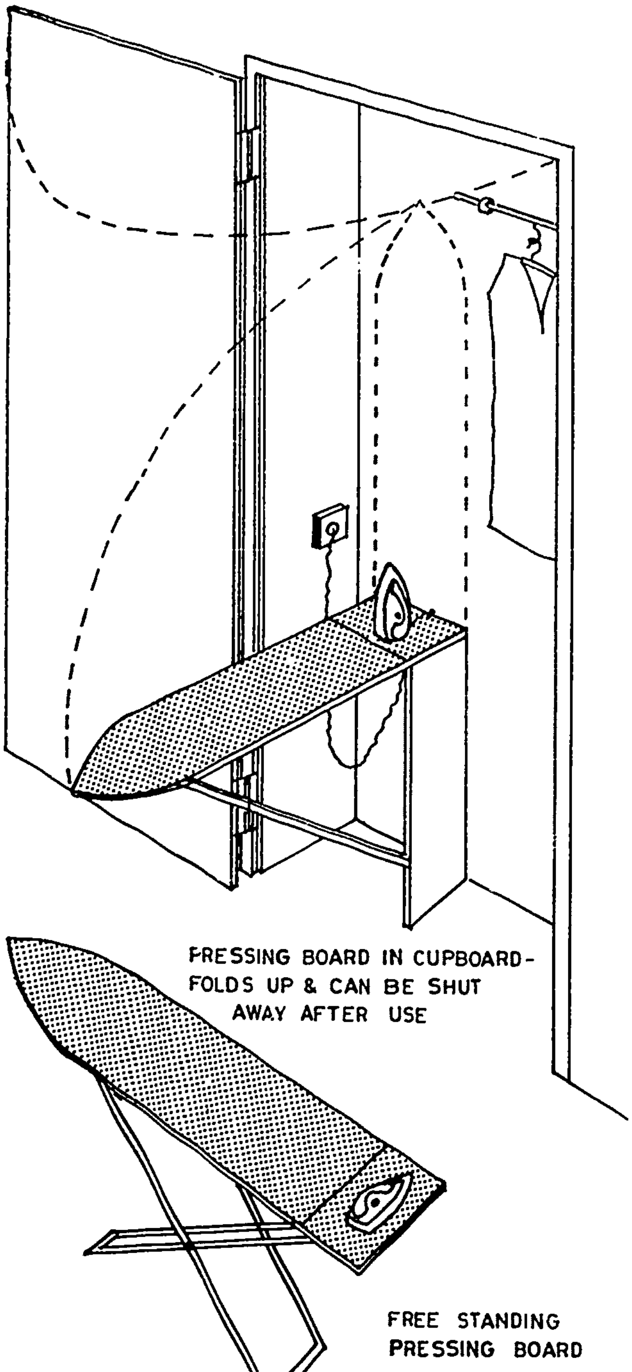


FIG. 120

..for pressing

Once the garment has been cut, it will be necessary to press the material at various intervals during the sewing process. Pressing will also be required before fitting and at the completion of the work.

This activity, facilities for which should be located close to the sewing machines, is carried out on a pressing board about 1.30m long and 0.35m in width. The height of the board should be 76cm above floor level. Pressing boards may be portable or hinged to the wall. When well-fixed, they may be raised when not in use and shut in a cupboard. At one end of the board, an asbestos pad is fixed on which to place the hot iron. A right-handed student will face the board with the pad and iron on the right. This fact is important as sufficient space should be left for this purpose. On the far side of the board about 10cm are sufficient to allow the pressed cloth to hang down as pressing proceeds (Figure 120). Irons used for pressing may be heated by electricity, kerosene or charcoal.

..for study of textiles

In some countries, study of textiles forms a part of the clothing syllabus. This study will involve examination of fibres, simple dyeing theory and the like. There should be a sink and bench top for this work with a small rack for bottles of dyes and reagents. Under the work top a lockable cupboard will be required for a small microscope and laboratory glassware (Fig. 121).

..for storage

Storage for the smaller items of equipment and visual aids listed in this section should be provided in a single unit the top of which can be used as a teacher's demonstration desk.

One larger drawer will be adequate for charts and the remaining small drawers for chalk, tape measures, scissors and the like. The desk top should be provided with a hinged flap to increase its area for use when drawing and demonstrating the cutting of larger patterns.

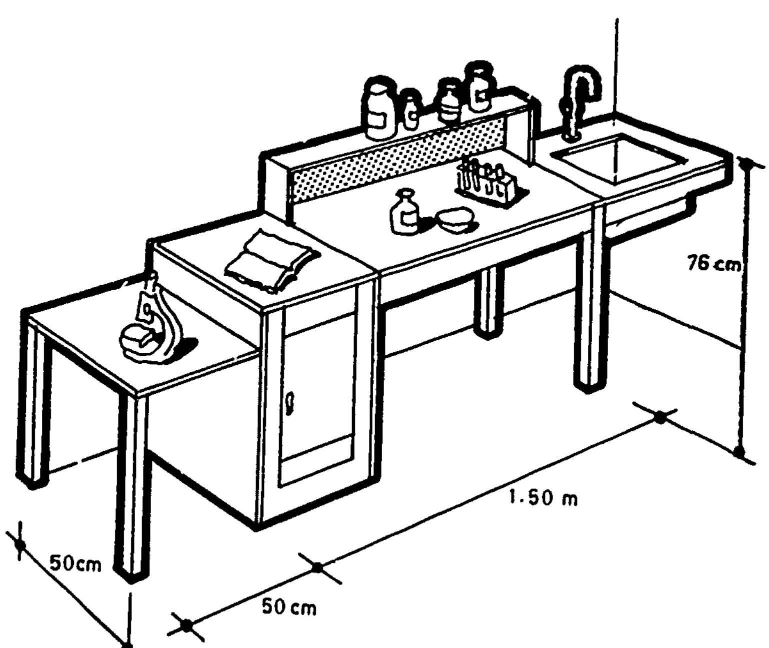


FIG.121

Figure 122 shows suggested alternative arrangements of clothing laboratories. Two sizes of laboratory are shown, one for twenty (Figure 122a), and one for forty students (Figure 122b).

The area required for twenty students and one teacher is about 3.00m per place. For forty girls, a total area of about $100m^2$ is required; that is $2.50m^2$ per place. "The larger the class, the smaller the area per place required" is an invariable rule in design and it is certainly more economical as far as building costs are concerned, to have a teaching space for 60 students with three teachers rather than three separate spaces, one for each group.

However, there may be certain educational objections to such arrangements.

Attention is drawn to the way in which the cutting and drafting tables are centrally located and closely linked with the sewing machines which are always placed near windows for maximum illumination. It is also of importance to note that, although the solutions are given for classes of twenty and forty students, the tote box storage required will need to be large enough to provide boxes for every student using the laboratory throughout the week.

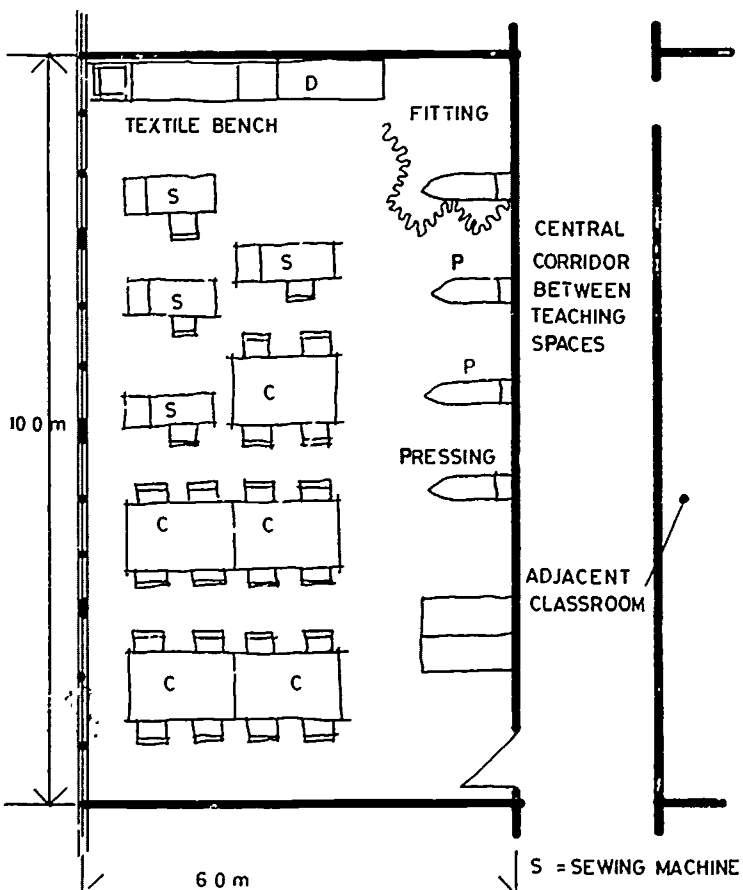


FIG 122 a

The designs show sewing machines in a ratio of 1:5 students but spaces for one or two additional machines can be found in each plan. As far as the pressing boards are concerned, they have been shown in the lowered position but it should be remembered that when they are not in use, they will be stored vertically. These boards can, moreover, usually be moved about the laboratory and the position shown in the drawings is simply that which is thought best. Where the irons used are electric, then boards must be located close to power outlets.

10.03 The Laundry

The laundry is a teaching space where the principles of laundering are taught. Laundry may be done either by hand or by machine. It may be that in future, simple hand-operated machines will be introduced into rural schools having no electric power supply. However, since the more customary method in Asia is hand washing, the design of the laundry in this chapter is based on the laundry-by-hand practice.

A separate syllabus for laundering is issued in only one or two Asian countries. Most education authorities prefer to consider the subject as a unit in the General Home Economics syllabus or as an aspect of the care of clothing in the Clothing and Textiles syllabus. Where this is done, it will be necessary to increase slightly the size of the clothing laboratories suggested in 10.02 above.

A study of several syllabuses for laundering and the laundering as element in more general syllabuses shows the main features of laundering as taught in second-level schools in Asia to be as follows:-

Reasons for washing materials; effect of dirt and perspiration on materials; properties of cotton silk, wool, linen and synthetics;
Selection and use of various soaps; hard and soft water, softening of hard water; use of detergents; preparation and use of starch;
Study of stains; removal of typical stains; washing, starching and drying of a variety of materials cottons, rayons, silks, synthetics;
Dry-cleaning of woollens, ironing.

The laundering process involves sorting, washing and ironing. These may be further broken down as shown in Figure 113.

The basic equipment required in laundering is as follows:-

- Basins – 50cm x 20cm
- Boilers, capacity up to 42 litres
- Charcoal irons and charcoal storage bin
- Kerosene irons and kerosene storage cans
- Electric irons
- Ironing boards 1.35m x 0.35m with covers and pads
- Pails, capacity 10 litres
- Laundry lines
- Drying and hanging racks
- Floor mops

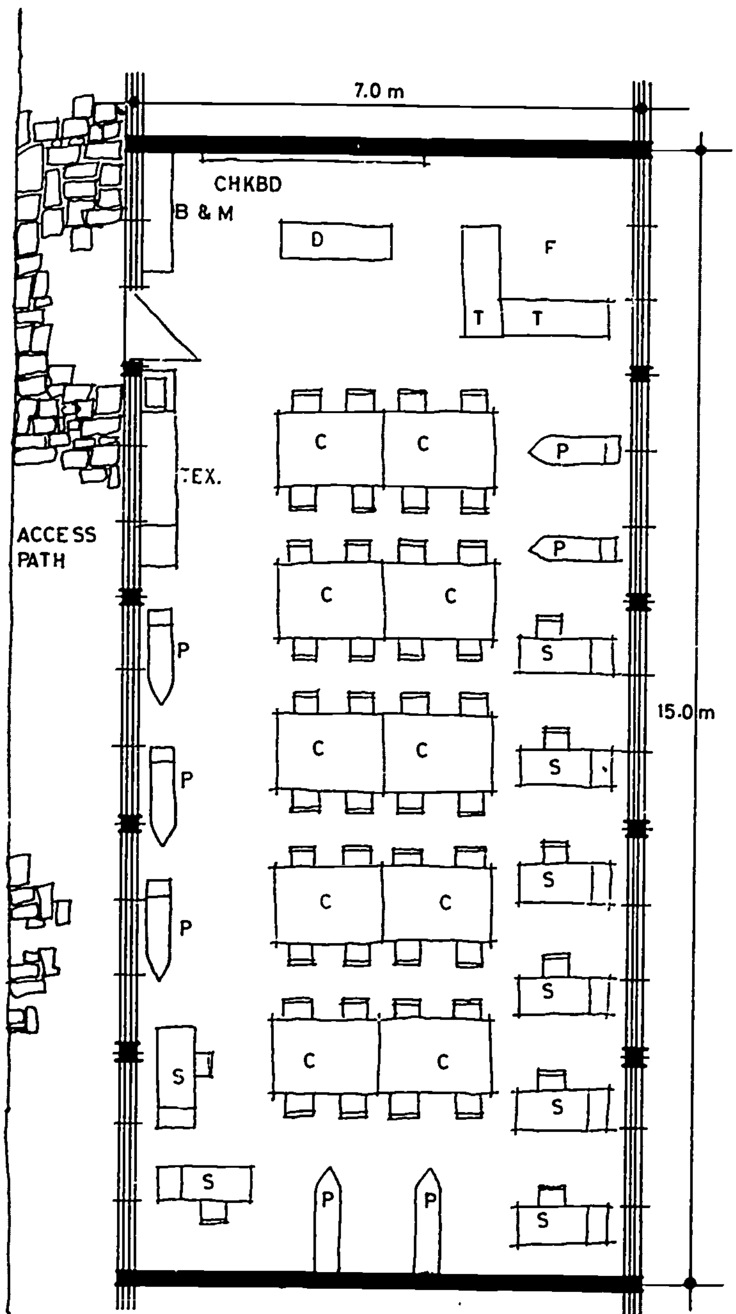


FIG 122 b

A limited amount of furniture is required in relation to the activities in the laundry. For sorting, tables are needed (Fig. 123) with shelves for storage of mending materials and stain removal reagents. These sorting and mending tables, can also be used for ironing and, where electricity is available they should be equipped with a socket outlet.

Washing and rinsing require sinks. If piped water is not available (and it is most frequently not) then it will have to be brought from a well for washing, and also for rinsing. In fixing sinks the important point to remember is that most of the work is done nearer the bottom than the top which should therefore be above normal work top height: 58cm is a good height for the bottom of the sinks for a comfortable standing posture.

The top edge should not be more than 80cm above floor level.

On one side of the sink, a low work top is required and on the other a drainer should be provided.

Boiling of clothes will require either built-in boilers fired with wood or more convenient kerosene or gas stoves on which can be placed a small boiling pot.

Boiling stoves in the ratio of approximately one stove to seven students is a reasonable provision. Figure 124a illustrates a boiling and washing unit.

For ironing of the washed items the pressing boards as illustrated in Figure 120 on Clothing Laboratories can be used. Spaces for hanging freshly ironed clothes will add convenience to the work at this final stage of laundering.

When laundering is taught in a small section of a multi-purpose laboratory then the wood, gas, kerosene or electric stoves provided can be used both for the cooking which forms part of the foods and nutrition course and at other times for the boiling of clothes as part of the laundering course.

Similarly, the pressing boards can be used for both the clothing and laundering courses.

Laundering in the tropics is an activity which is more often carried out in the open than indoors. Two types of laundry can thus be suggested for schools, the first entirely inside the building and the second with the wet part of the process located outside in the shade. There are several advantages to the latter arrangement. Not only is the daily soaking of floors inside the building avoided but also in the many rural areas where water for washing is drawn from a nearby well and where wood fuel is used for boilers, the students will not have to manoeuvre heavy buckets and bundles of wood through doors and between furniture to the sinks and boilers. Moreover, once the washing of garments is completed outdoors, they can be hung to dry, again without movement from inside the building to the outside drying areas.

Figure 124b shows suggested arrangements of laundries, and includes an outside laundry which is much cheaper and more functional. In this example only the sorting and mending tables, pressing boards and storage cupboards are enclosed in a lockable space. The washing and drying is arranged under an outside covered paved area. Students would wash in plastic or other bowls which could stand in a trough or sinks. Wood fired boilers could also be located in this covered area. This arrangement has the advantage of excluding the wet processes from the building. In the drawing where the entire laundry is in the building, it would be wise to lay the floors to slope to a drain or towards the doors so that the excess water spilt whilst washing can easily be swept away.

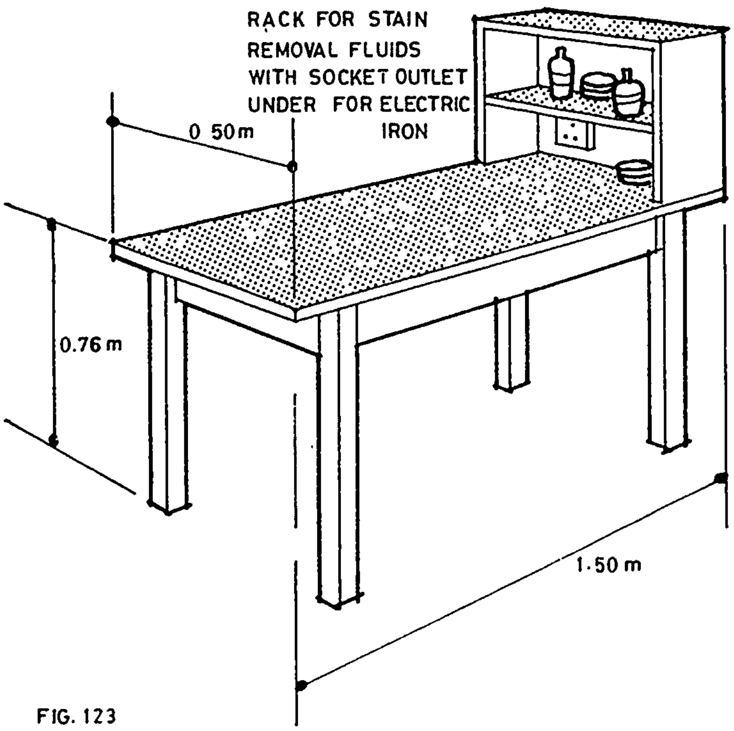


FIG. 123

In each plan, an outside open paved area is shown for drying and this too should be well sloped to throw water away from the building. Where heavy rain is common during the school day, the outside drying area can be covered with a light roof.

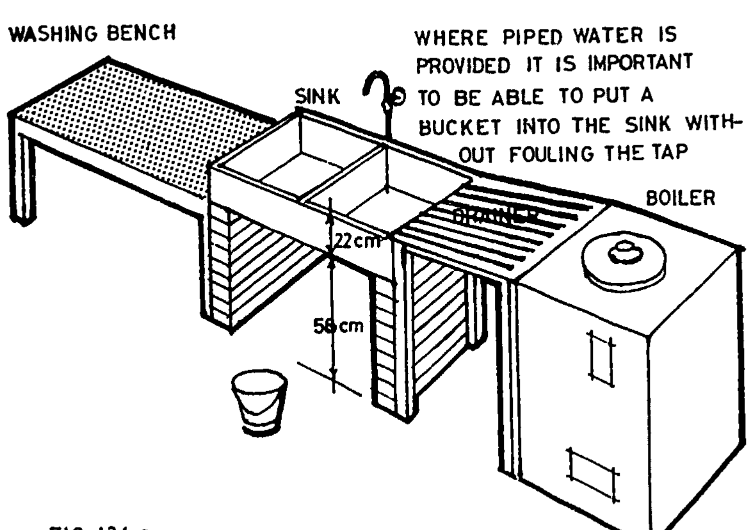
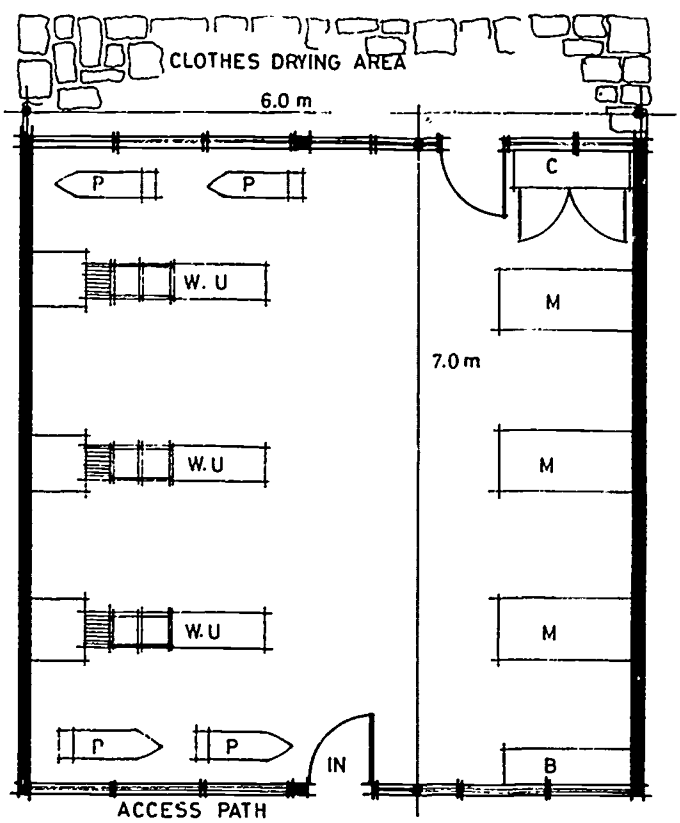


FIG. 124 a



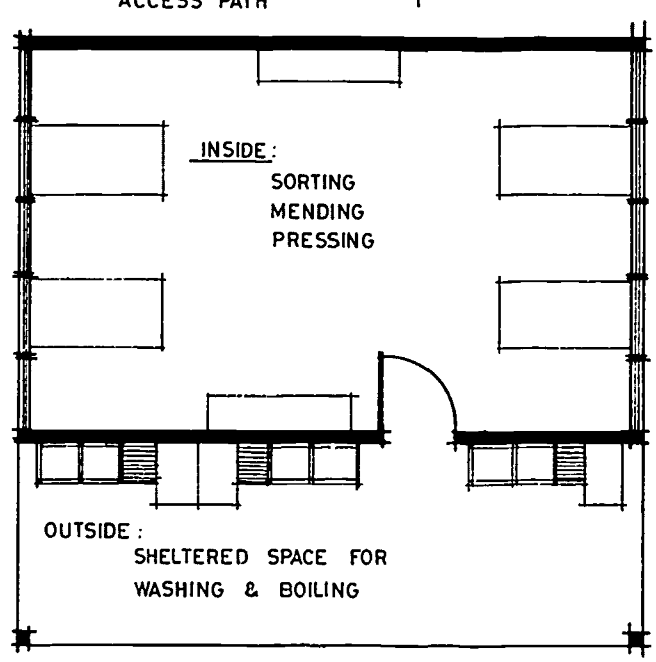


FIG 124 b

10.04 The Foods and Nutrition Laboratory

The foods and nutrition laboratory is a teaching space used mainly for the study of foods in one or more family cultures, as well as for courses focused on the nutrition elements of food and their utilisation or non-utilisation by the human body. The word "nutrition" has been used here although in third level education, a "nutrition laboratory" may be a special form of chemistry laboratory for advanced study of the nutritive elements of foodstuffs.

The foods laboratory is the one teaching space the equipment for which is greatly influenced by the cultures of the country. This study, which is intended for readers from Japan in the East to Iran in the West, from Mongolia in the North to Indonesia in the South, can only suggest general design principles for foods and nutrition laboratories and these principles will then need to be applied to the particular situation in the country for which the laboratory is being designed. For example, reference to a stove in the following pages may mean variously, an electric, gas or kerosene stove, a wood-fired stove, such as the Indian "chula", or a clay stove or clay-lined bucket in which charcoal is used for fuel, as found in Thailand. Some stoves require chimneys and storage for fuel. Others, such as the charcoal bucket stove, can be easily moved and located in a variety of places in the laboratory. It is clearly impossible in a book such as this to outline cooking customs for the whole of Asia, but it is possible to suggest the best location and the working area required for a cooker and this is what has been done.

A number of syllabuses for foods and nutrition courses in the Asian Region have been studied and although they differ greatly in detail, the general content shown below is common to all of them:-

— Nutrition value of common foods; carbohydrates, fats, proteins; vitamins and minerals; calculation of daily requirements of nutritive elements; simple chemistry in relation to cooking.

— Knowledge of basic methods of cooking: boiling, steaming, stewing, baking, frying, preparation of foods by different methods; preparation of foods needing little or no cooking; preparation of milk foods; preparation of pickles; preservation of nutritive properties of foods.

— Food hygiene; spoilage, preservation; storage; food substitutes.

— Planning meals; marketing and food selection.

— Planning and care of kitchen; merits of various types of kitchen equipment; fuels, stoves, ovens; safety in the kitchen.

— Serving of food; convenience, comfort, cleaning up after meals.

The activities in this laboratory include the planning, preparation and serving of food in family-size quantity and the study of food nutrients in relation to the human body. Experimental work on certain foodstuffs may also be done to illustrate physical and chemical reactions between and among food substances; between food substances and containers; effect of acids, alkalis, and salts, temperature and the like on the nutritive quality of food.

The group method of teaching is generally employed and students are usually arranged in "families" of from 4 to 6 students. Laboratory exercises are planned with the size of this "family" in mind.

Some work simplification principles utilised in industry and in the home are applicable to the design of teaching spaces for cooking food. Three of these are:

Decide what activities are to be carried out in the room.

Eliminate all unnecessary work (movement) connected with these activities.

Provide the best conditions for the necessary work.

With the limited time given for laboratory work, care should be taken to save as much time and energy as possible by good planning. It is suggested that a definite place for each activity be arranged and that by careful dovetailing of tasks the possibility of one space serving more than one activity be considered. Floor space should be adequate for students to walk around one another easily.

The stages in the preparation of a meal by one "family" of students in the laboratory, are illustrated in Figure 111.

In this arrangement, a "family" of six girls will each prepare a separate dish for a combined family breakfast or other meal.

The typical equipment for a food and nutrition laboratory of one country will differ from that of another. For example, in areas where coconuts are used for food, equipment will include special graters and coconut milk strainers. These will not be found in Mongolia or Korea. Neither will the tiered steamers used in China be found in Iran.

More fully equipped laboratories, usually in urban areas, may have some electric or gas equipment such as a refrigerator, electric or gas oven and electric mixing devices.

Plate 24

Certain guides with respect to location and stage of equipment relevant to the planning of this teaching space are given below:-

(i) Place some of the large equipment side by side or in storage units at angles to one another to shorten the walking distance when a particular item is required.

(ii) Storage space should be flexible and adequate to permit adjustment for varying sizes, amount and kinds of items. It should moreover be easily accessible, clearly visible and conveniently located. Work areas should be designed so that supplies on shelves can be seen quickly and grasped easily (See chapter 6).

(iii) Small, inexpensive items used at more than one place of work, should be provided wherever used, to avoid undue movement of students from point to point.

(iv) Store all items at or nearest the point of first use. It would be practical, for instance, to have saucepan, rice and measuring cup all located at the sink, or to have skillet, fats, salt, pepper and other seasonings, and pan covers, stored by the stove.

(It will be noted that this particular suggestion is radically different from the usual practice of storing equipment, foodstuffs and chinaware in separate cupboards located at different parts of the room.)

(v) For use of cleaning and better sanitation, particularly in warm humid climates, it would be preferable to store items above or at counter level, leaving the floor beneath easily accessible.

The logical placement of furnishings and equipment in relation to activities performed in this teaching space has the added educational feature of presenting students with time and energy saving procedures and devices.

Laboratory activities are generally centred round the larger equipment, and in a food laboratory the following areas may be identified: the sink for vegetable preparation or cleaning and dishwashing; the food-mixing area which might also have a refrigerator; and the cooking and serving area.

The word "area" in the preceding paragraphs has been used advisedly for, whilst in urban schools, tables, counters and work-tops will be included in the furniture of the laboratory, in the remote rural schools in countries where all cooking activities are traditionally carried out in the squatting position or sitting on very low stools, it is unlikely that sophisticated furniture will be provided. Thus in the following paragraphs when the words "counter" or "work-top" are used, they may be taken to mean a working space 76cm above floor level or a similar space raised some 10cm above finished floor level.

(a) Sink Area

This consists of sinks, drainboards, counter space at both sides of the sink, storage space for dishwashing supplies, utensils, a limited number of dishes, and a garbage container (Figure 125).

A double-bowl sink is highly desirable for washing, rinsing and draining dishes or for vegetable preparation. This should be large enough for a pan and a dish drainer with space at the side for emptying pans or dishes.

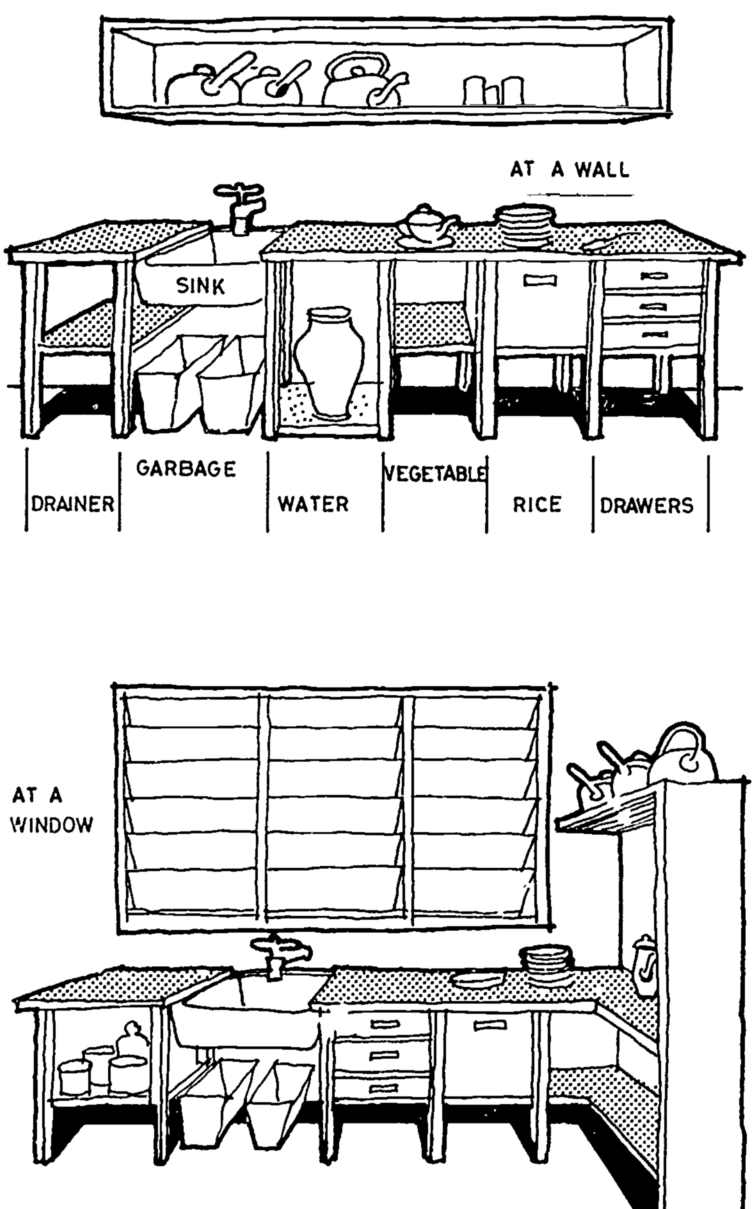


FIG. 125

A drainer 0.50m long on the left side of the sink bowl and a counter 1.50m long on the right side are recommended. The latter allows for stacking the used dishes and pans. It also suffices for activities requiring water.

From the sketches of this and other furniture, it will be seen that the drawers, rice bin and shelves are all mounted loosely on timber runners so that the whole unit or shelf can easily be drawn out for periodical cleaning. This is most important. Too much kitchen furniture is "fixed" in position and can only be cleaned with difficulty. The designer should always pay especial attention to this point. In places where piped water is not available, a water container will need to be provided. This can be placed either in front, or at the right-hand side of the sink. If it is a clay container, it should be set on a pan which will catch the moisture drops and thus avoid rotting of the wood counter.

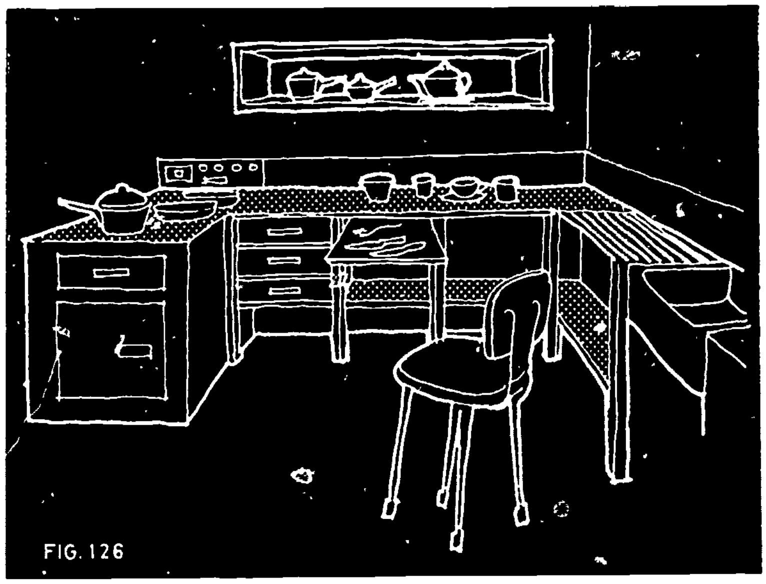


FIG. 126

Food mixing should be done away from the sink and requires work counters, possibly a refrigerator or cool box and storage space for most of the supplies and utensils used in the preparation of a meal. For a "family" of 4 - 6 students, the foodmixing counter would measure 1.5m x 0.5m and this assumes that of the "family" only two students at a time would be working in this space (Fig. 126). Additional working space might be provided by pull-out boards which could be used for slicing bread, meat or vegetables while the student sits.

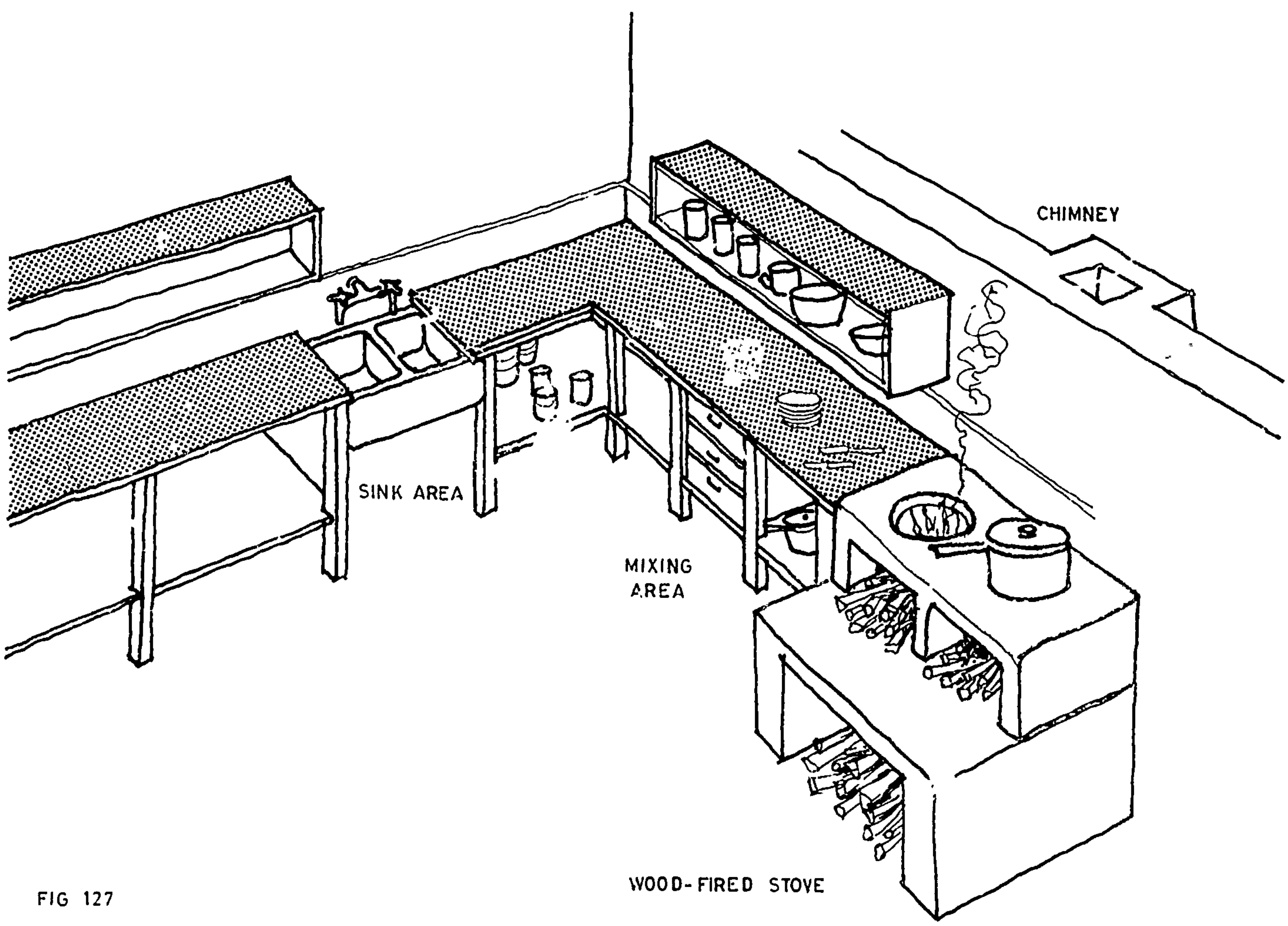


FIG 127

(b) Cooking Area

The area required for cooking is dependent on the type of stove and fuel used. Stoves may be designed to burn wood, sawdust or rice-hull, kerosene, gas or electricity. Wood, sawdust, rice-hull and charcoal are more often used in rural schools, while kerosene, gas and electricity are more common in urban situations. It has been observed recently that because of price and convenience, an increasing number of kerosene stoves are used in both the urban and rural areas of Asia.

Counter space on which cooking equipment or serving platters might be placed is desirable beside the stove. A minimum of 1.50m should be provided.

A hood constructed above wood, rice-hull or sawdust stoves will help clear the room of smoke. Storage space for firewood could be located at one end of the counter or under the stove where it will quickly dry, or, if the stove is located close to the back door, extra firewood could be kept just outside. Figure 127 shows an arrangement of a wood-fired stove. Storage space for utensils and supplies might be found on either side. Plate 25 shows an arrangement of a kerosene cooker.

Solid or liquid fuel stoves should, in hot humid climates, be arranged on a cross wall so that a breeze can blow across the students who are using the stove and work surfaces on either side of it.

(c) Storage Area

Although each of the activity areas mentioned above includes space for storage of items needed in connection with the functions of these areas, there remains the problem of storing uncooked and cooked foodstuffs, as well as special items not normally kept at the work area. Food, either in solid or liquid form, may become unfit for use due either to the heat or to the activities of insects, rats and mice.

As far as the need for cool storage is concerned, this may be resolved by the provision of one or more refrigerators; but in places where this solution is impossible then various types of unglazed clay pot and water are commonly used, the evaporation of water from the surface of the pot very effectively lowering its temperature.

Provision for storing a small battery of these cooling pots can be made under the central table on which food supplies are placed at the start of each lesson.

In those areas of Asia where rice is the staple item of the diet, it is likely to be purchased for each school in quantities sufficient perhaps for a school term. Rice in bulk can best be stored in a tin-lined wooden box with tightly fitting lid, secure against rats, mice and insects.

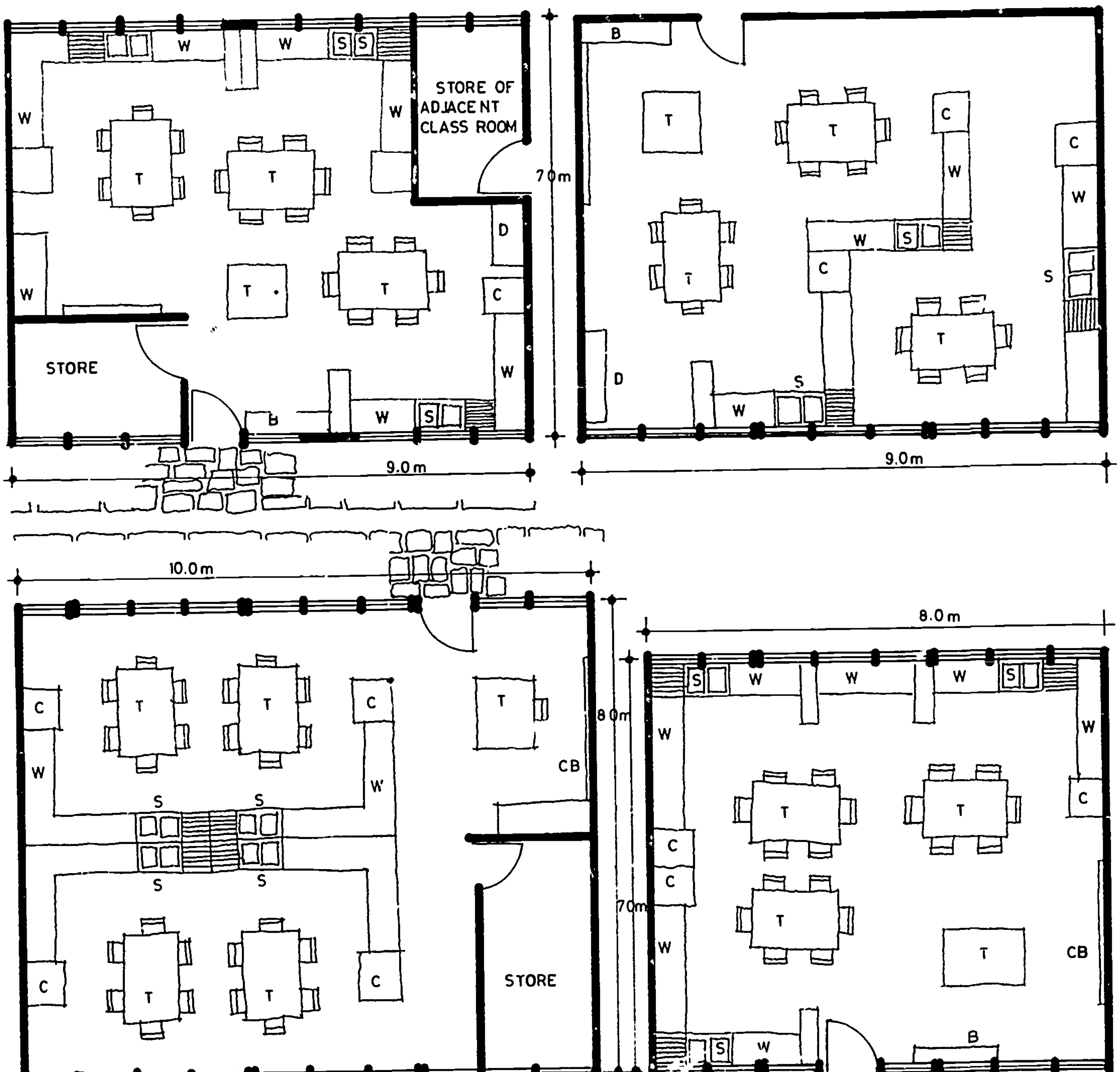
Smaller quantities of food such as dried fish, vegetables etc., either cooked or uncooked can be kept in a small, screened box or "safe" which can be hoisted free of

Plate 25

the floor by a rope hung from a ceiling hook at the end of each day. Vermin and ants will find it difficult to approach food stored in this way.

The "family" concept in the foods and nutrition laboratory results in the division of the total space in the laboratory into a number of smaller, self-contained spaces. Each family should be able, within its own space, to prepare, cook, serve, evaluate and eat a complete meal. Storage units above desk level will assist in creating the visual division necessary to provide this family atmosphere. Although the most economical laboratories will usually be rectangular, if opportunity occurs, small spaces created by adjoining units of accommodation can be used as family recesses as is shown in the 20 place food laboratory in Figure 128.

The arrangements suggested in Figure 128 are for two types of laboratory, some having cookers using solid fuel and either using gas, electricity or kerosene. Solid fuel cookers somewhat naturally restrict the location of the various elements of furniture. The solid fuel cooker needs a chimney and should be not too far from the doors through which the fuel has to be carried. Gas, electric or kerosene cookers permit more variations in arrangements as they can be located almost anywhere, although even with these cookers, ventilation to remove fumes and smells is important.



B	=	STUDENT BAGS	S	=	SINK
C	=	COOKER	T	=	TABLE
CB	=	CHALKBOARD	W	=	WORK COUNTER
D	=	STORAGE CUPBOARD			

FIG. 128

10.05 Family Living

This section contains suggestions for teaching spaces which could be used for courses dealing with the work and business of the home (home management, house-keeping, consumer education; the artistic aspects of the home (home decoration, home furnishing); health and sanitation (home nursing, health and hygiene, child care and guidance, mothercraft) and its social aspects (family relationships, entertainment). The space allotted for these courses should provide for a living room and flexible area for home nursing, child care, home furnishings, group discussion, demonstrations and film viewing. As with foods and nutrition courses, the activities in this laboratory may be influenced by the cultures of the country and thus the suggestions made here should be regarded as providing a planning framework rather than final solutions to the problems posed by detailed design for a particular situation

The syllabuses of the countries of the Region in this subject are very similar and include the following:–

- The family and its functions: role of the student as home-maker; basic human relationships.
- Housing: study of well-planned homes; use of colour in the home; flower arrangements; cushions; furniture; curios; pictures and accessories; lighting; water supply; provision and storage of drinking water; gas and electricity in the home; simple electrical repairs; refuse disposal; sewage, cleaning; floors, walls and ceiling; caring for wood, metal, glass and leather: cupboards, mats, lamps; household pests, insecticides.
- Planning and budgeting: the family budget.
- Care of the sick: types of beds, choice and cleaning; making beds; disinfecting the sick room; care of scratches; small cuts; bruises, minor burns and insect bites; metallic poisoning.
- Needs of a baby: foods, comfort, training; affection; vaccinations, inoculations, making toys for baby and children.

Students who take the more advanced courses in home science need space in which to put theory into practice. Principles of art, health and sanitation, and home management are better learned when practical opportunities are available to apply them.

The family living laboratory is, as will be seen from the above, something of a multi-purpose unit comprising accommodation for living, home nursing and child care. Typical equipment needed for each of these activities is as follows:–

(a) The living unit

Magazines	Sewing accessories
Knives	Brushes, paint and distemper
Scissors	Pails
Sewing machines	Ladder
Leather work tools	Simple carpentry tools
Basketry tools	Rug-making hooks

(b) The home nursing unit

Invalid tray	Tray, enamel
Hot water bag	Kidney basin
Ice cap	Medicine glass
First aid supplies	Water pails
Enema outfit	Bedpan
Forceps	Flashlight
Roller bandages	Backrest

(c) The child care unit

Toys and playthings	Children's toilet set
Children's furniture	Bedding
Toilet chair	Layette
Children's feeding kit	Toilet supplies
Feeding supplies	Medical supplies
Basins	Cups
Pitchers	Full size baby doll.

The furniture required for teaching and for storage might be as given below. Local customs and culture will determine precisely what is required and these lists are thus only a guide.

(i) The living unit

Sofa	Vases
Chair, armless	Framed Pictures
Side tables	Craft work benches
Lamps	Storage cupboards and drawers

(ii) The home nursing unit

Bed	Chair or stool
Night table	Table for demonstrations
Trolley	Storage cupboards

(iii) The child care unit

Baby crib	Table
Bassinet with storage drawer under	Sink and work counter
	Receptacle for soiled diapers.

As far as the living unit is concerned, a space will be needed in which furniture can be arranged in different ways and a table with drawers will be required at which to make rugs, cushions, curtains, toys, lamp-shades and the like. Figure 116 shows a suitable unit for four students making large articles. It could be used conveniently by six students working on small items such as toys. The problem of providing a facility in which students can practise distempering of walls and ceilings wall-papering and picture and furniture arrangements can be overcome by the provision of several small working bays. A group of two or three students can be assigned to each bay which they can decorate and arrange. Stimulation by competition and comparison of the work of other groups in adjoining bays makes this perhaps a more interesting way of encouraging work in house arrangement than the conventional living spaces located in a multi-purpose laboratory.

The home nursing unit centres round the bed and adequate space should be provided for demonstration, possibly with a group of students on one side of the bed and the teacher on the other. The child care unit can be arranged together with the home nursing unit as indeed would be the case in a normal home. Again here, there should be adequate space for small groups of children to watch demonstrations.

In areas where furniture is difficult to obtain and where space is at a premium, a divan can be used for a bed and for sitting and the design for all three units can be more closely interlocked.

As much standardised furniture as is possible should be used: for example, the tables in Figure 116 from the clothing laboratory are very suitable for craft work connected with toy-making and home furnishings. The work counter, sink and drainer unit from the foods and nutrition laboratory (Figure 125) is also suitable for the child care area where babies' foods are mixed. Figures 129a) and b) illustrate some family living spaces.

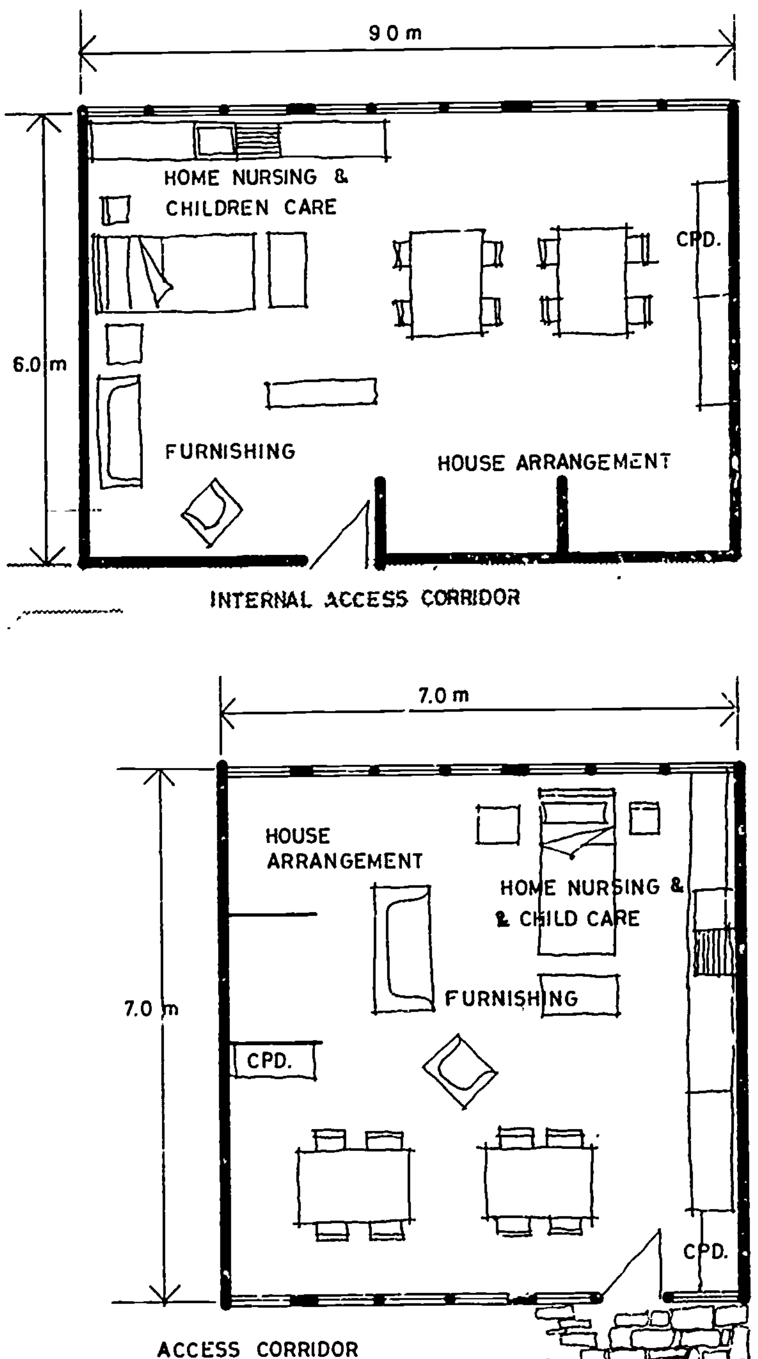


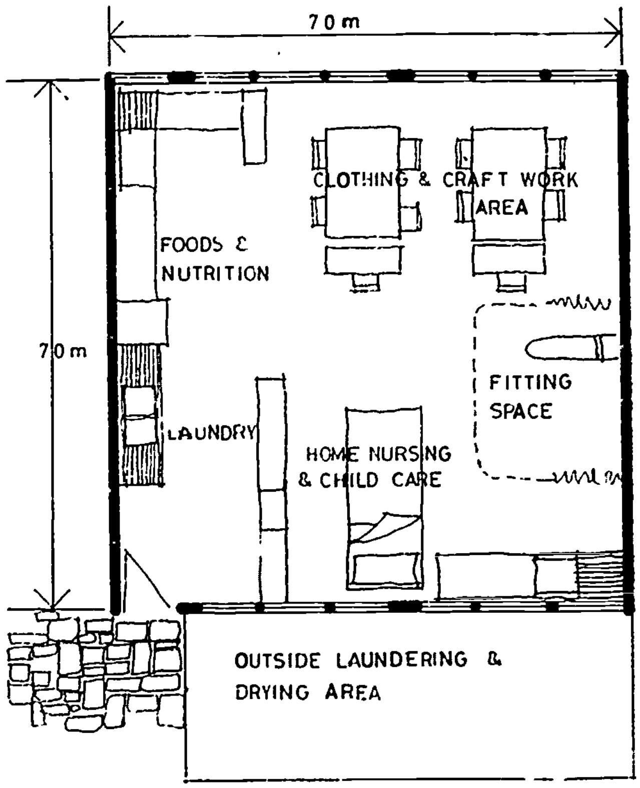
FIG. 129 a

10.06 Multi-purpose Home Science Laboratories

Many Asian countries are in the early stages of initiating home economics teaching. Moreover, at present the majority of laboratories are in urban situations. Although the accommodation described in the preceding pages provides only a minimum of furniture and equipment in the smallest possible areas, it will often be found to cost far more than can be afforded from a capital expenditure vote. One solution to this problem is to build, on a more modest scale, simple multi-purpose laboratories, in which can be taught most of the topics for which separate laboratories may eventually be planned as education in this field develops.

Such is the present practice in many Asian countries today. Indeed, the view has been expressed that "whether the Home Economics Department consists of one room or several rooms, the use for all space needs to be multi-purpose". Castaldi of the Massachusetts School Building Assistance Commission (10.4) refers to the old fashioned "practice of planning a separate 'foods room' and 'clothing room'" and suggests "a 'general home making room' (arranged) as if it were a complete cooking room and a complete serving room".

In co-educational schools where the numbers of boys and girls are roughly equal, a class of forty students will probably normally divide into two groups, the boys for woodwork and metalwork and the girls for home science. It is for this reason that designs for laboratories for 20 students have been suggested in the previous pages. Twenty students is a convenient teaching group and, in a multi-purpose laboratory, a competent teacher could plan for 6 students to work in the clothing area, 6 in the cooking area, one or two laundering, and the rest working in the family living section.



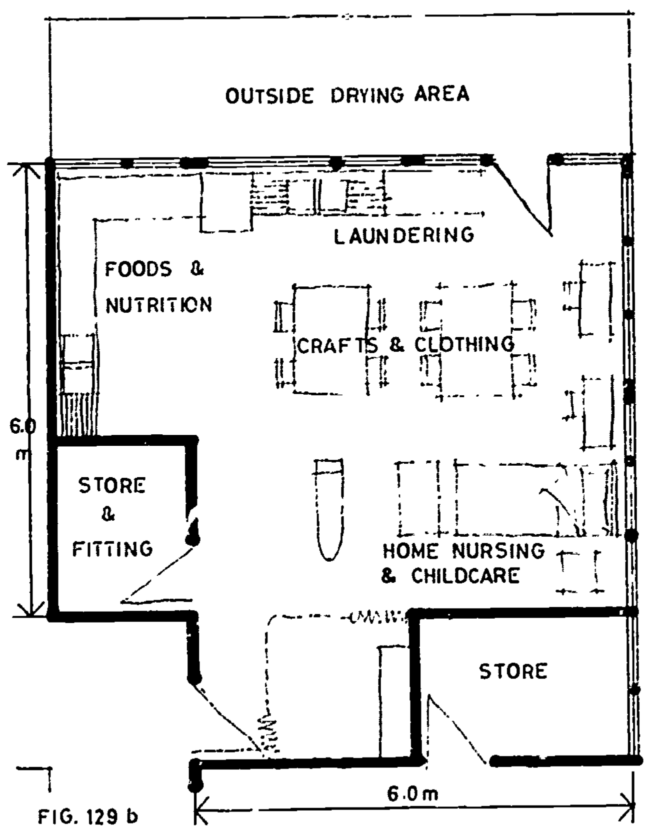


FIG. 129 b

In a girls' school, however, where normal teaching groups are about 40, then, as has been already mentioned, the entire group may study home science at one time. The problem then becomes one of adequate pre-planning of the lesson and of supervision. In such a case, experienced teachers indicate that whilst it might, for a large group, be possible to handle two courses such as clothing and foods in a large laboratory, it is more convenient to arrange a series of lessons for the entire class in one of the topics in the work programme. The design of a laboratory for this purpose will thus need to be quite different from that of the laboratory for smaller, multi-activity teaching groups.

One of the main conclusions that can be reached from the foregoing is that where teaching groups of 40 are envisaged, the furniture will be used for several weeks perhaps for clothing, then for several more weeks for foods and nutrition, and so on. This implies fixed storage units for each topic and a number of other units, multi-purpose in use and designed in such a way that they can be moved depending on the nature of the lesson. It is important that these units be designed so that they can be joined together in a variety of ways. For this reason, standard heights should be adopted throughout for table and counter tops, standard lengths and, as far as possible, standard widths.

The furniture discussed earlier in this chapter is suggested with this in mind: 76cm is the standard height adopted, 1.50m the standard length and 50cm the width. The 50cm dimension has had to be varied occasionally where specific tasks require a wide work space, but in such cases the wider space has been made a multiple of 50cm, as for example in the drafting and craft tables which are 1.00m wide. Two standard tables joined together will give 1.50m x 1.00m and this may suffice; if a larger area is needed then four such tables could be joined together.

As explained in Chapter 6 above, the basis for table design must be the body size of the student, the comfortable standing work height, the maximum width needed to perform a task with elbows and hands out and the maximum reach. The furniture in this chapter has been designed with these factors in mind.

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Chapter 11

DESIGNING FOR INDUSTRIAL ARTS

11.01 General

The object of industrial arts as an area of secondary general education (it is not taught at the first level) is to help the child to develop basic practical skills through the use of common tools and to arouse interest in and simple understanding of industry and industrial processes. The experience gained by the child in this area of education may be either of very general use after leaving school or sometimes, through the interest aroused and the aptitude revealed, may lead on to further, purely vocational studies.

As at present conceived in many countries of the region, industrial arts, although part of general education, has a frankly vocational flavour: Syllabuses usually include common crafts such as wood or metal work and emphasis in teaching is on acquiring skills with tools and materials through the construction of personal projects. It is for this situation that workshops have now to be designed.

The more modern approach to learning however is through directed "discovery". The current changes in science teaching will, as time passes, be reflected in the industrial arts area and will demand similar changes in workshop design, furniture and equipment as those already made in laboratory design.

Perhaps the most important conclusion to be drawn by the designer from a study of this situation is that spaces for industrial arts should be much less tightly tailored to the needs of specific subject fields than was the case in the past. Just as in design for industry, the trend is towards "general purpose" factories, so, in secondary general schools, the trends should be towards general purpose spaces for all industrial arts teaching and learning.

A study of the utilization of workshop accommodation in the countries of the region shows that, if economic use is to be made of the facility, there is a case for a single multi-purpose workshop in most schools, rather than the separate workshops for the separate crafts that are in common use at present

In many countries, policy makers have to decide on whether to give more children education in multi-purpose workshops or provide far fewer children with separate workshops for each craft. The designer can, in estimating the accommodation needs and calculating utilization factors for each element of accommodation, draw the attention of education authorities to requests for designs for workshops which are demonstrably to be under-utilized and explain some of the alternatives that might lead to more economic investment. Teacher training is, of course, also linked with the problem of better workshop utilization, as there is a need in multi-purpose shops for teachers trained in all of the subject areas for which the shop provides facilities.

11.02 Industrial Arts in the Lower Second Level School

The lower secondary school industrial arts programme is usually the most diversified of all and offers a variety of experiences in organised laboratories.

Under the direction of specialized teachers, the students are provided with basic exploratory experiences in using many of the tools, materials, processes and products of the major industries. Through experiences in drafting, wood-working, metalworking, industrial crafts and the electricity electronics areas, the students can develop an appreciation of industrial design, good craftmanship, safe work habits, orderly procedures and an understanding of common tools, machines and devices. Opportunities to study the underlying functions of industry and to explore their inter-relations are also often part of the total programme.

As a result, the student can assess and understand his interests, abilities, limitations and potentialities in modern industrial society. Through this type of general education programme, guidance can be provided in both prospective levels, educational and occupational.

11.03 Industrial Arts in the Upper Second Level School

The industrial arts programme at the upper second level usually enables a student to progress in one of two directions. (Figure 130)

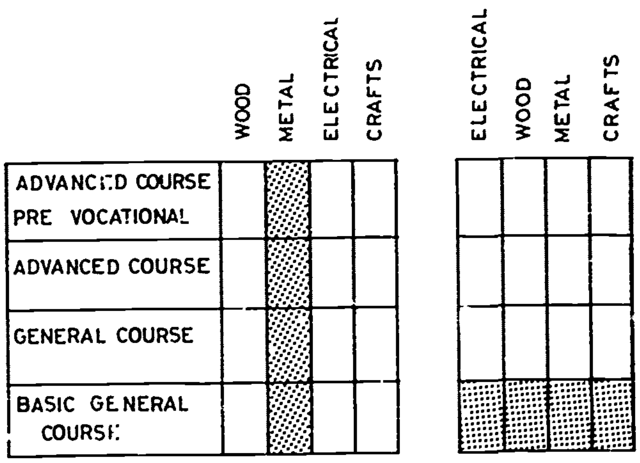


FIG. 130 VERTICAL LATERAL

The lateral curriculum approach enables the student to explore in a general way a variety of kinds of activity which are suited to his objectives, whilst the vertical approach, offers an opportunity to concentrate and specialise in a selected field of industrial work.

At the upper second level, a good industrial arts programme, therefore, provides a broad general background for some students, while for others, it provides pre-vocational experiences. Whichever path the student selects, numerous opportunities for experimentation, problem-solving, the application of scientific principles and the integration of physical, chemical and electrical aspects of the materials and processes of industry are made possible.

11.04 Fields of Industrial Arts Activity in the Curricula of the Countries of the Region

The main fields of Industrial Arts activity in the Region are shown in Table XIX, below.

Table XIX

INDUSTRIAL ARTS FIELDS IN SECONDARY GENERAL CURRICULA IN THE ASIAN REGION

Country	FIELD OF ACTIVITY				
	Wood	*Metal*	*Electricity*	*Technical Drawing*	*Others**
Afghanistan	–	–	–	–	x
Burma	x	x	–	x	x
Khmer Republic	x	x	x	–	x
Ceylon	x	x	–	x	x
India	x	x	x	x	x
Indonesia	–	–	–	–	x
Iran	x	x	–	–	x
Japan	x	x	x	x	x
Republic of Korea	x	x	–	x	–
Laos	x	x	–	–	x
Malaysia	x	x	x	x	x
Mongolia	–	–	–	x	x
Nepal	x	x	x	–	–
Pakistan	x	x	x	x	x
Philippines	x	x	x	–	x
Singapore	x	x	x	x	x
Thailand	x	x	–	–	x
Republic of Vietnam	–	–	–	–	x

**Others include ceramics, textiles, cane and bamboo work, mechanics, leather work or fields not specifically mentioned.*

It will be seen that almost all countries include wood and metal work in their curriculum and about 50% electricity and technical drawing.

The course material for similar fields varies considerably from country to country. In some countries, for example, the syllabus is framed in very general terms and its development in detail left to the teacher. In others comparatively more detail is given. For the designer, designing the individual industrial arts facility, a detailed syllabus or a fully developed scheme of work is most useful. There is, however, a danger in designing for detailed requirements, for syllabuses and teaching schemes are subject to regular review and not infrequent change. From this view point, designing to accommodate the varied situations that may develop from a general syllabus, may result in the creation of a more satisfactory, longterm, design solution.

It is, moreover, and in this connection, reasonable to assume that the wave of curriculum reform that is fundamentally changing science and mathematics teaching and learning in the region, will in time be reflected in similar changes in the industrial arts area. Just as in science, the main feature of change has been from the assimilation of facts (many of which become outdated almost as soon as they are learned) to learning to learn, so in industrial arts the change may be from learning specific skills to studying the approach to an industrial problem.

Whilst the designer has, of course, to design for the existing curriculum situation, it is very important that he creates spaces that are readily adaptable to possible future requirements.

11.05 Present Instructional Methods in Industrial Arts

An instructional method refers to a teaching procedure designed to reach pre-determined learning goals. Industrial arts teachers make extensive use of several types of teaching methods such as demonstrations, questioning, class discussions, lectures and self-instructional devices.

A common way of organising material for industrial arts teaching is to break the subject matter to be taught into small units, which form a correct sequence for instructional use. These units may be listed separately as "manipulative operations" (i.e. the things students do) and "information topics", (i.e. what the students know). Manipulative operations or "doing" units still form the basis for preparation of a list of "demonstrations" to be given by the teacher while the information topics or "knowing" units, would be the "topics for full group discussion".

On the basis of these lists, the teacher should prepare a workable teaching plan which would include the list of suggested projects, teaching aids and activities.

While an exercise in filing, making joints, etc. may have some value in certain areas like welding, the manipulative operations and skills and processes can be learnt by making useful 'projects' catering to the interests and abilities of the pupils. Although the making of an article or project is not the prime purpose in industrial arts, it is an excellent vehicle for learning. The assumption is that during the construction of the project, related technical and other topics of information and investigation will be injected or "sandwiched in" as construction progresses.

From the standpoint of class organisation and teaching procedure, projects may fall into several different classifications. In an 'individual project' all operations and processes are performed by a single person. A 'group project' is undertaken by several students or a whole class. The term "project" here may also cover services performed, as for instance, planning and designing a tool panel. "Mass production projects" differ from the group project in that they offer opportunities for stimulating methods of production and will give participants a limited view of mass production techniques.

A striking example of the application of production line in an industrial arts class was provided in Nalanda College, Colombo, Ceylon where a group of some 40 students were manufacturing the single desk and chair, designed in ARISBR. The design itself was based on the probability that it would be manufactured in industry on a production line basis and all timber members were thus fixed at 2 cm thick and either 15 or 7.5 cm wide. The boys, as is shown in Plates 26 to 28, have organised themselves to plane and thickness the timber, to cut to length using jigs, to assemble using jigs, to stop, to paint and finally to check. The furniture moves along the line, the boys remain working at one place.

This learning experience is most valuable as it involved the boys in planning; they all quickly discovered a lot about production lines and also developed one or more psycho-motor skills.

As was briefly mentioned above, a characteristic of industrial arts in most Asian countries is continued adherence to a traditional curriculum structure and content. The subject has, with the exception of the occasional introduction of electronics and autc .iobile mechanics, changed but little over the years with woodwork and metalwork remaining the dominant fields in the area. As far as content is concerned, emphasis continues to be placed on tools, materials and personal project construction. In woodwork and metalwork for example, students continue to make bowls and trays although for years past these items have been provided by industry in a wide variety of plastics. This sort of change is not reflected in industrial arts teaching.

11.06 Accommodation Schedules

The industrial arts facility is probably the most expensive element in a general secondary school. It requires special furniture, water services and often gas and three-phase power. The equipment, whether it be a set of carpenter's hand tools, a potter's wheel or metal lathe, is always costly. Above all, teachers trained in this field are often in very short supply and, unless wisely used, will prove an expensive and recurrently wasteful asset.

It follows from a consideration of these factors that all industrial arts facilities must be very carefully tailored to the precise needs in respect both of utilization during the week and of size in relation to occupancy. In other words there must be neither too many industrial arts laboratories nor must they be too large. The old traditions of providing, for example, a separate wood working shop and a separate metal working shop, irrespective of the size of the school and the number of periods taught in these subjects, must be critically reviewed and, where such an arrangement is found wasteful, alternative solutions sought.

A study of the periods allocated to practical education in the various countries of the region shows that in respect of lower secon^d level schools, Indonesia, Iran and the Philippines assign a sufficient number of periods to industrial arts to utilise a multi-purpose workshop

Plate 26

Plate 27

Plate 28

in single stream schools. All other countries, however, would require two or three form entry* schools to make full use of one multi-purpose workshop. Table XX describes the needs, country by country.

Table XX

MINIMUM SIZE OF LOWER SECONDARY SCHOOL TO MAKE ECONOMICAL USE OF A SINGLE MULTI-PURPOSE WORKSHOP

Country	*Size of Lower Secondary General School in Streams or Sections per grade (see note)*
Ceylon	Two form entry
India	Three form entry
Indonesia	One form entry
Iran	One form entry
Japan	Three form entry
Khmer Republic	Two form entry
Republic of Korea	Three form entry
Laos	Three form entry
Mongolia	Three form entry
Pakistan	Two form entry
Philippines	One form entry
Singapore	Three form entry
Thailand	Three form entry
Republic of Viet-Nam	Three form entry

Note: This table has been calculated from the latest curricula available in the Institute.

11.07 Educational Resistance to Change

The idea of combining in one laboratory such diverse subjects as wood and metal working and possibly ceramics and electricity, is one which is likely to meet with stiff resistance from the inspectorate and teachers who have been trained and who have practised in unit laboratories. In a report on industrial arts teaching from one country of the region it was said that, "Educators feel that, in view of different objectives and physical maturity of pupils, separate shops should be maintained..." This, it should be noted, was in a situation where the scarcity of funds for industrial arts laboratory construction was such that, "of 6,047 schools in which the official curriculum included industrial arts subjects, only 300 have workshops for general wood working, hundred for general metal, 301 for textile weaving and hundred for pottery". Acting on the report, industrial arts has been now introduced in all schools, using classrooms converted into a multi-purpose workshop.

**Two form entry means that there are two parallel streams, classes or sections in each grade.*

The changes to be faced in the design of laboratories for industrial arts are two fold. First, the need to build multi-field laboratories in order to make better use of the money spent on buildings and teacher's salaries and, secondly, to design these laboratories in such a way that they meet, not only present curricula needs but also the changed curricula of the future. "Once (a building) is built to fit education's changing technology, it stands firmly for at least two or three generations to thwart any serious changes in the traditional deployment of space, time and students". (11.1)

11.08 Multi-purpose Facilities for Lower Secondary Schools

The fields of industrial arts activity in the countries of the Asian region are given in Table XIX.

A study of the schemes of work in these fields shows the following common accommodation requirements for workshops (or industrial arts laboratories):-

(i) Storage space for raw material

(ii) Storage space for finished work

(iii) Storage space for tools and small, movable equipment

(iv) A work room for the teacher

(v) An area in which a group of students can watch a demonstration given by the teacher

(vi) Space for fixed machinery

(vii) Work spaces for individuals (not at machinery)

(viii) Common work places to which all students may come

(ix) A space for students to plan projects (making drawings, estimates etc.)

(x) A place for changing to working overalls and for washing at the end of the period

(xi) Storage space for students' books and belongings.

The designer is concerned with, first, the space needed for each of the sub-elements of accommodation listed above and, secondly, with their arrangement in relation to the activities in the workshop (industrial arts laboratory).

As far as space is concerned, the areas per place suggested for work stations in a multi-purpose laboratory are shown in Table XXI. These areas are slightly higher than would be required in a single field workshop as there is likely to be more movement, and space should be provided for it. (11.2)

Table XXI

PER PLACE AREAS FOR WORK SPACES IN MULTI-PURPOSE INDUSTRIAL ARTS LABORATORIES

Field of Activity	*Area per place in m^2*
Woodworking	6.10
Metalworking (fitting and sheet metal)	6.50
Electricity/Electronics	4.25
Spinning and weaving	8.75
Ceramics (pottery and clay craft)	6.25
Rattan and bamboo work	5.00
Leather work	4.00
Masonry	4.25
Power mechanics (motor mechanics)	9.50

Once the fields of activity have been determined, and the groupings of students agreed, then the working space can be calculated. For example, if the curriculum includes woodwork, metal work, weaving and ceramics and the classes are of 40 children, then 10 children would, involved in each activity in rotation throughout the course, require the following area.

10	places for woodwork	at	$6.10\ m^2$ per place	= $61\ m^2$
10	,, ,, metalwork	,,	$6.50\ m^2$ per place	= $65\ m^2$
10	,, ,, weaving	,,	$8.75\ m^2$ per place	= $87\ m^2$
10	,, ,, ceramics	,,	$6.25\ m^2$ per place	= $62\ m^2$
			Total	= $275\ m^2$

or $6.9\ m^2$ per place.

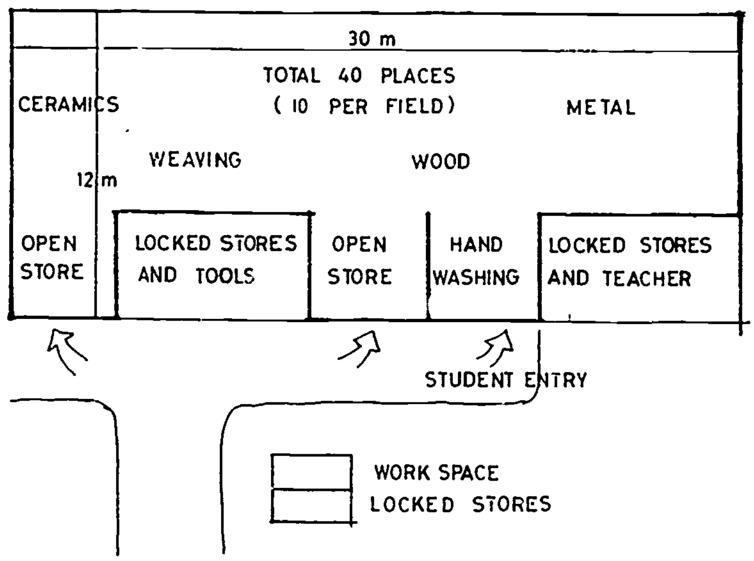
An illustration of a laboratory for these activities for Ceylon is given in Figure 131 (top). Two teachers will work in this laboratory at the same time, one in wood and metals and the other in ceramics and weaving.

Somewhat tighter spaces have been provided in Iran's new guidance cycle schools (Figure 131) where woodwork, metal work and electricity will be taught to 42 students in an area which provides $5.33\ m^2$ per place.

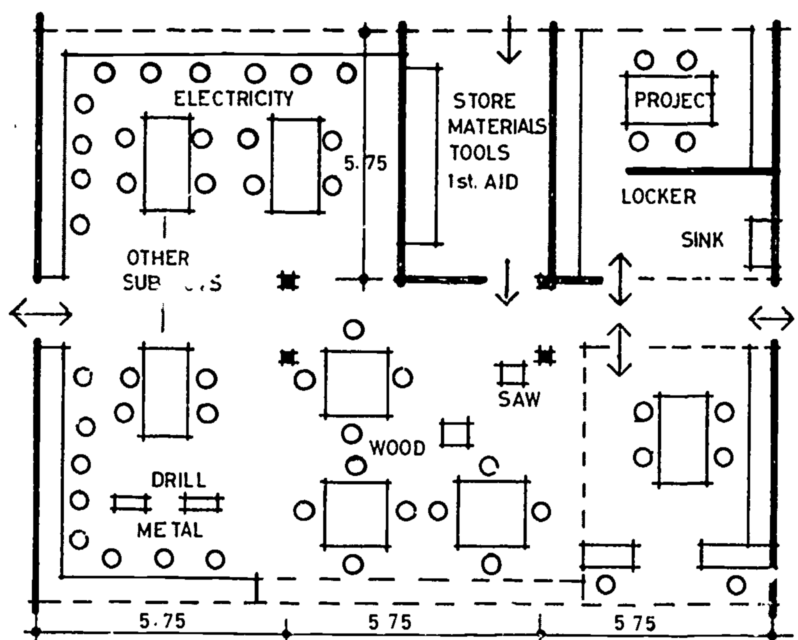
The comparison is not precise as the per place area for the Iran School is based on the gross area including the store and project area. If the stores and washing areas are included in the calcula... the Ceylon laboratory, then the comparison is ... and and as follows:–

Iran	$5.33\ m^2$/place
Ceylon	$9.00\ m^2$/place

As in Ceylon, two teachers will work in the laboratory at the same time. This is due to the system of teacher training which in most countries of the region, continues to aim at giving industrial arts teachers a high level of skill in one or two fields, rather than a much wider variety of skills, but at a somewhat lower level.



MULTIFIELD LABORATORY SUITABLE FOR CEYLON INDUSTRIAL ARTS CURRICULUM



WORKSHOPS FOR IRAN'S NEW GUIDANCE CYCLE SCHOOLS. AREA $224\ m^2$ FOR 42 STUDENTS = $5.33\ m^2$ PER PLACE

FIG 131

11.09 Storage for Industrial arts in the Lower Secondary School

Any storage space should be arranged to provide for:-

(a) Receipt of new items (from outside);

(b) Storage in a way that:-

(i) provides for selective withdrawal;

(ii) provides a suitable environment in relation to the items stored;

(iii) permits rapid stock checks;

(c) Issue to preparation or working areas as and when required;

(d) Security in relation to the value of the items stored.

Raw materials for industrial arts activities may be distinguished as either bulky or small. For woodwork, timber may be delivered in 3 or 4 metre lengths and plywood in full size sheets. The same is the case with bar and sheet material for metal work. Rattan and bamboo will be in long lengths and clay for ceramic work will usually be delivered in bulk.

As far as wood and metal are concerned, some schools are supplied with pre-cut materials in short lengths, thus simplifying the storage problem and also saving the students' time in the laboratory. Practices in this respect vary from country to country and even, within a country, from one district to another. Activity fields such as electricity/electronics, weaving, leatherwork and the like require storage almost exclusively for small items. The size of the stored items is important as it effects not only the quantum of space required, but also the access into and out of it.

The design of stores will have to be arranged to accord with the methods of delivery of materials and the processes to which the materials are to be subjected when they are brought from the store into the laboratory. In industry the 'flow' of materials is important as, if arranged in an optimum manner, it can reduce handling, lower costs and lead to cheaper products. In education where there is no profit motive, the handling of materials is often not taken seriously as is shown in the example in Figure 132a. Students learn nothing from this sort of situation which may indeed engender the start of a healthy contempt for education. They can learn about flow of materials if storage is arranged as in Figure 132b.

A judgement on the value of the materials (and tools) to be stored and an informed opinion of the risk of petty pilfering will be necessary first to establish whether lockable stores or spaces open to the laboratory are to be preferred. Clearly there is little risk of pilfering a 3cm x 10cm x 5cm balk of timber, nor of the theft of clay or a big sheet of plywood or steel. These items can be considered for storage in convenient additional areas in the main laboratory space. Small items of raw material, infrequently used tools and finished work, on the other hand, require security of storage and lockable space(s) should be provided for them. In practice it may be considered difficult to decide when a piece of wood is small enough to be put in a security store and for this reason in many schools, all materials are stored in one large, lockable space.

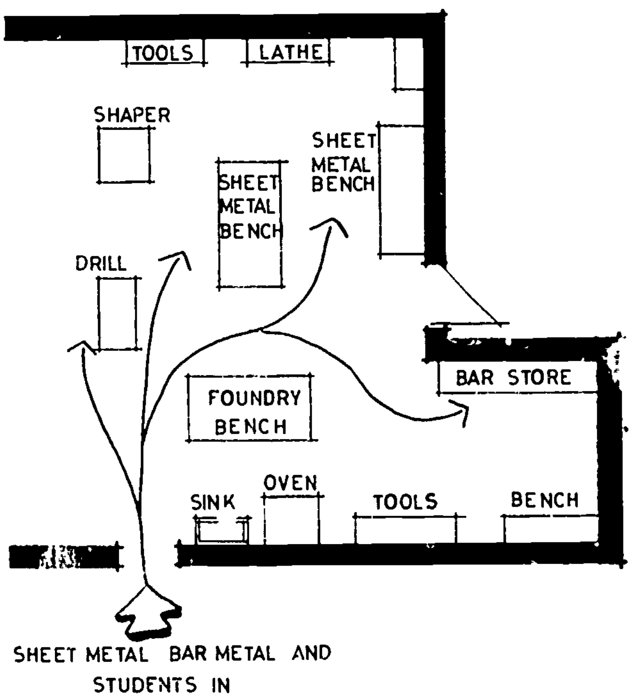


FIG 132 a CONFUSED MOVEMENT OF MATERIALS

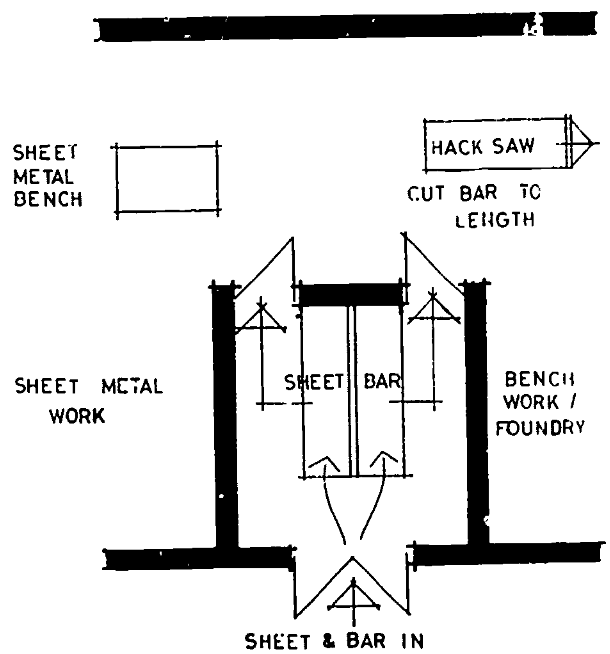


FIG. 132 b LOGICAL FLOW OF MATERIALS FROM VEHICLE TO STORE TO LABORATORY

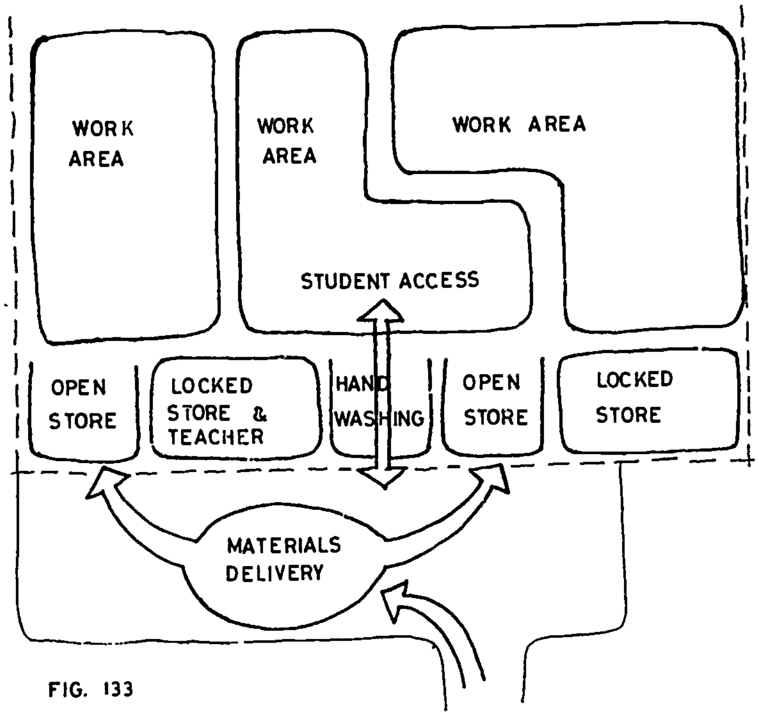


FIG. 133

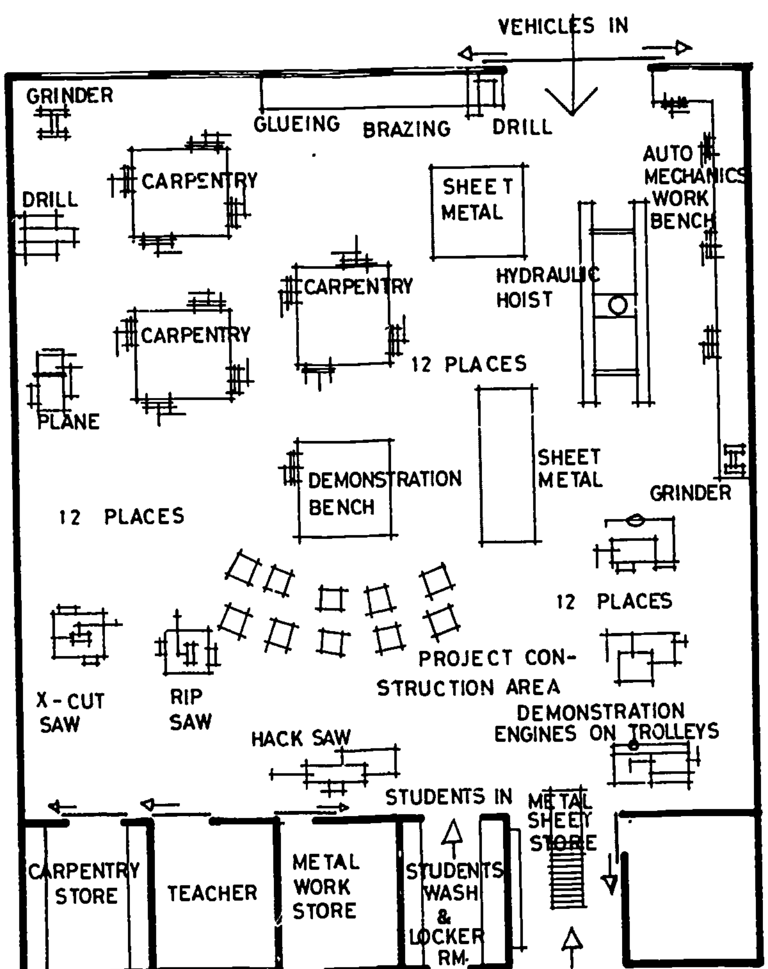


FIG. 134 PLAN

The area required for storage will obviously depend on the activities in the laborato.y. An average area which will meet most needs is about one fifth of the area of the work space. (11.2)

11.10 Arrangement of Multi-purpose Workshops

Figure 133 shows in diagrammatic form, the elements of the workshop. These include the approach road for vehicles with materials/equipment and students, stores, workspace, teacher's room and cloak room for students. The development of the diagram into a multi-purpose workshop for carpentry, sheet metalwork and auto mechanics is shown in Figure 134. It will be seen to comprise a large. open area in which small groups of children can work in each of the three fields. There is a space for construction or other larger projects and it is possible to group stools in a variety of places in the workshop for brief discussions or ıonstrations. Tools in common use can be stored arou. ıe workshop in tool boards (Figure 135) fixed to the walls at 40 cm above floor level.

Where electricity is available and machines are to be installed, the service conducts can best be fixed at ceiling level to allow for the subsequent movement of existing or the introduction of new machines (Figure 136).

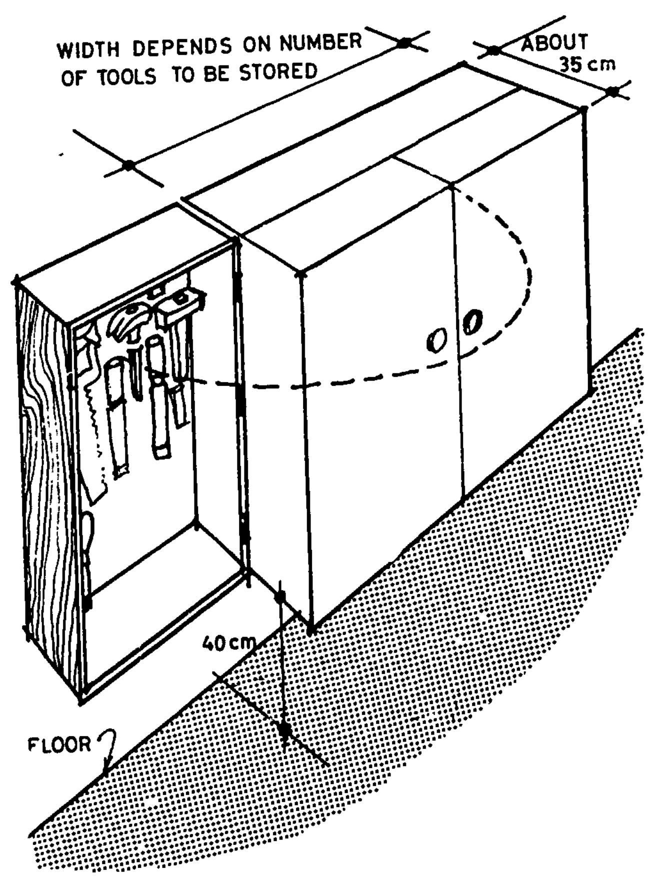
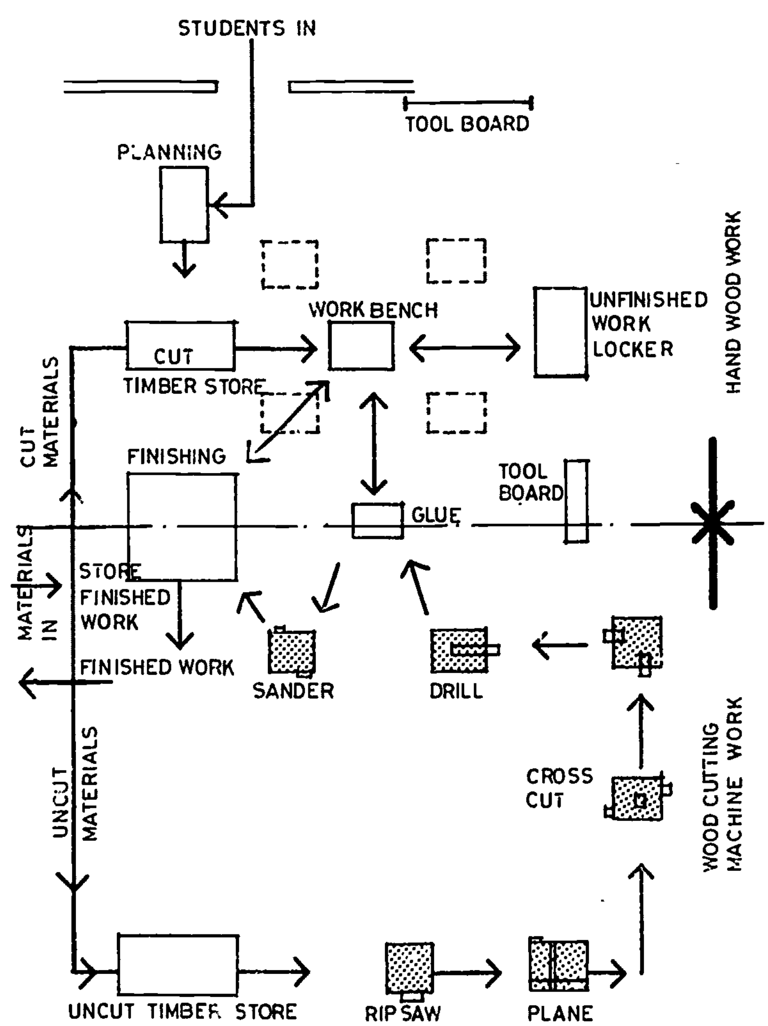


FIG.135 CENTRAL TOOL BOARD

The designer's main task will be to study the activities and consequent movements and to design in such a way that movement is reduced to a minimum through the correct location of the main physical elements in the workshop. An analysis of movement in a woodwork shop made, using an association chart, and the subsequent development of the layout is shown in Figure 137.

In a combined hand woodwork and wood-cutting machine shop, flow of material is an added consideration in the wood machine section. Figure 138 shows the flow diagram for both shops. Upper second level single field workshops differ little, if at all, from shops in technical schools and colleges to which reference can be made in (11.3 – 11.10).



DIAGRAMMATIC LAYOUT OF COMBINED HAND WOODWORKING AND WOODCUTTING MACHINE WORKSHOP

FIG. 138

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Chapter 12

MULTI-PURPOSE SPACE

12.01 General

There is a natural tendency in writing a book of this kind, to try to describe the desirable design features of separate spaces to suit each individual subject in the curricula of every country in the region. To the list of spaces already described in previous chapters could be added spaces for arts, for crafts, dancing, singing technical drawing, agriculture, etc. The likelihood of any country in the Asian region, except Japan and, possibly, Singapore, having sufficient resources during the next decade to provide separate spaces for these activities in a majority of their schools is so remote as to make discussion of the design of such spaces little more than an academic exercise.

Whilst the main investment in school building in the immebiate future is likely to be in classrooms and possidly spaces for teaching science, there is a need to make provision for teaching and learning the wide range of subjects that require a little special equipment some services, however simple.

Thus, whilst in earlier chapters reference has been made to designing for science, mathematics, geography, industrial arts and home economics, in many countries there are simply insufficient resources to make separate special provision, however simple, for teaching and learning in all these areas. The most that is likely to be feasible during the next decade and where resources are desperately limited, will be a few classrooms and a multi-purpose space which will serve for all those subjects that cannot be taught in the classroom (Figure 139).

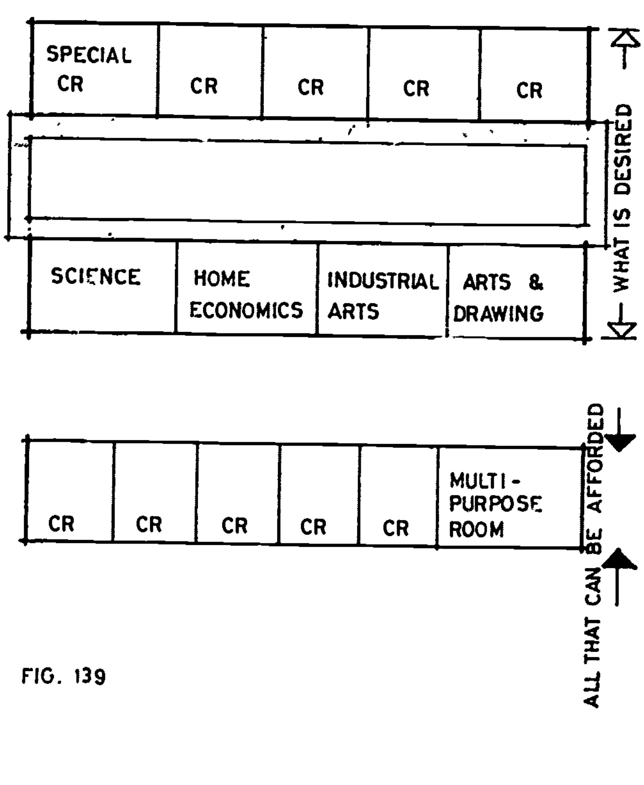

FIG. 139

12.02 The Need for a Multi-purpose Space

A multi-purpose space will have little use in a primary school where most of the activities take place in the base classroom or on the site. The main need for a multi-purpose space will be in connection with lower-second level education, especially in small rural schools.

A typical curriculum for such a school for grades 6, 7, 8 & 9, might include:

	Language arts	10 periods
	Religion	2 periods
	Social Studies	8 periods
	Science	3 periods
	Mathematics	5 periods
	Physical Education	2 periods
and either	Home Economics	3 periods
or	Industrial Arts	3 periods

for a single stream school.

The needs for rooms, other than classrooms, would be as follows:–

Science –
3 periods x 4 groups = 12 space periods
Home Economics or Industrial Arts
3 periods x 4 groups = 12 space periods
Total = 24 space periods

Such a school could *not* make economic use of separate science, home economics and industrial arts laboratories, whereas it *could* make full use of a multi-purpose space, tailored to meet the needs for teaching and learning in each of these subject areas. What are the implications in making such a multi-purpose space available to a school?

12.03 Problems Connected with Multi-purpose Spaces in Schools

The design of such a space presents few, if any problems. Working surfaces and stools can be of uniform height, storage can be provided that is of general utility and such services as are available in rural areas can be arranged for use in connection with teaching and learning in any subject area.

The real problems are likely to be administrative and connected with traditions in teaching practice. In many countries, as has been mentioned in previous chapters, equipment is issued to individual teachers who are quite frequently financially liable for loss or damage of all but the smallest and cheapest items. Where such a situation exists then there will need to be as many separate, lockable storage units in the multi-purpose room as there are teachers using it.

Secondly, it is probable that there will often be strong teacher resistance to sharing a space with teachers from other subject areas. Science teachers, trained in upper

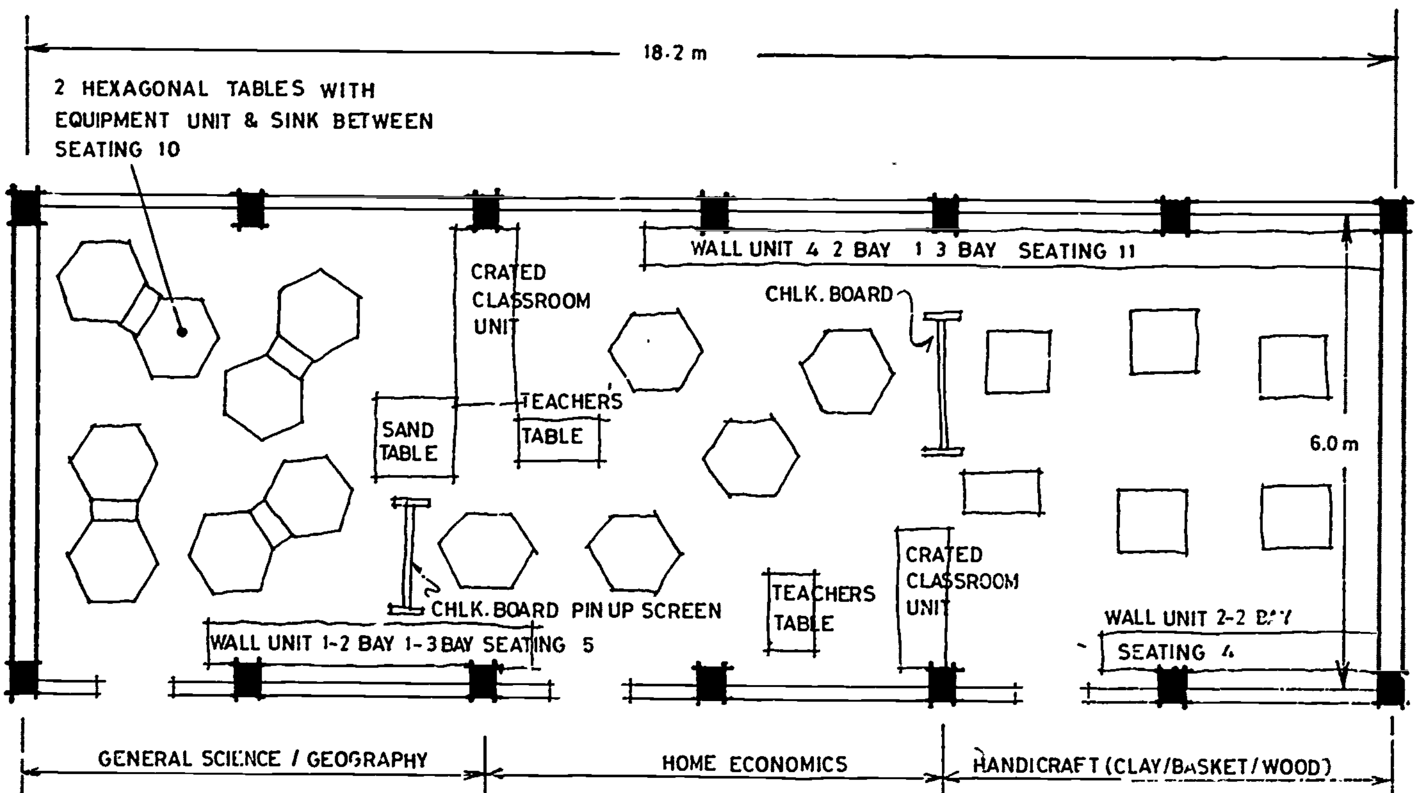

FIG. 140

secondary schools, universities or teacher training colleges with special science laboratories, find it difficult to adjust to the real situation in the schools which is one of scant resources and improvisation, all requiring the use of considerable imagination. A trained science teacher, a trained home economics teacher and a trained industrial arts teacher will have been usually trained in about everything except in how to work together in one space.

The outcome of this situation which is regrettable but real, is that, even in a multi-purpose space, there is a desire to divide it up into separate areas, each the "territory" of a particular teacher. Figure 140, illustrates an example of this type of accommodation from one of the countries of the region. Quite obviously, little has been gained in this arrangement which is virtually a series of specialist spaces without formal dividing walls between them.

Of course, the teachers have some cogent arguments against sharing spaces, apart from the question of responsibility for equipment.

Supposing, in the example given in 12.02 of a 4 grade school, a single multi-purpose space is provided and in it there are 10 tables, each accommodating 4 students. Is it reasonable successively to cook, sew, work with chemicals and with glues, nails, hammers and saws, all on the same tables in home economics, science and industrial arts lessons?

The answer will, of course, depend on whether or not each class cleans its work space thoroughly at the end of every lesson and this again depends on adequate motivation of the children by the teacher and the development of appropriate attitudes – a matter referred to at some length in chapter 1.

12.04 The Design of the Multi-purpose Room

The design criteria include:–

(a) Provisions of a variety of separate lockable storage units;

(b) Internal arrangements of furniture capable of complete and rapid re-arrangement by children;

(c) A separate area for rough/wet/dirty work.

Plates 29 and 30 show the situation in one country of the region where, with the help of a lockable and movable storage unit and specially designed science trolleys, the internal arrangement allows for the teaching of general science 10 minutes after the end of a general subject lesson.

Three situations need consideration, namely, hot-dry, hot-humid and upland (Himalaya/Hindi Kush). The elements of design solutions are suggested in Figures, 141, 142 and 143.

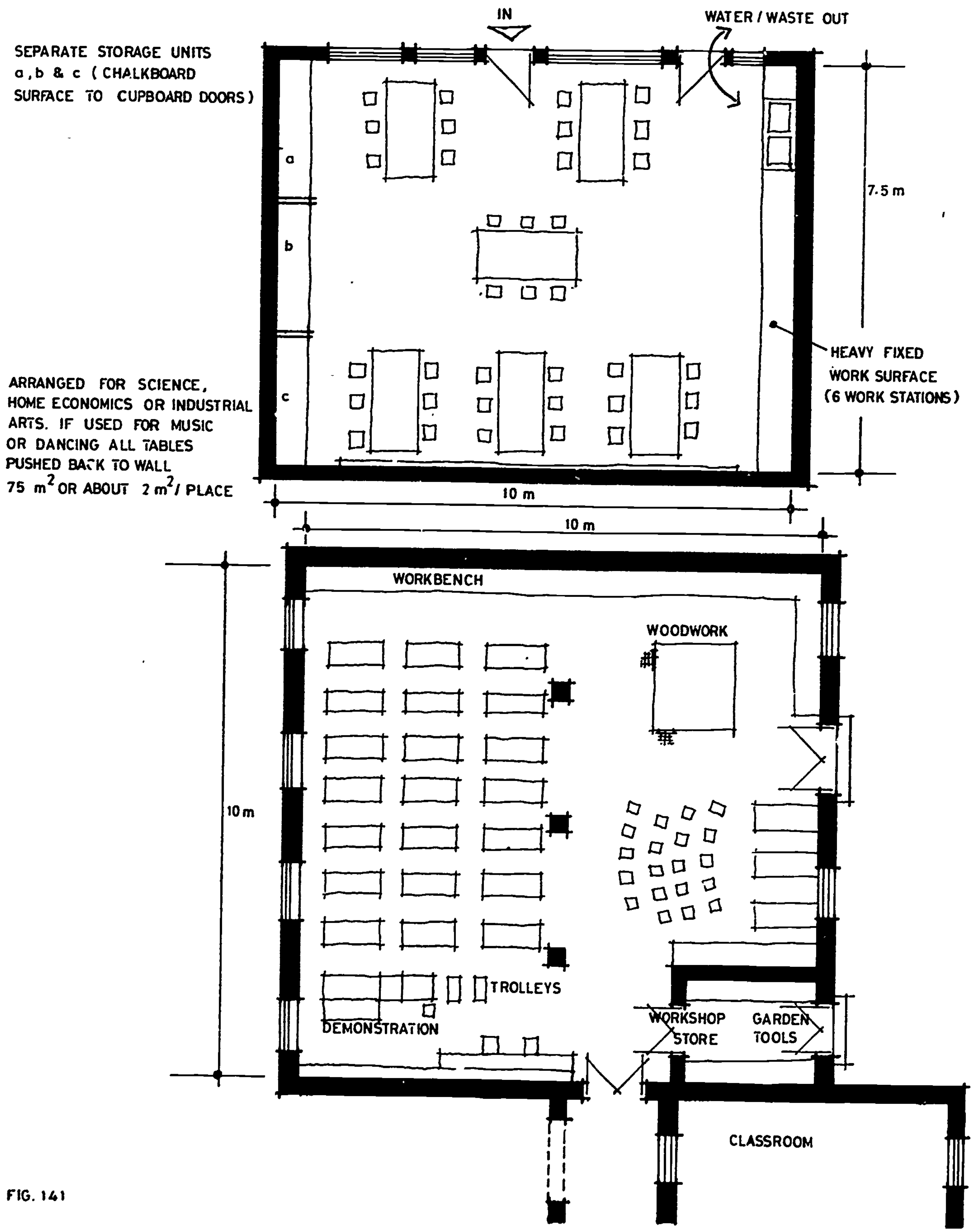
IN
WATER / WASTE OUT
SEPARATE STORAGE UNITS
a, b & c (CHALKBOARD
SURFACE TO CUPBOARD DOORS)
a
b
c
7.5 m
HEAVY FIXED
WORK SURFACE
(6 WORK STATIONS)
ARRANGED FOR SCIENCE,
HOME ECONOMICS OR INDUSTRIAL
ARTS. IF USED FOR MUSIC
OR DANCING ALL TABLES
PUSHED BACK TO WALL
75 m² OR ABOUT 2 m²/ PLACE
10 m
10 m
WORKBENCH
WOODWORK
10 m
TROLLEYS
DEMONSTRATION
WORKSHOP
STORE
GARDEN
TOOLS
CLASSROOM

FIG. 141

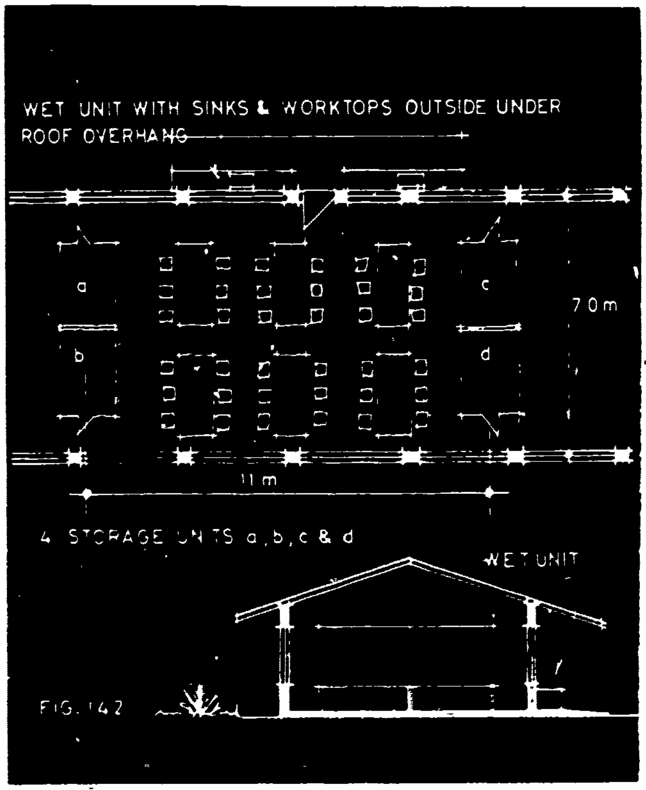

FIG. 142

Plate 30

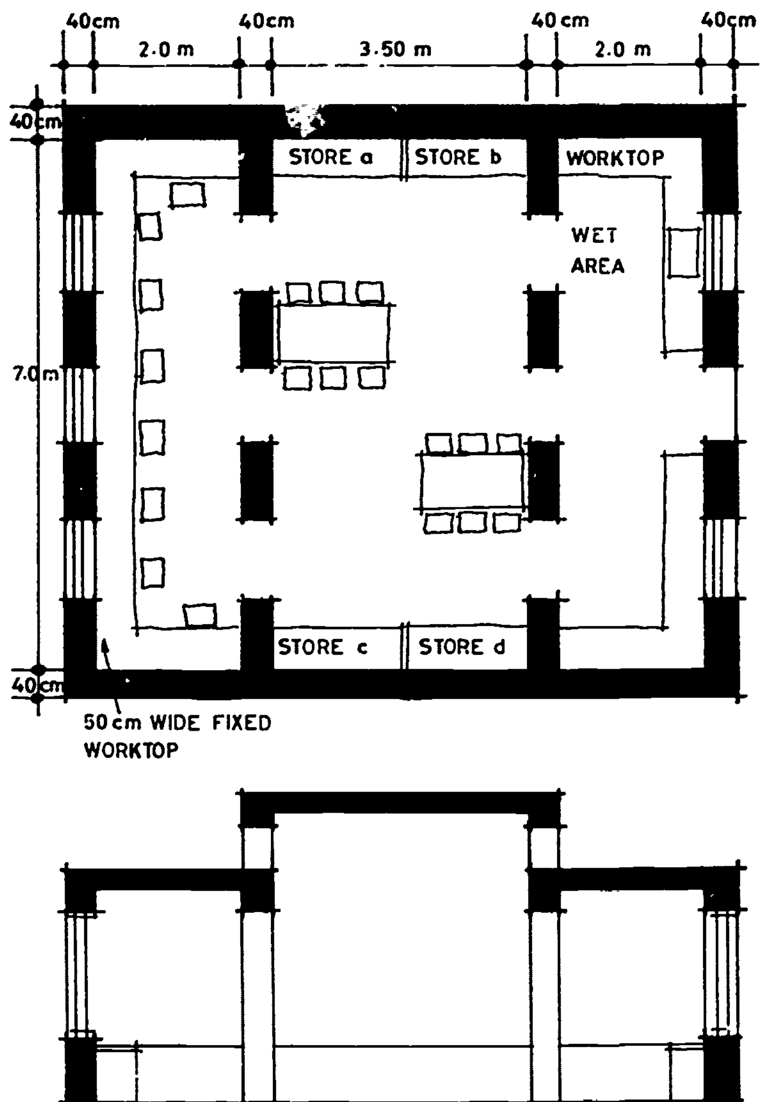

FIG. 143 CROSS SECTION

Plate 29

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Chapter 13

SCHOOL LIBRARIES

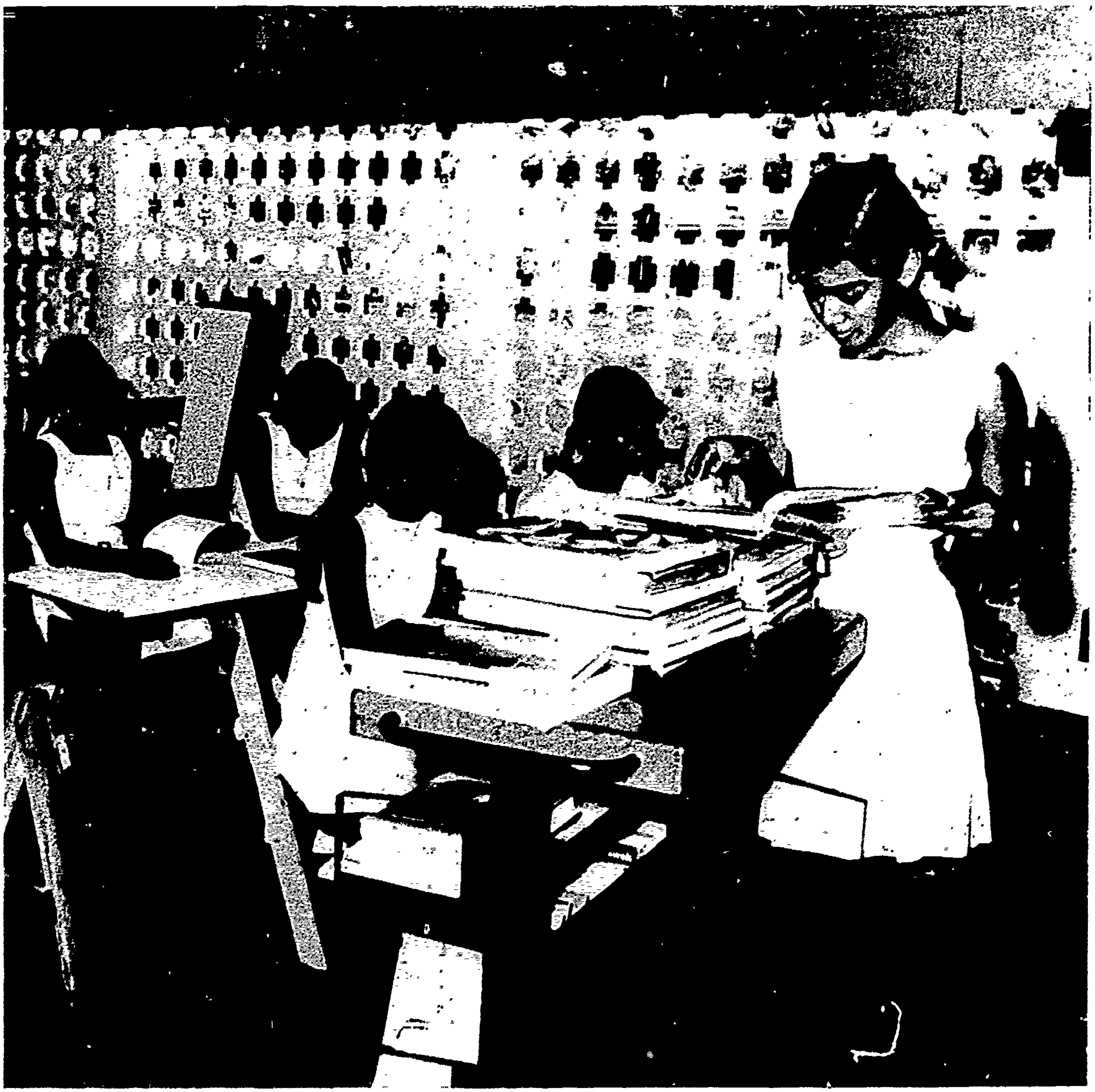


Plate 31

13.01 General

An effective school library requires a good supply of books and periodicals, adequate furniture, sufficient space and a person trained to manage the facility efficiently. A library thus forms an expensive element of education and few countries of the Asian region have yet been able to provide the necessary resources for school libraries from their already strained educational budgets.

There is, however, an almost universal determination to improve the present position – a determination which matches, in some ways in its intensity[1] the moves for reform in science and mathematics education, already mentioned earlier in this book. Indeed the two situations are complementary, for, without access to library material, it seems unlikely that the concepts of learning to learn, on which the reforms are based, can be fully developed.

The provision of libraries to the schools of the region poses a problem already familiar to educational planners and administrators, namely, that of assigning priorities for development in situations where existing facilities are obviously inadequate. Different countries of the region have, for reasons that seem best to them, decided to approach the problem in different ways. Some have concentrated on the basic problem of text book production (13.1; 13.2; 13.3;) and have invested little in either the training of librarians or on the construction of libraries. Others have provided library buildings whilst doing less towards the training of librarians and increasing the supply of books and periodicals.

In a few countries, investment has been concentrated on the training of librarians and teacher-librarians and on book production. It is only in the wealthier countries of the region that a balanced approach to the provision of school libraries has proved financially possible. In no country, however, is there lack of awareness of the total needs.

Plate 32

Plate 33

Plate 32 shows a library with plenty of space but few books, while Plate 33 shows a primary school where books are provided but no library facilities.

Of course, the main function of a library is not to provide a store for textbooks, but rather a wealth of material which will enable the child (and, often, the teacher) to extend his or her understanding beyond that achieved through reading books prescribed for the classroom. Indeed, modern science teaching relies, as has already been mentioned, heavily on the availability of a wide and up-to-date range of books, using which, the child can pursue his own interests in topics as they arise.

The main problem is basic – the lack of suitable books. Local publishers are hampered by complex problems. Often, writing is unremunerative, production costly and publishing risky. The distribution of books is sometimes difficult as, outside the main towns, there are often few commercially viable retail outlets. In some countries, transport is difficult. Additional problems are presented by plural societies where books have to be published in a number of languages and

[1] *In an introduction written in 1965 to Trehan's, Administration and Organization of School Libraries in India (13. 15), T. R. Sharma wrote, "We are passing through a stage of library revolution in the country. Although the revolution has a slow pace, yet it has firm roots and definite directions."*

scripts which results in demands for uneconomically short runs. Primary schools, which house the bulk of the children receiving education in Asia, suffer especially in this latter respect, as education at this level is often in the mother tongue which is not necessarily the national language. Secondary schools are more fortunate in that supplementary reading material can be more easily made available in a second language such as English or French.

The problem has been thought critical enough to receive attention not only at national but also at international level. Unesco has established a Regional Centre for Book Development in Asia at Karachi and is sponsoring the Tokyo Book Development Centre, both of which encourage the production of general reading matter for children, suggesting, where possible, the achievement of economies through co-operative publishing.

During a meeting of Experts on Book Development Planning in Asia (13.4) in 1968 in Singapore which was organised by Unesco, several recommendations were made which are of interest and may provide pointers for the designer as to future development in the use of libraries in Asia:

"(a) ...the extension of school libraries to villages with the aim of having a library in every village school;

(b) Emphasis should be laid on the importance of school libraries in improving the quality of education. . Governments should adopt the principle of a school library in every school... at least 1% of the primary education budget and 2.1% of the secondary education budget be appropriated for school libraries.

(c) School libraries should be used to provide services to t[illegible] where public libraries do not exist."

Table . [illegible]ables the situation in respect of school libraries in the countries of the region to be assessed. The information on the number of schools covers in some countries only government schools in others government and private institutions and the data for libraries are those available and in no case less than four years old; since then the situation will, no doubt, have improved somewhat.

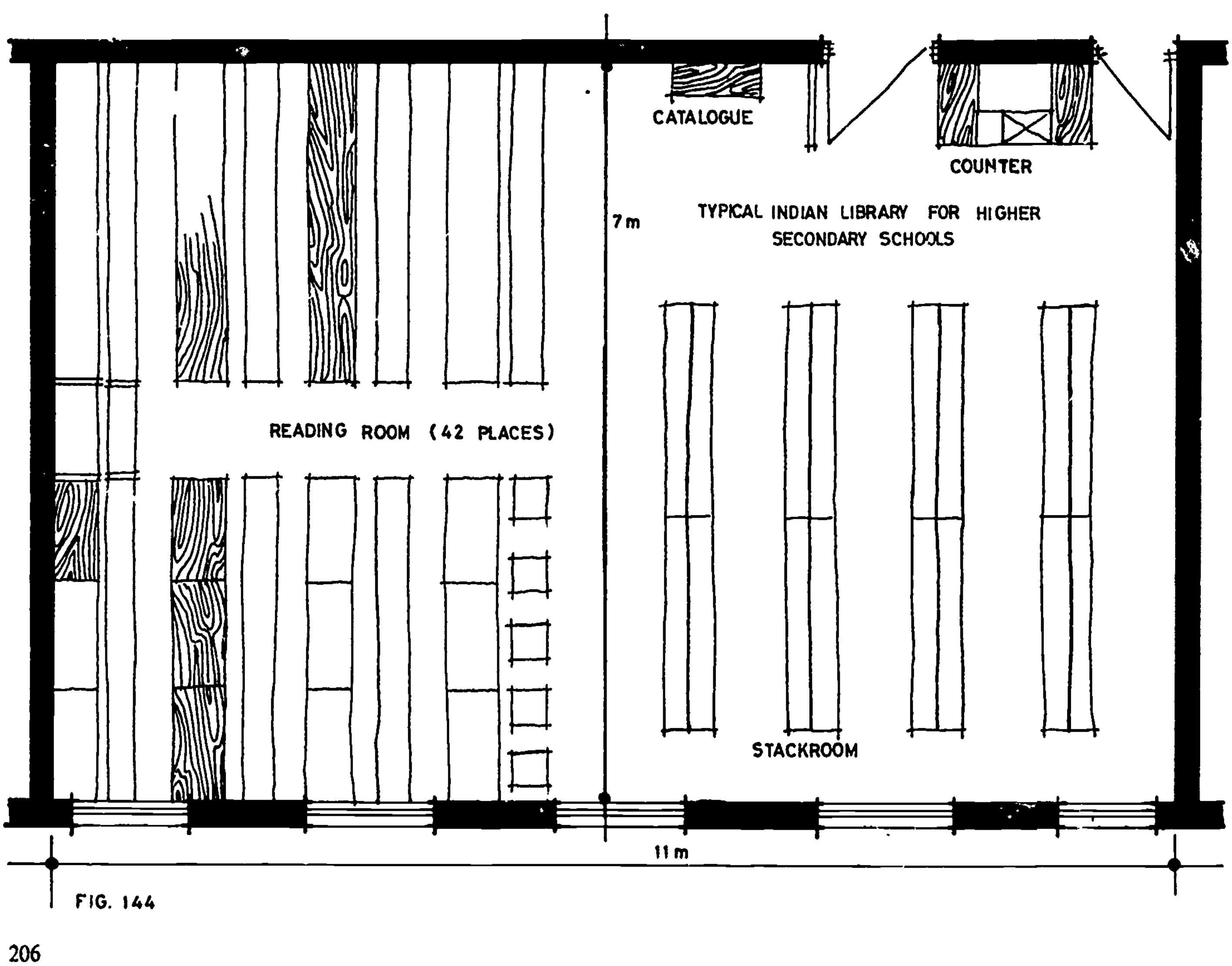


FIG. 144

Table XXII

SCHOOL LIBRARIES IN SOME OF THE COUNTRIES OF THE REGION

(These data have been collected from many sources nd are approximate; they do, however, indicate the scale of the problem of provision of school libraries.)

Country	Number of schools 1st & 2nd level and date of information	Number of school libraries and date of information		Total No. of Vols. in thousands
Afghanistan	2,848 (1970)	25	1966	56
Ceylon	9,434 (1966)	395	1968	3,420
Hong Kong	2,357 (1967)	60	1968	387
Japan	42,654 (1966)	36,677	1968	89,189
Khmer Rep.	4,205 (1965)	131	1966	—
Rep. of Korea	7,260 (1966)	3,322	1968	5,991
Laos	2,655 (1966)	3	1968	12
Malaysia	7,536 (1967)	202	1966	845
Pakistan	80,160 (1969)	2,180	1962	4,510
Philippines	32,645 (1960)	767	1964	2,300
Singapore	697 (1967)	43	1968	527
Thailand	28,747 (1968)	253	1960	303
Rep. of Viet-Nam	6,360 (1965)	3	1968	16

However, even where libraries exist, many problems remain yet to be resolved. Often books are unevenly distributed and some schools have only very small collections. This is especially true of schools in rural areas. Where there is neither a trained librarian nor a trained teacher-librarian. books are often locked away in cupboards for fear of theft. Frequently a collection of books, once established, fails to grow and the incentive for children to continue reading no longer exists. Often the collection consists almost entirely of text books. Finally, library periods are rarely time-tabled and thus there is little chance of access to the library in an otherwise fully programmed school day. This is a time-tabling problem that is still more difficult to resolve in schools working in shifts although, as suggested earlier in this book, it is a problem that can partially be solved through building design as shown in Figure 19, page 30.

What is encouraging about the situation is the attention it is receiving in the countries of the region, in many of which not only is book production and the training of librarians sharply increasing, but also the design of school libraries being actively stimulated (13.5).

Against this background, the designer must be prepared to offer a wide variety of design solutions to meet the very different situations that have been described above. These solutions may range from the design of a complete, secondary school library to the provision of small book racks that can be squeezed into tightly designed, one-or two-teacher rural primary schools. Figures 144 to 147 illustrate the ways in which library design problems have already been tackled by some of the countries of the region. Plate 34 shows a well stocked and equipped library in an Iran school.

13.0 Libraries and the Primary Schools

There can be little doubt that, not only in Asia, but also in Africa and Latin America, the provision of library facilities at the first level of education presents a problem which, because of its sheer scale, is the most difficult to solve. It is at this level of education (see Fig. 5,

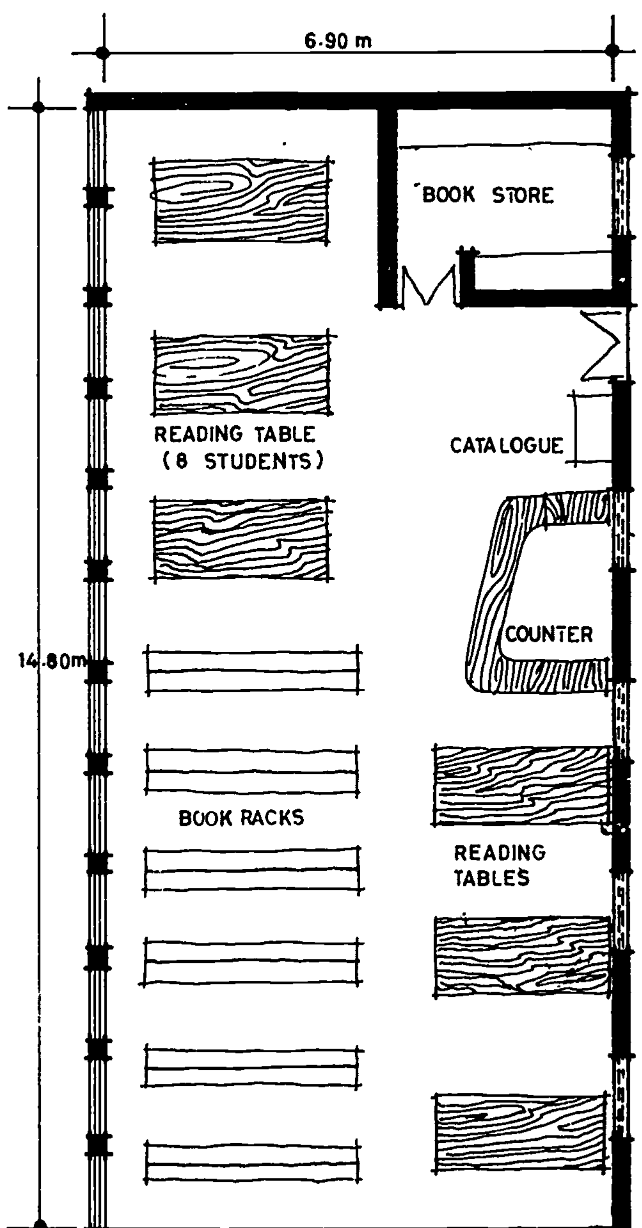


FIG. 145 INDIAN CENTRAL SCHOOL LIBRARY

Chapter I) that there are by far the greater numbers of children and, for most of them, it is at this level too that education will terminate.

The need for accommodation of libraries in primary schools is to inculcate habits of reading[1] which will carry on into later life. This, it seems, given the books and the trained teacher librarians, might be made possible in one or other of three ways. First, in the few countries which are able to afford it, separate library accommodation can be incorporated in all newly designed primary schools. Secondly, and using an approach already adopted by some countries, schools can be provided with a library room "even if it is a converted classroom or other space". Thirdly, where no "other space" is available, small collections can be kept either in each classroom and/or on a trolley that can be wheeled from room to room. Any of these approaches is better than none[2] (Plates 31, 35, 36 and 37).

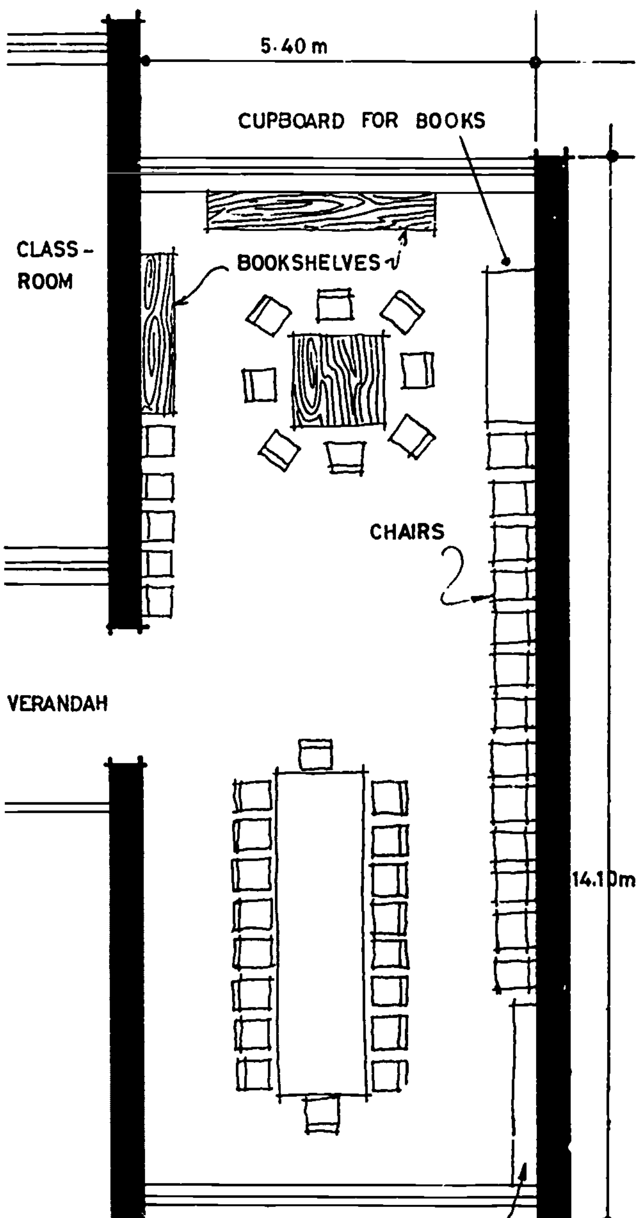


FIG. 146

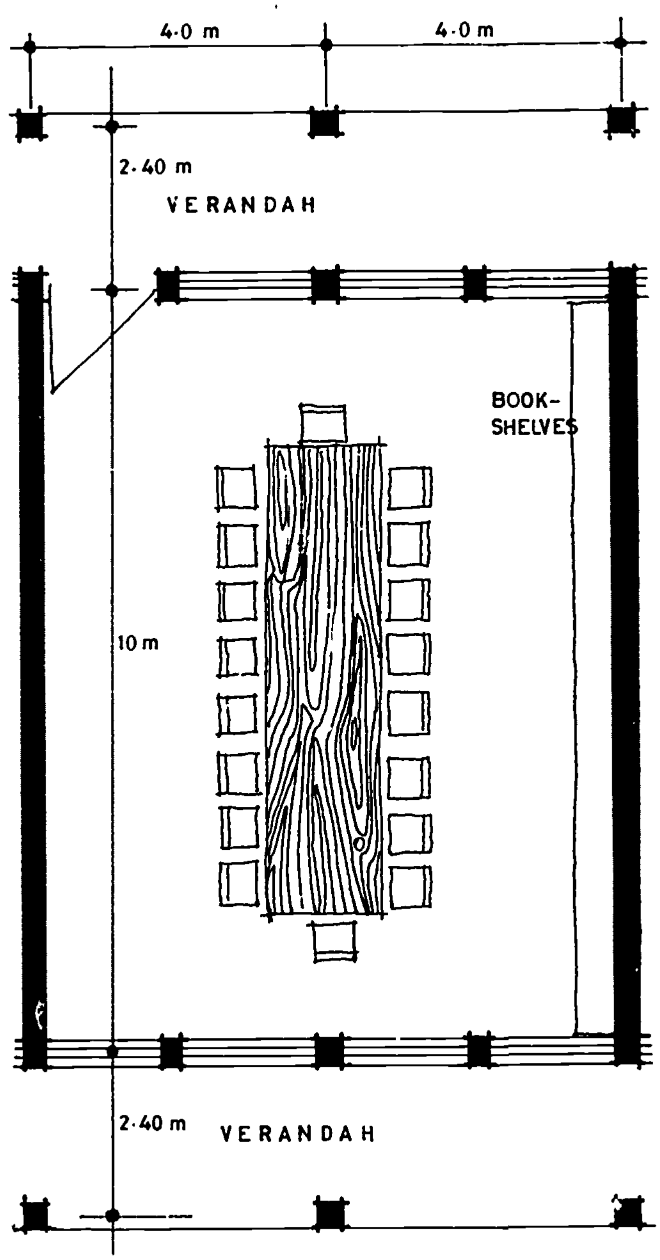


FIG. 147

[1] *In (13.8) are given the reading lists for a boy of ten years of age and a girl of seven. The boy reads 25 books of average length 50 pages; the girl reads 19 books, both in a period of six months.*

[2] *The fourth solution, which is not described in detail here, is that of the use of a mobile library from which children can borrow books when it calls and which can leave circulating book boxes until the next visit.*

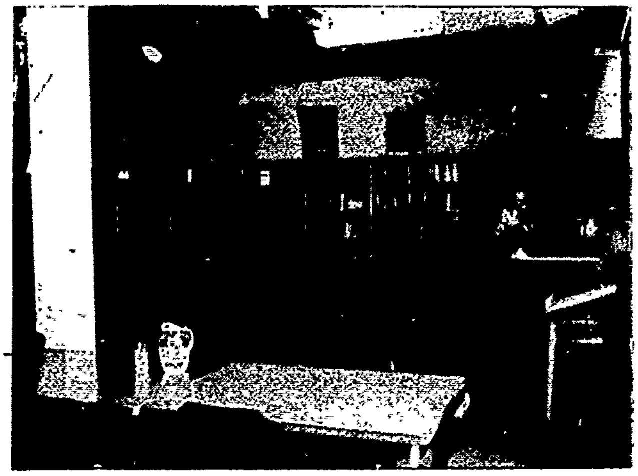


Plate 34

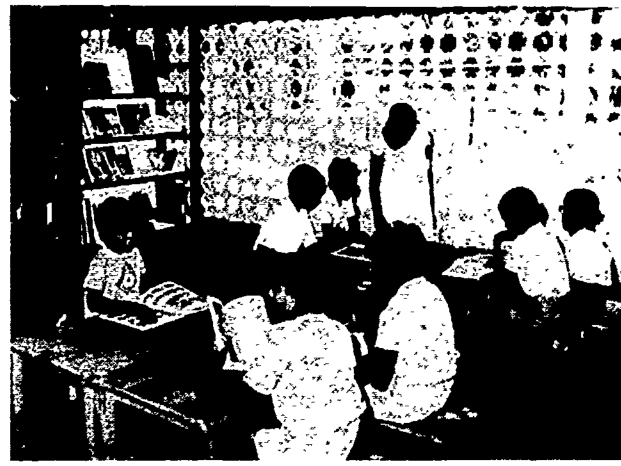


Plate 35

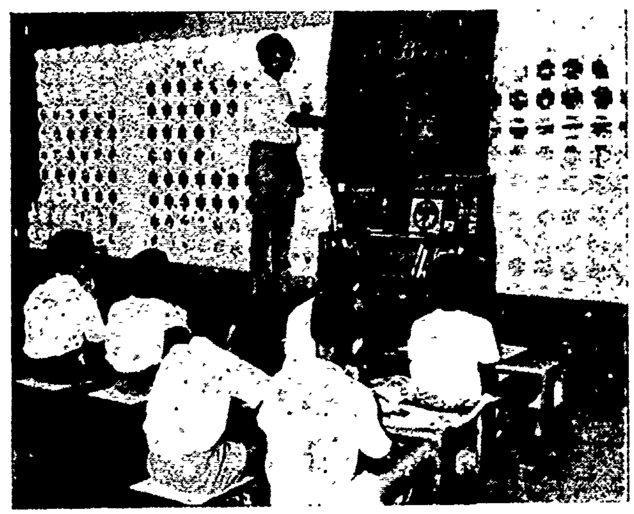
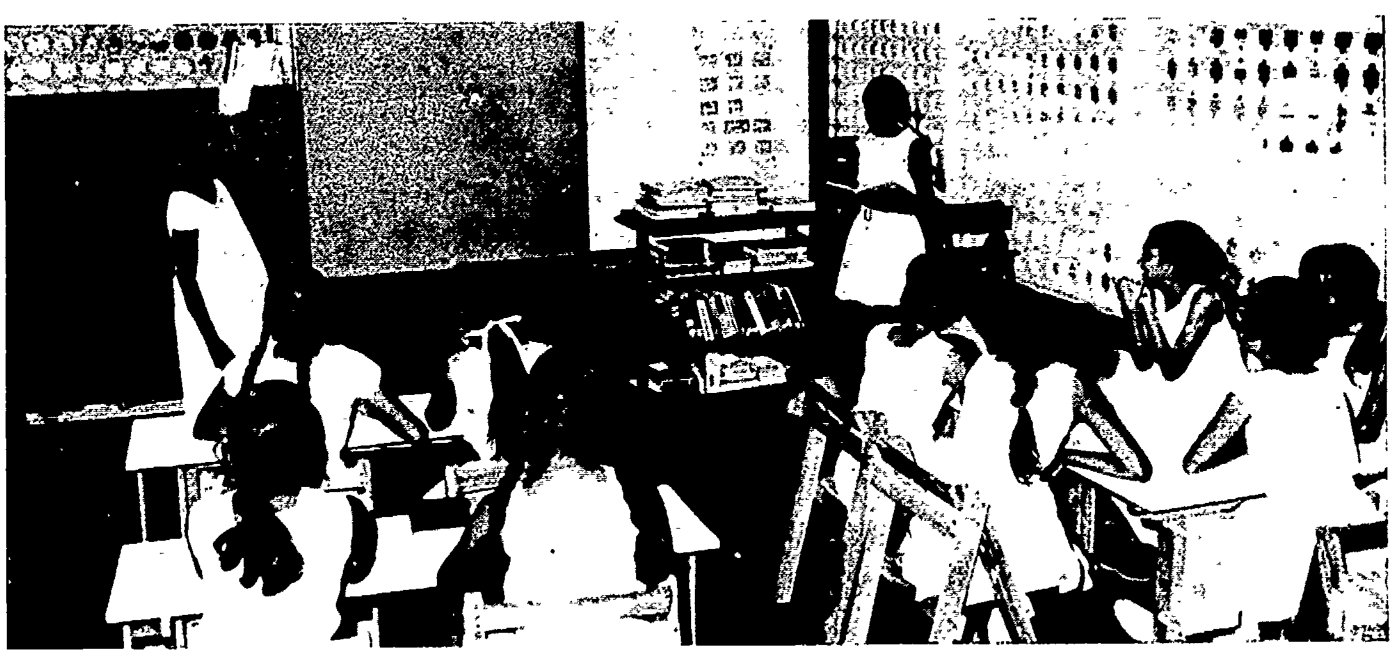


Plate 36

Plate 37



By the time a child has received six or seven years of primary education, the following library skills should, optimally, have been acquired (13.6; 13.7):

Lower grades: ability to handle and read books; understanding of borrowing routines; ability to locate material by subject; ability to select and use books independently.

Middle grades: ability to make and use alphabetical files and to use simple dictionaries; ability to select and use correct children's encyclopaedia volumes; some knowledge of library terminology; reading magazines using an abridged dictionary; understanding classification and the use of a simple card catalogue.

Upper grades of primary school: use of information file; bibliography making; note taking; use of magazine and poetry indexes; using almanacs and year books; using an unabridged dictionary; using other media – atlases, maps, globes, film strip etc. (depending on library resources).

It should be added that the acquisition of these skills can be measured by testing in much the same way, as child development in any other subject area, prescribed by the curriculum, can be measured. (13.6)

The methods used by teacher-librarians or librarians in assisting the children to develop library skills are varied and include (13.7) the following activities:-

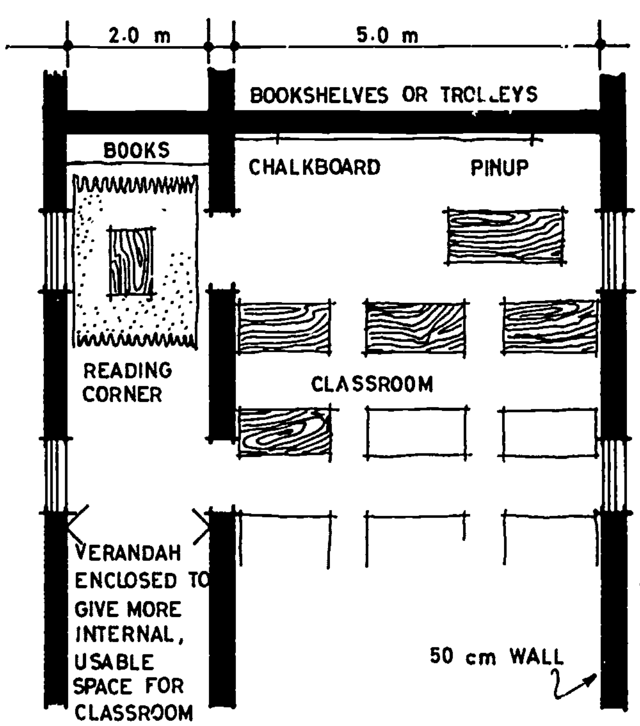


FIG. 148

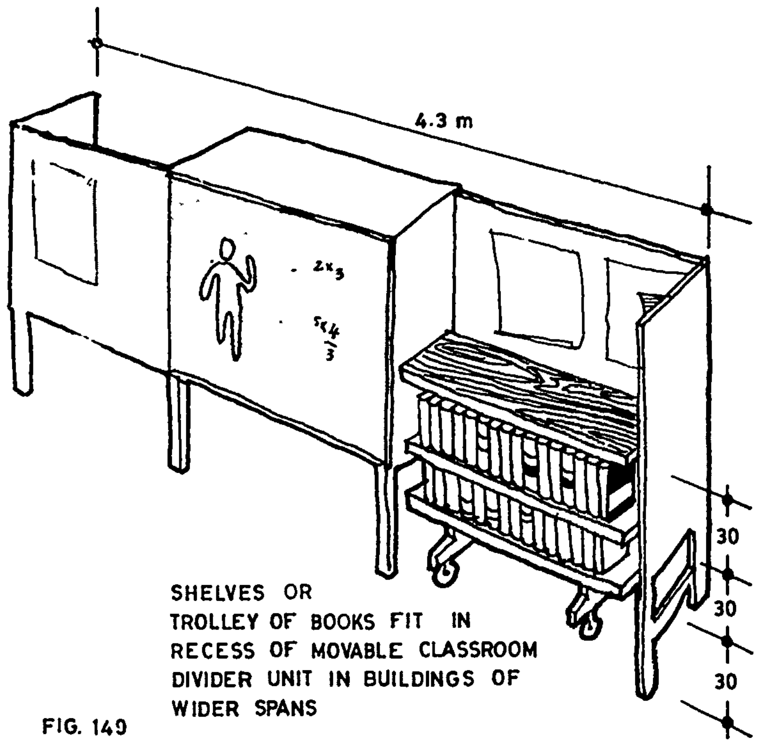


FIG. 149

Story telling; reading aloud; book talks; discussions; browsing periods; book games; dramatization; annotation; written and oral exercises; art from reading etc.

Ideally, some library periods will be timetabled and it should be possible for the teacher to take the whole class to the library which would thus have to be large enough, not only to accommodate the class but also the library material in it.

As the lower grades of primary schools in the region frequently comprise between 50 and 100 children, it would seem unrealistic to tailor the library to hold such large numbers. If use is made of trolleys or, alternatively, a good selection of books is kept in the classroom, then the acquisition of skills such as the ability to handle and read books and ability to select and use books independently, can be acquired in the classroom, leaving "understanding of borrowing routines and ability to locate material by subject" to be taught in the library. If two periods per week are allocated to acquisition of library skills in grades 1 and 2 then the following arrangement would seem practical:-

Period 1 = (a) Half class in the classroom
– handling, reading books etc.

(b) Half class in library
– borrowing routines; locating books;

2 = (a) Half class in classroom.

(b) Half class in library.

This, if grades 1 and 2 each have an enrolment of say 70 to 80 students, would require a library to seat 40 children. The arrangement also presupposes the availability of a second teacher or librarian in the library. Such a situation would be unlikely in small rural primary schools but in larger, urban schools will be easier to arrange. Often, parents of a child may, if they are familiar with libraries, be encouraged, through an active Parent-Teacher Association to come to the school for a few hours each week to assist with library work.

Of course the collection of books in a formal library, whether it be in a special space or in a spare space such as a store, would not meet the total needs of the children. "Books are too important to be kept in a special room at the end of the corridor. The classroom collection will reflect the special curriculum interests of the class and the age group,..." (13.9). The size of such a classroom collection will probably need to be between 100 and 200 volumes of which about 30 may be for reference (13.9). This collection may be, perhaps, in a corner of a room. "With enough space and appropriate school furniture, it is often possible to gather the class round the corner on the occasions when the teacher reads to the class". (13.9)

Where the shortage of books is acute, and as has been explained above, such shortages are evident in most countries of the region, a compromise between the needs for a library as well as for a classroom collection can be met by arranging for the library to be partly "on wheels" (13.9) (Plate 37).

(a) The Library in the Classroom

Two methods of accommodating the classroom collection (or a trolley of books on loan to the classroom from the school library) are suggested in Figures 148 and 149. One of the two examples illustrated is suitable for use in buildings having classrooms of wide span (from 7 to 8 metres) and the other for the narrower classrooms, common in the mountainous areas of the Himalaya and the Hindu Kush. For the wider spans simple adaptation of the furniture unit shown in Figure 78 is suggested (Plate 35). Where buildings have very narrow spans and external verandahs, then, as has been indicated in the previous chapters, the verandah can be incorporated with the classroom (instead of remaining sterile and unused for most of the day) and the space, thus enclosed, will provide excellent accommodation, *inter alia* for a book corner.

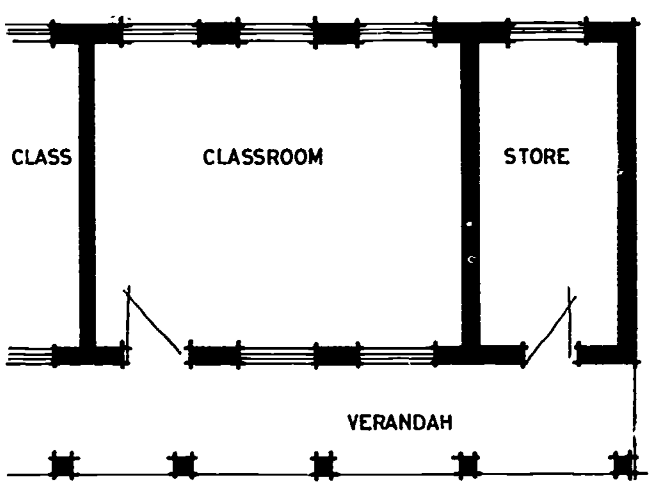
Shelving can be formed out of the squatting table shown in Figure 79 (top) and designed for use by children seated on the floor. Plates 36 and 39 show these units in use for library shelving.

(b) The Library in Unused Spaces in the School or in Buildings near to it

It is true, with one exception - verandahs - that most Asian schools are over-crowded and thus what is suggested in this section is likely to be limited in its possible application. None-the-less, a survey of literature on library facilities, coupled with observations made in hundreds of schools, indicates that many libraries have started in what is essentially make-shift accommodation.

Plate 38

The verandah-store relationship (Figure 150) is a common one and many schools have taken advantage of it. As is repeatedly stressed in this book, a verandah is both expensive and little used. Its main function is to provide shade in the brief periods between lessons, a luxury the provision of which is quite incompatible



TYPICAL ARRANGEMENT IN HUMID AREAS

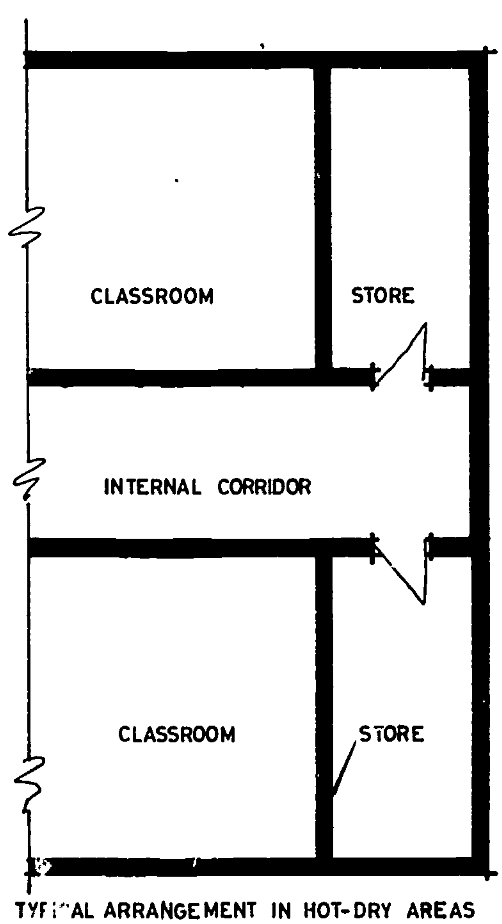


FIG. 150 TYPICAL ARRANGEMENT IN HOT-DRY AREAS

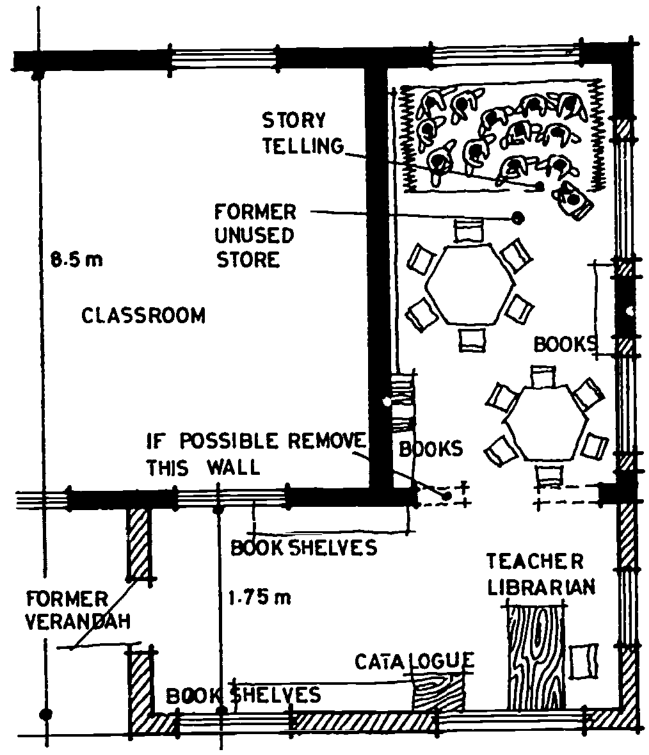


FIG. 151 NEW CONSTRUCTION THUS

with the real needs for teaching spaces of various sorts, such as spaces for management, libraries, stores and the like. Many of Asia's schools are so overcrowded that classes have to be held on the verandah the covered area of which could be much more sensibly disposed into spaces more convenient for classroom teaching.

Thus, where verandahs exist, they can confidently be used, at least in part, for library accommodation as is suggested in Figure 151. In hot-humid climates the arrangement should be such as not to obstruct cross ventilation through the adjacent classroom. The area of the accommodation shown in the figure is $30.75m^2$ and, as it is suitable for use by a half class of 20 children, the per place area is $1.54m.^2$ With the shelving shown, some 800 books could be housed. This is a small collection but, of course, a very much larger one than is normally found in many of the region's primary schools. It could, in the space shown, probably be doubled.

Some interesting examples of the adaptation of existing spaces for library use are given in (13.12) and (13.13).

In addition to the spaces suggested above, the idea of using half of the classroom assigned to the top grade in the school should always be considered as, with dropouts, this grade may occupy little more than half the classroom assigned to it. (See also chapter 14). Where the use of half of this classroom is suggested to house administration (Figure 164 c).

13.03 The Primary School Library

Where resources are sufficient to provide a properly designed and equipped primary school library, then a somewhat greater per place area than is suggested above would be needed. It seems likely in such situations, that the library will have the services of a trained librarian as well as a budget for a good stock of books and possibly some resource material such as atlases, globes, periodicals and perhaps even some audio visual aids. These functional requirements have implications for furniture and working space that can be quantified as follows:–

(i) Working Area for the Librarian

This should be large enough for a desk and chair and for shelves for books awaiting classification or repair (the wear and tear on books when they are in short supply is heavier than when books are more readily available). There should also be a storage cupboard for repair materials, catalogue cards etc., and a short length of work bench with sink and water. Usually the librarian will be single-handed and the desk will need to be located so that outgoing and incoming books can be checked and the library kept under observation. A space open to the shelves and reading areas is thus to be preferred to a closed work room in all but the very largest primary school libraries. Figure 152 indicates the accommodation needs of the librarian.

(ii) Book Shelving

The shelving for books should be of appropriate dimensions in relation both to the body sizes of primary school children and to primary school books, which usually tend to be larger than books intended for older children and adults.

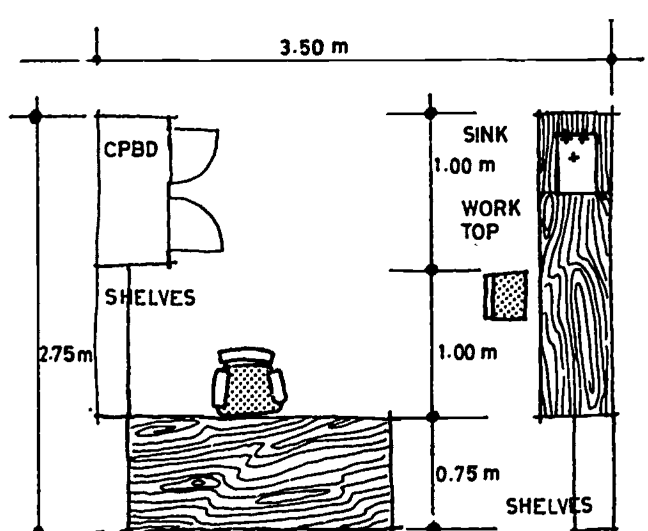


FIG. 152

Suitable cross sections of shelving for 6 and 13 year old children are shown in Figure 153. The dimensions of books are given (13.11) as:–

25 cm high x 18 cm wide } illustrated volumes
18 cm high x 25 cm wide } for the very young.

20 cm high x 13.5 cm wide } for text books
13.5 cm high x 20 cm wide } all ages.

The fact that the reference quoted (13.11) is, itself, 27 cm high x 21 cm wide suggests that the best type of shelving will be adjustable, for standardisation in the field of book production, whilst no doubt desirable, has not yet been achieved. The size of this book makes the point. The length of shelving required will depend on the number of books. One metre length of shelf will hold about 60 picture books and 30 books of the size of text books.

(iii) Display Shelving

One of the problems of the young child is deciding "what" to read. Books conventionally arranged on shelves with only the titles visible will not help a primary school child, especially from the lower grades, to choose a book. What is needed are shelves on which books can be arranged so that the front cover, which is often a coloured picture, can be seen. The normal shelf, illustrated in Figure 153, is quite suitable for this purpose, if a loose insert is slipped into its upper surface as shown in Figure 154. Where some of the collection is exhibited in this way more shelving is required.

(iv) The Catalogue

As one of the aims of encouraging children to use books is to enable them to find what they want to read, they have, eventually, to learn how to use a card catalogue. In the lower grades of the primary school, a *general* indication of the location of books based on content or some other criteria is all that is needed and can be given on sheets of paper pinned up on the library walls near the shelves. Pin-up boards should be liberally provided for this purpose. The catalogue itself is a standard set of drawers in which the catalogue cards are kept. For a small library perhaps five or six drawers will be sufficient. The important point is that they should be low enough for children, to look into them.

(v) Seating in the Library

Very young children will usually be happy to look at books while sitting on the floor. Mats are necessary in part of the library for this purpose. Standard classroom double desks as shown in Figure 79 can be used for the older children and arranged in a variety of ways.

The number of seats required will be optimal for 10% of the population of the school (13.14) and in any case, for not less than one class of children. Where insufficient money is available then, as has been suggested above, the seating accommodation should be adequate for half a class.

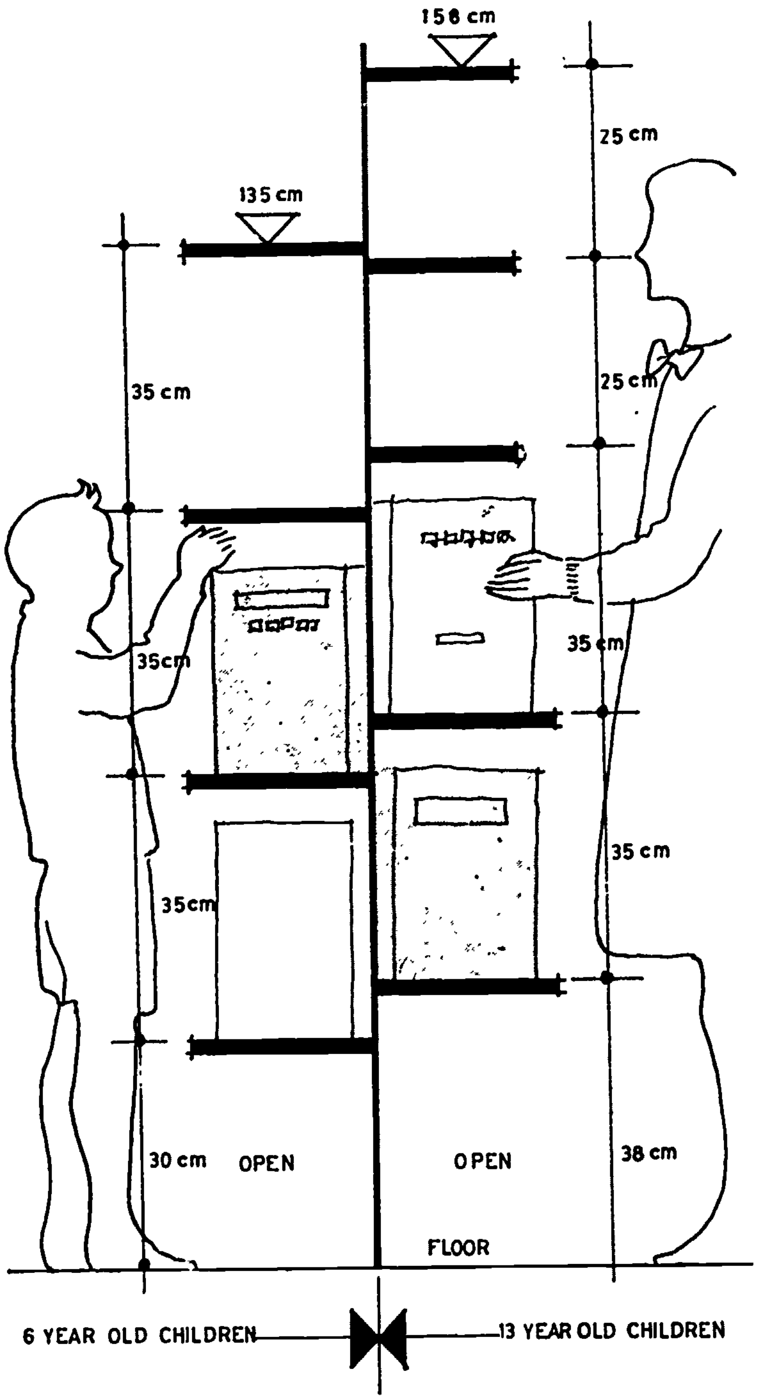


FIG. 153

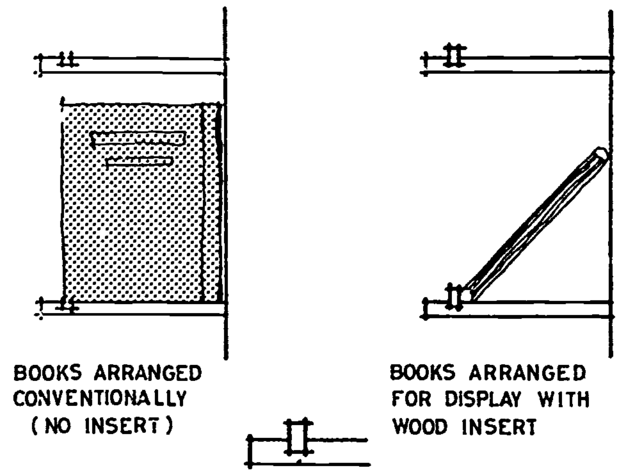
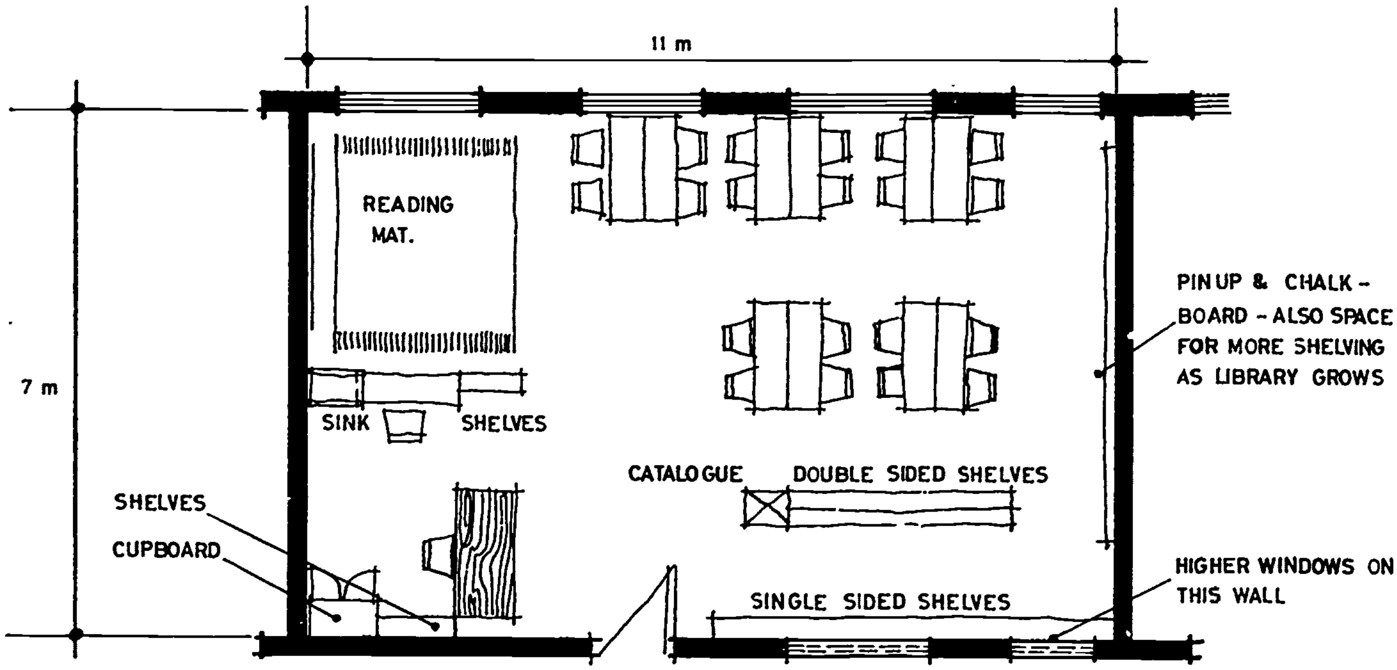
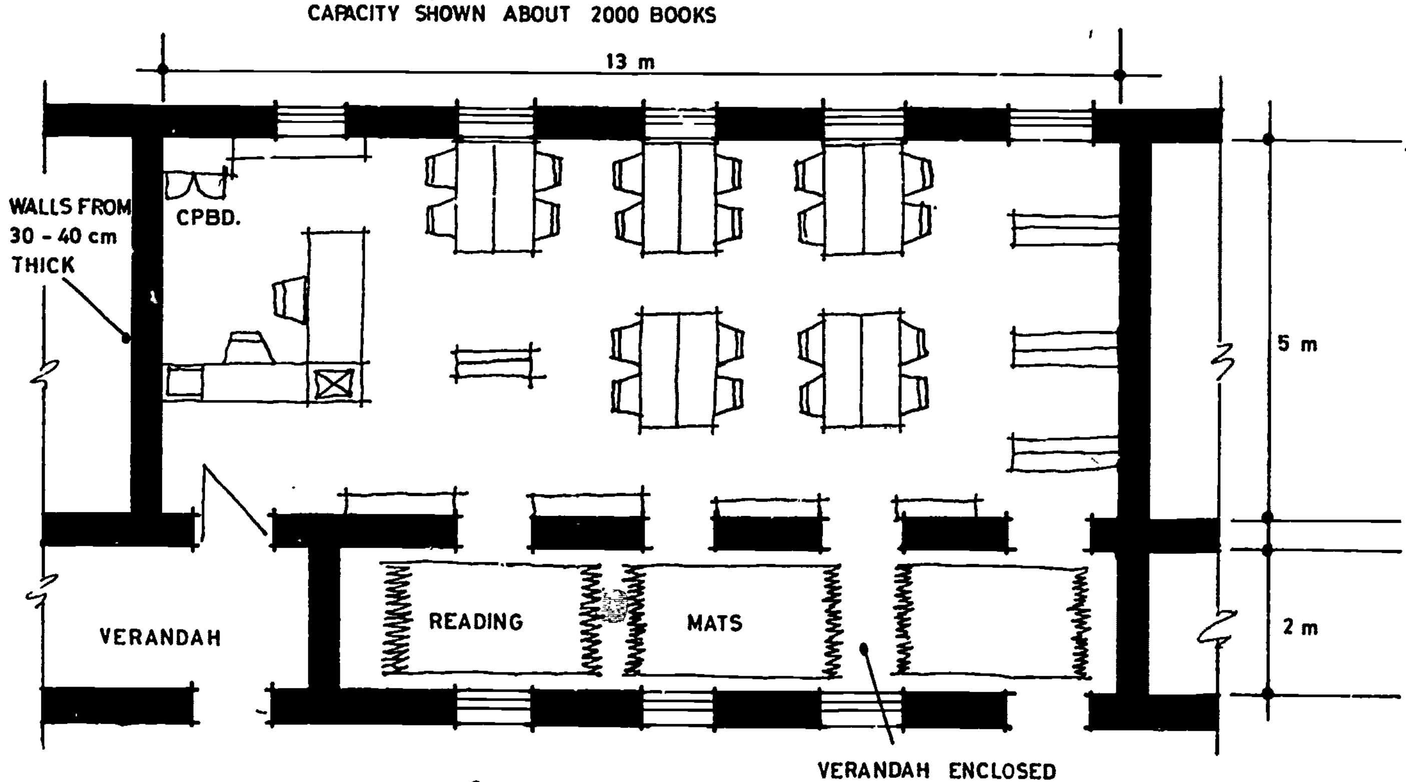


FIG. 154

Figure 155 suggests arrangements of the elements, i) to v) above in the form of primary school libraries for buildings with spans of 7 or 8 metres and for buildings in mountainous areas with much narrower spans. The 20 place library on the 7 metres span building has a per place area of 3.60m²; the library in the 5 metre span building has a 4.30m² per place area.



20 PLACE LIBRARY (3.6 m^2/ PLACE)
CAPACITY SHOWN ABOUT 2000 BOOKS



20 PLACE LIBRARY (4·3 m^2/ PLACE)

FIG. 155 CAPACITY SHOWN ABOUT 3000 BOOKS

13.04 Libraries for Secondary Schools

The function of a secondary school library is to provide a wide range of resource material using which the students can:-

(a) extend their reading beyond that of the standard text books:

(b) undertake learning assignments set in the class-room and requiring a variety of books and reference material.

It should be possible for a teacher to discuss a topic with the students, to decide with them how it is to be studied and for the students to move to the library to complete the work using the library resources. In a secondary school, it is thus important to timetable library use. A double period can be assigned for a subject area, the first period in the classroom or laboratory and the second in the library.

In addition to this, individual use will be made of the library by students and by the school staff. There should thus ideally be seating accommodation for one class as well as for individual readers. The provision of chairs and desks for 10% of the student population will usually be found adequate for schools of 500 places (40 places in the library for one class and 10 places for individuals). In schools of 3,000 places, the figure of 10% could be reduced to 7% giving 210 places.

In India, where 600 to 700 place higher secondary schools are common, the National Buildings Organisation has recommended libraries to seat 42 students and accommodate 6,000 books (13.5; 13.15)(Figure 144) and this would seem to represent a good target for libraries for secondary schools in many other countries of the region.

The basic differences between primary and secondary school libraries are the need for more desks and chairs for reading and working (mats on the floor are not appropriate) and, because of the larger numbers of books, and the greater likelihood of a full time librarian, a separate work room for receiving new books and preparing them for the shelves as well as for repairing damaged books. In addition, a larger card catalogue and more shelving will be required.

(i) Shelving

The mean standing heights of secondary students range from 146 cm at 14 years of age to an adult stature of about 163 cm. The shelving needed will thus be quite different from that for primary schools, although the need for adjustment to fit books of varying sizes will be the same. Figure 156 suggests a suitable profile Note that the common practice of arranging books down almost to floor level is *not* recommended. It leads to aching backs and may encourage white ant under the plinth. The figure also indicates a profile for periodicals shelving and the larger reference books, etc., that are a common feature of second level school libraries.

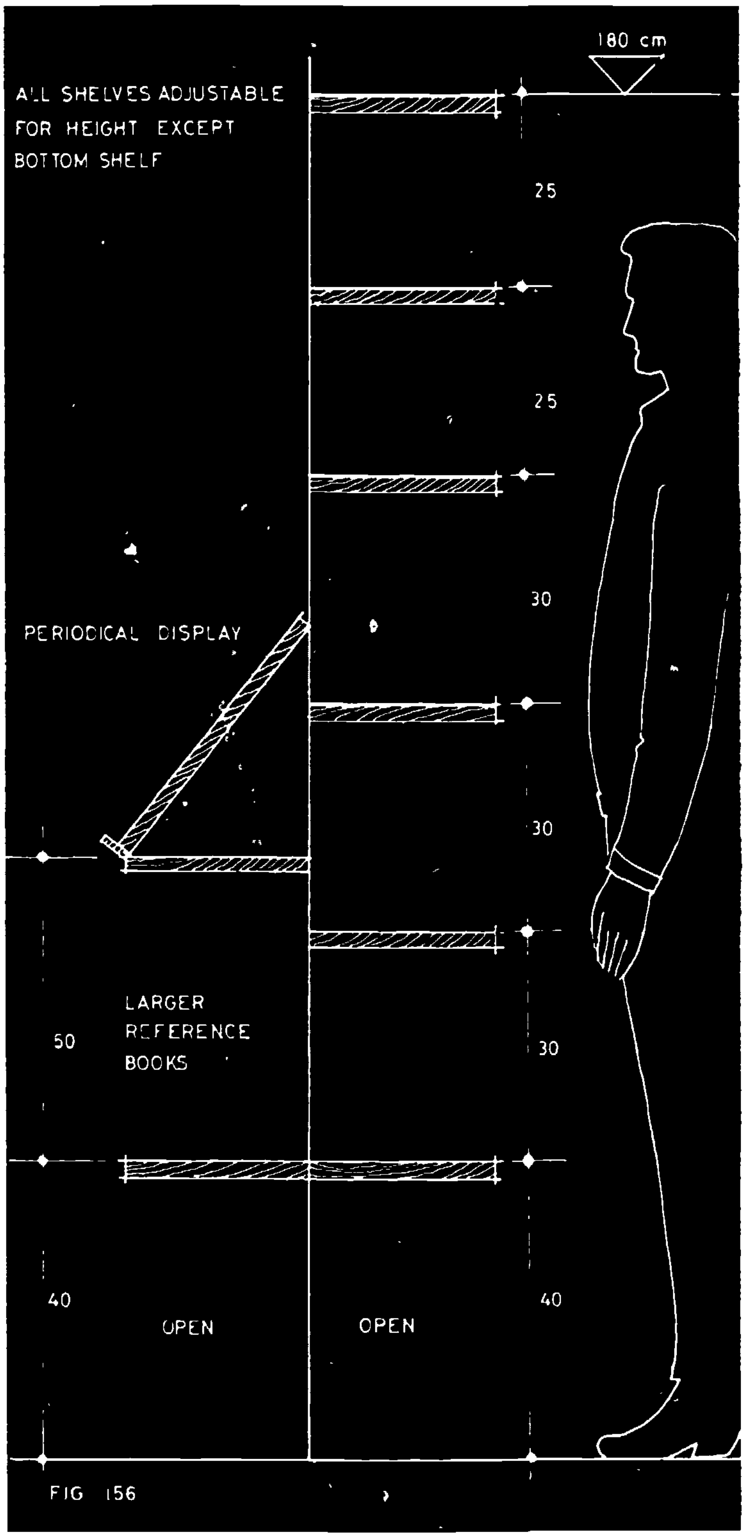


FIG 156

(ii) Working Areas for the Library Staff

Two areas are needed – a workroom cum librarian's room and an area for controlling activities in the main library, such as issuing and receiving books. The workroom accommodation can be similar to that shown in Figure 152 with shelving to accommodate about 600 books and an extra storage cupboard. The counter or desk at which books are loaned or returned should be about 2 metres long with shelving under the counter top on which temporarily to place returned books.

In addition, the library should have sufficient space for pin-up boards and various items of mobile or free-standing equipment such as dictionary and atlas stands, book trolley, card catalogue cabinet etc. Figure 157 illustrates an arrangement of a library to seat 50 students and accommodate 6,000 books. Note that, as in the primary school library, desks should be arranged so that light falls from the side of the student.

Finally, in respect of location of the secondary school library in the building, the question of possible future use by the community – especially rural communities – should be considered. Where community use is planned or can be foreseen, the library should be easy of access from the site entrance.

13.05 The Library as a Resource Centre for Learning

Passing reference has been made in this chapter to the library as a resource centre. In some countries, notably the U.S.A., the school library in a number of recently designed buildings, has been completely replaced by an accommodation element known as "the resource centre for learning" in which books are only one of a wide variety of resources. These resources may include individual television screens which can be tuned to individually pre-selected video tapes; telephone connections to computers; film loops; tape recorders with tapes available to cover a wide variety of subject areas and, of course, books, maps and similar material. The resource centre is essentially based on the individual and his or her learning needs and may use a considerable amount of electronic equipment.

In the Asian region it may be anticipated that Japan, with its highly developed electronics and audio-visual industries, will make greater use of the resource centre concept in years to come. If the hardware becomes *much* cheaper in the future then resource centres, which are well described in (13.16; 13.17; 13.18; 13.19) may slowly begin to be provided in other Asian countries.

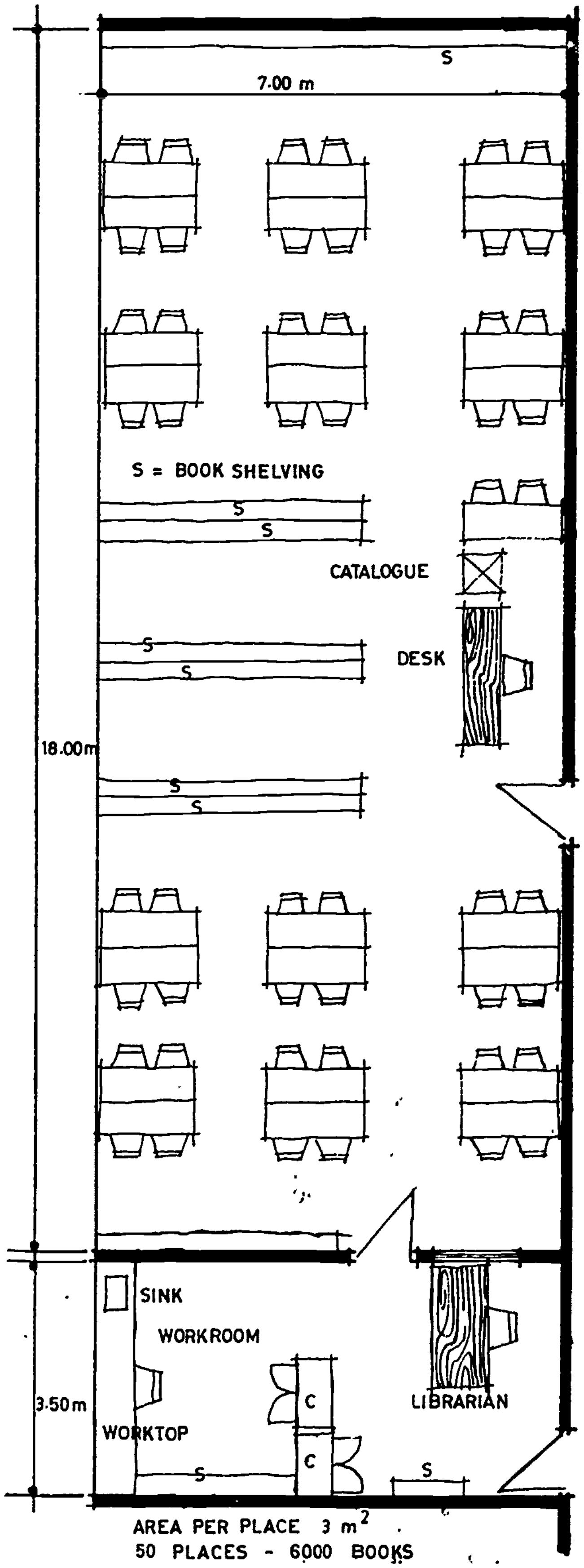


FIG. 157

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Chapter 14

FACILITIES FOR SCHOOL MANAGEMENT

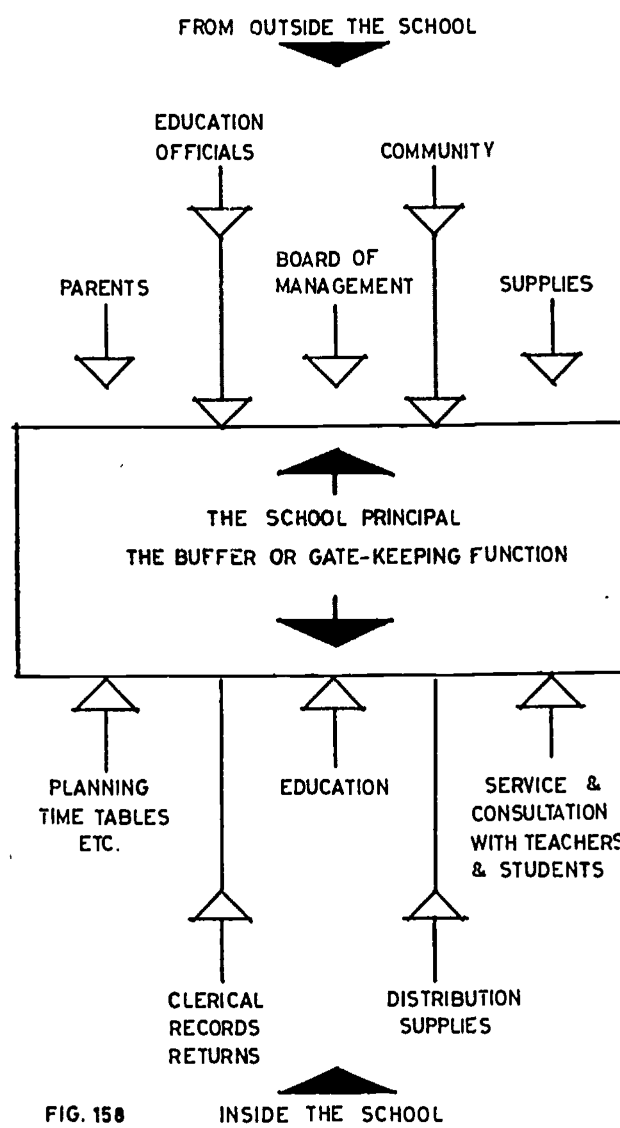
FROM OUTSIDE THE SCHOOL
EDUCATION OFFICIALS
COMMUNITY
PARENTS
BOARD OF MANAGEMENT
SUPPLIES
THE SCHOOL PRINCIPAL
THE BUFFER OR GATE-KEEPING FUNCTION
PLANNING TIME TABLES ETC.
EDUCATION
SERVICE & CONSULTATION WITH TEACHERS & STUDENTS
CLERICAL RECORDS RETURNS
DISTRIBUTION SUPPLIES
INSIDE THE SCHOOL

FIG. 158

14.01 General

It will be evident from reading the earlier chapters of this book that, whilst the main objective of education is to develop the child's mind, character and intellect, the main purpose of school management is to enable the teacher and the child to pursue this objective without hindrance. The business of arranging this is somewhat complex. It involves control of physical plant, guidance of teachers, provision of equipment and material for teaching and learning, the maintenance of records of attendance and progress and the concomitant contact with the outside world in the shape of parents, education officials, the local community, and so on.

There is, in short, in every school, a management function, the successful exercise of which will be reflected in the quality of education provided in the classroom. In almost all countries of the region, this is one of the functions of the principal of the school, assisted, depending on the enrolment, by teachers, clerks and maintenance staff.

Management, it is now well recognised, is no less a discipline than pedagogy. Managers, like teachers, are, in many countries of the world, selected for their experience and training and the application of modern management techniques by skilled, trained managers has become a common feature of business, industry and other organisations such as the armed services. Indeed, in some of Unesco's Member States, it would be unusual to find a firm of some 2,000 employees without one or more qualifications in business administration or business management among its senior staff. It would, however, be very unusual indeed to find a secondary school of 2,000 pupils, 65 teachers and a dozen clerical and maintenance staff with a principal who was trained in anything other than an academic subject and possibly, though not necessarily, pedagogy. The introduction of management to schools has not yet, in any formal sense, occurred. Where large schools are apparently well run – and there are many well managed, large schools in the Asian region – it is due to the experience and imagination of outstanding principals, in much the same way as, where good teaching occurs with untrained teachers, the individual concerned displays more than the usual facility in his or her approach to education.

This situation is, however, unlikely to continue. Just as it is universally accepted that the quality of education is likely to be raised through the increased use of trained, rather than untrained teachers, so it seems, must quality of school management be improved through training in these specialized skills.

In 1970, at a notable Asian Regional Seminar (14.1), one of the recommendations to Unesco's Asian Member States was that the feasibility be considered of introducing management techniques, applicable to education, as part of teacher education curricula.

It would be misleading to suggest that this will result in the production in the near future of large numbers of school principals trained as managers as well as pedagogues; it will not. However, as most buildings built now will be in use twenty or thirty years hence, they will almost certainly ultimately be used for education, the management of which is much better developed than it is at present. There is, thus, a strong case to be made for the design of facilities which not only help today's principals in their management tasks, but which will meet the more exacting needs of the management-trained principals of the future.

An important corollary to this, based on current experience in schools of many countries of the region is that, *where the designer makes no provision for spaces for administration/management, teaching or other areas will be taken over for this purpose at the expense of other functions.*

That spaces for management, such as a principal's office, general store etc., are so often not provided, is due usually, not to any lack of understanding of their necessity, but usually to inability to allocate the limited resources in a balanced way between teaching and non-teaching areas in the school. Typically, schools, often having expensive verandahs for which there is very rarely any functional justification, lack even the smallest office from which the principal can manage the affairs of the school, however small. This is a simple example of failure to establish priorities in design in relation to the overwhelming need to improve educational quality through the provision of more functional buildings. It would, perhaps, be less common if designers understood the functional requirements of educational management.

14.02 The Functional Requirements of Educational Management

Dayal (14.2) has suggested that an important task for institutional management and in particular, one which should be performed by the principal and the immediate administrative staff, is the buffer or "gate-keeping" function in which those within the institution are shielded from constant interference from the external environment so that internal activities can continue in a stable manner. This suggests, in the context of school building design, the need for identification of an area within the school at which those from outside can 'face' the person or persons responsible for managing its internal affairs. Figure 158 illustrates some of the main external influences and internal functions; the responsibility for linking these functions is that of the principal. The work of the designer is to provide facilities for this linkage which are as economical and as simple as possible in relation to the size of the school and the resources available for construction. Obviously there will be differences in scale depending on:–

(a) The enrolment;

(b) The number of teachers;

(c) The number of ancillary or non-teaching staff;

(d) The level of education, type of curriculum and methods of education;

(e) The rules and regulations of the education authority;

(f) The services to be provided;

(g) The situation – urban and rural.

It will be evident that in a small, rural primary school, little more than a small space for meetings, records and storage of supplies will be needed. In a larger, urban secondary school it may be necessary to provide a waiting space, principal's office, large enough for meetings, staff room(s), clerical office, records and duplicating space, ancillary staff room, store(s), guidance offices and medical and rest rooms.

Another view of the school as an organisation is given in (14.3) in which the administrative and academic functions are seen as the predominant characteristics of the school.

At both the first and second levels of education, the need for spaces for management is likely to grow. As the quality of education improves, it seems likely that retention will increase and this will lead to higher enrolments in individual schools. In some countries, especially at the first level of education, automatic promotion from grade to grade is replacing examination based progression through the school, but this often involves the maintenance of more complicated individual records for each child with a resulting need for better record storage facilities. The need for guidance services for children is becoming increasingly to be recognised. A guidance counsellor's room has long been a feature for example, of Philippines schools whilst, in Iran, so-called "guidance-cycle" schools are provided for children between the first and second levels of education and the building facilities include provision for guidance counselling.

As more and more teachers are trained, the pupil-teacher ratio will decrease and the need for staffrooms become greater. In many countries services such as regular medical and dental inspection are being provided. In urban Colombo, for example, a number of key schools have their own dental clinics serving, not only the school in which they are located, but also a net-work of surrounding schools. Frequently, the principal, in addition to what might seem to be already onerous enough duties, is required to collect salaries and pay the teaching and ancillary staff. The demands for more data for educational planning make it unlikely that the number of returns to the controlling education authority will decrease and this is a further administrative task that falls to the management of the school.

Some idea of the present provision of facilities for management in the secondary schools of selected countries of the region is given in 14.6; 14.7; 14.8 and 14.9 and this information, to which has been added data for schools in Afghanistan, Iran and the Union Territory of Delhi, India, is given in Table XXIII:

Table XXIII

AREAS FOR MANAGEMENT ADMINISTRATION IN SECOND LEVEL SCHOOL IN THE REGION EXPRESSED AS A PERCENTAGE OF THE TOTAL AREA OF TEACHING SPACES

Country	*Management Areas as Percentage of Total Teaching Area*
India	from 1.9 to 5.8%
Ceylon	from 2.0 to 4.0%
Malaysia	from 6.8 to 8.0%
Singapore	from 3.3 to 6.3%
Khmer Republic	from 4.6 to 24.0%
Afghanistan	from 8.8 to 17.4%
Iran	from 7.9 to 22.8%

The facilities for management will be seen from the foregoing, to vary somewhat from country to country and from place to place. (See also (14.4); (14.5): (14.6); (14.7)).

An approach to the design of facilities is probably thus best given through two examples – a small rural school and a larger, urban school. The methods suggested for design can then be extrapolated to any other situation.

14.03 Facilities for Management/Administration of a Small, Rural School

The school for which the facility for management is needed comprises 200 children in five grades with five teachers, one of whom acts as headmaster. Two of the teachers are female. All books, materials etc. are provided by the central education authority which is also responsible for paying the teachers and for inspection and curriculum. The authority requires the headmaster to maintain registers of daily attendance of teachers and children, an inventory of furniture, equipment and materials and to submit periodic returns on these matters. Promotion is automatic from grade to grade and a record card is kept for each child on which is regularly noted his or her progress for the entire five years of primary education. This progress is to be communicated annually, or more frequently if necessary, to the child's parents and the child. The education authority encourages a link between the community and the school through a small three member board of management, drawn from villages near the school, which meets monthly, and through a parent-teacher association that meets once a term. Both of these organisations require clerical support from the school staff.

The elements of accommodation suggested by this description are:–

(a) Waiting-cum-meeting area for 5 persons (that is for teachers' meetings/the head meeting with the management board or parent-teachers association representatives/head meeting with parents and child/head meeting with education officials).

The space needed is shown in Figure 159 and should be just sufficient for five comfortable chairs and a low table;

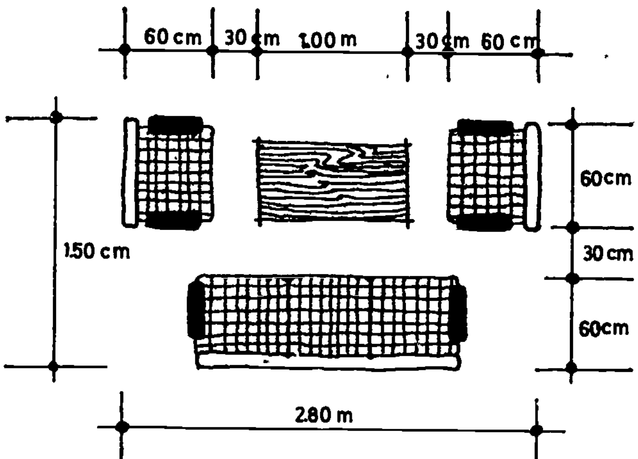

FIG. 159

(b) The working space for the headmaster/mistress in which are located a desk, chair, typing table and bookshelf (Figure 160);
(Many primary schools may not at present have a typewriter but space should be included for this)

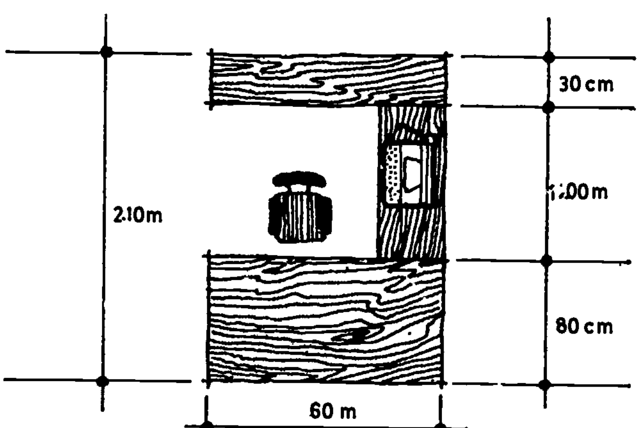

FIG. 160

(c) Individual working spaces for four teachers (records, marking etc.), one of which is shown in Figure 161;

(Note that the spaces and the small tables and chairs are extra to those provided in the classroom);

(d) Space for storage of student's records, registers, copies of returns to education authority, inventory of equipment, furniture and materials; storage for text books, maps and other teaching aids, not currently in use in teaching spaces; small safe for cash (teachers' salaries, petty cash P. T. A. funds) (Figure 162);

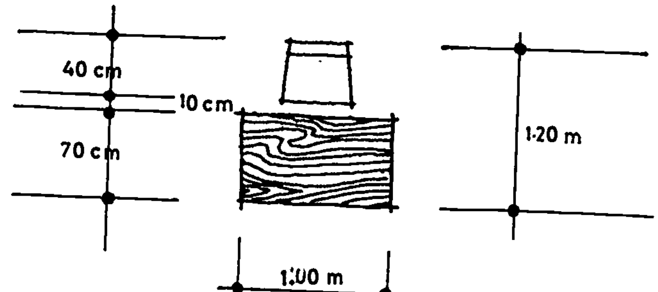

FIG. 161

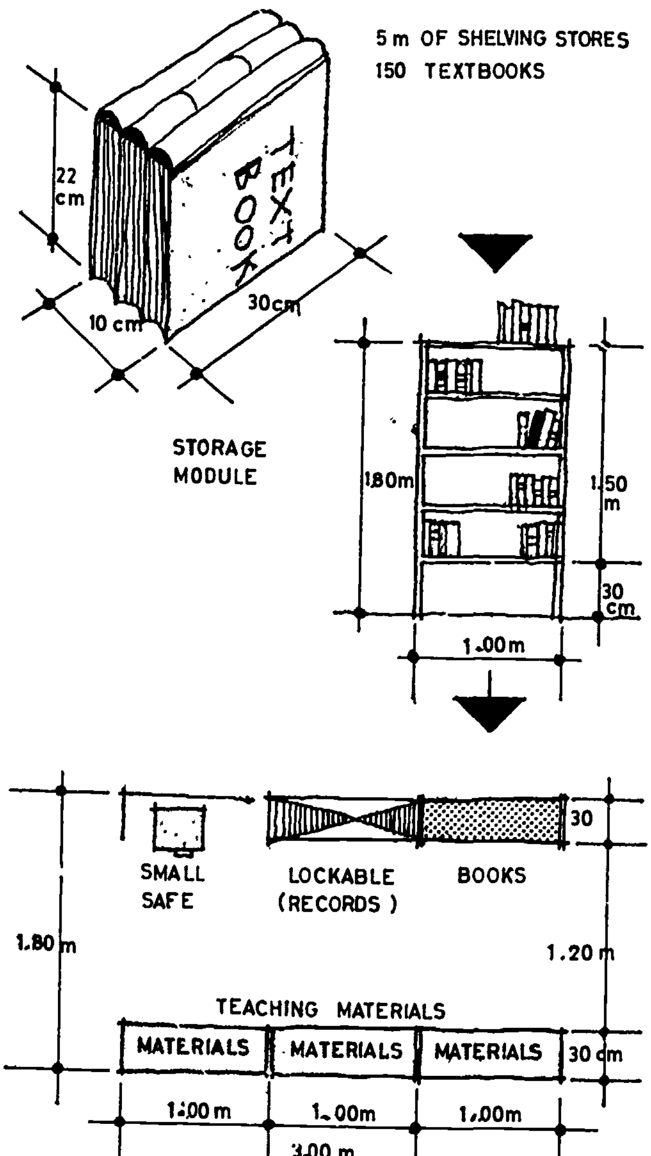

FIG.162

(e) space for storage of garden tools, cleaning materials, balls, nets, etc., for physical education (Figure 163).

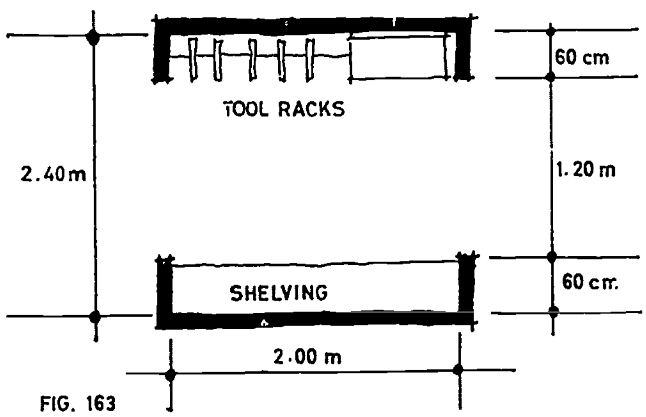

FIG. 163

These elements described in a) to e) and shown in Figures 159 to 163 above, can be combined in a variety of ways, one of which is shown in Figure 164a. It will be noted that the entire facility occupies 32 m^2. If reference is made to Chapter 7: Classrooms, it will be seen that the total teaching area for a 200 place, 5 classroom primary school is about 200 m^2. The space suggested for management is thus approximately 16% of the teaching area.

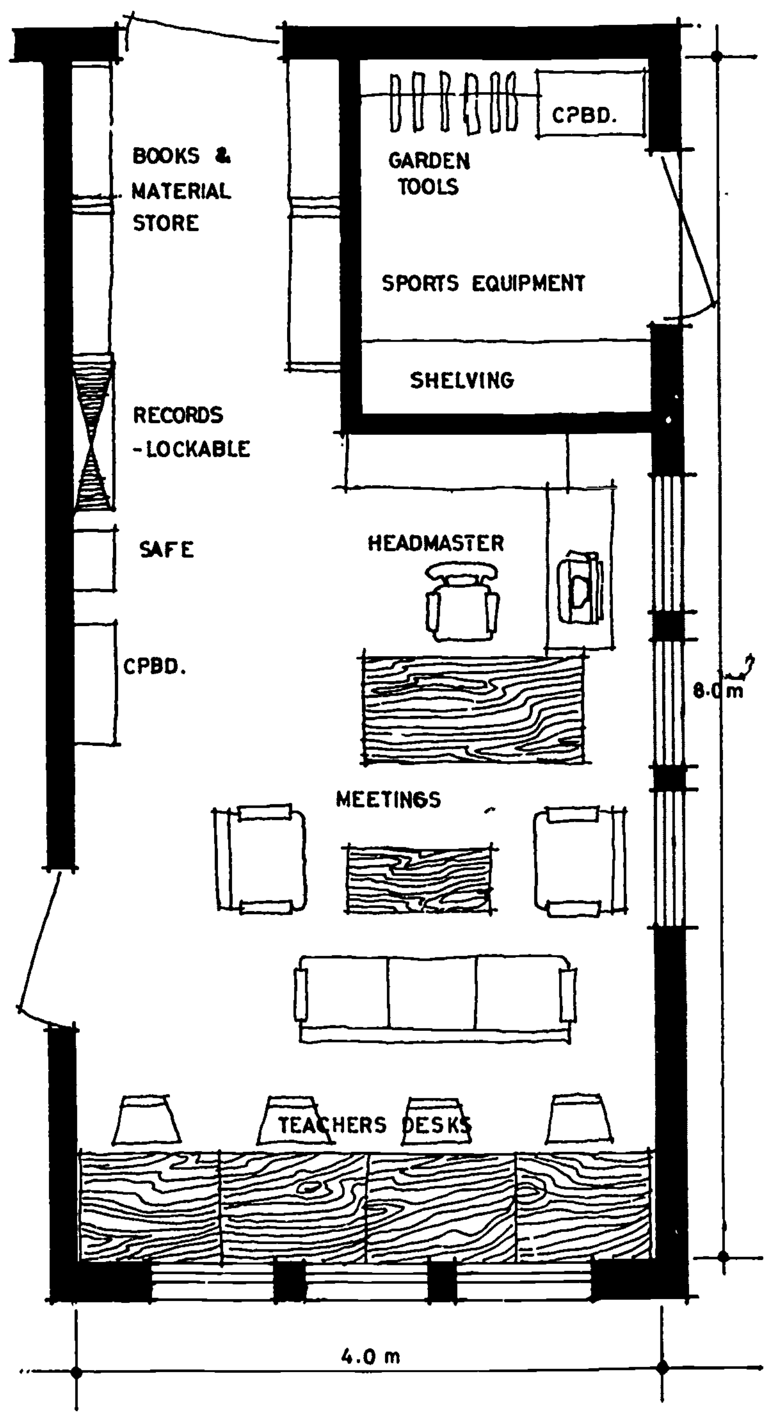

FIG. 164 a

Figure 164b shows a suggested arrangement for a school in mountainous areas where building materials limit spans to 4 or 5 metres. Figure 164c shows a temporary, yet well reasoned use of classroom space for management purposes that is sometimes found in primary schools in the region. In Chapter 1, reference is made to the practice of providing a number of class rooms, all equal in area, in schools where, due to drop-outs, a grade 1 class of 60, might be reduced to 20 children at grade 5. Where this sort of situation exists, the grade 5 children will obviously be occupying a room that is much larger than is necessary. This room can be temporarily partitioned with cupboards such that part of it is used for teaching (possibly by the headmaster) and the other part made the headmaster's office for management of the school.

It is mentioned earlier in this book, that, where the issue of furniture and equipment for schools is usually not well organised by the education authority it is recommended that the designer provide as much "built-in" furniture in the building design as is possible. A study of the elements of the management unit in Figures 164a to 164c will show that all of them can be provided as built-in fittings except, possibly, the chairs and table in the meeting area. It will also be noted that whilst the unit suggested is adequate for a 200 place school, it would not be inadequate for a school of three or four hundred places.

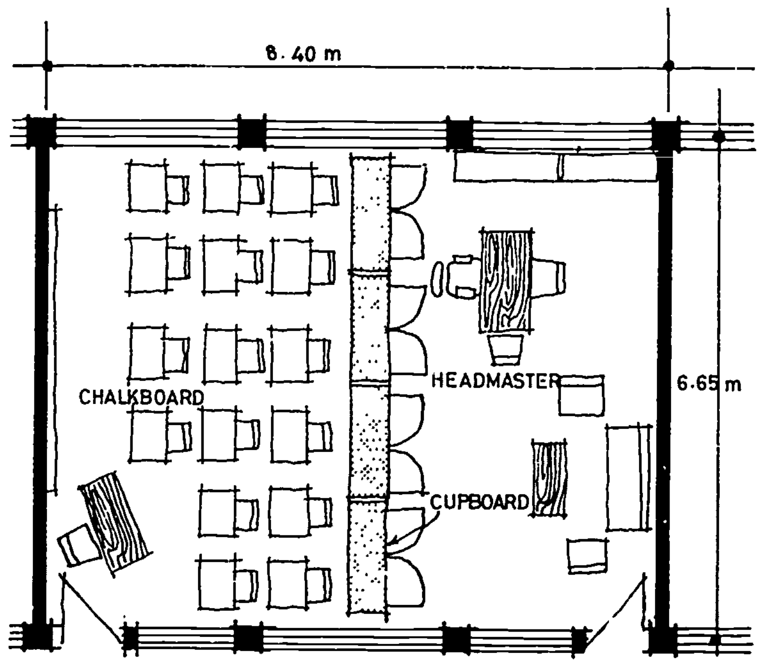

FIG. 164 c

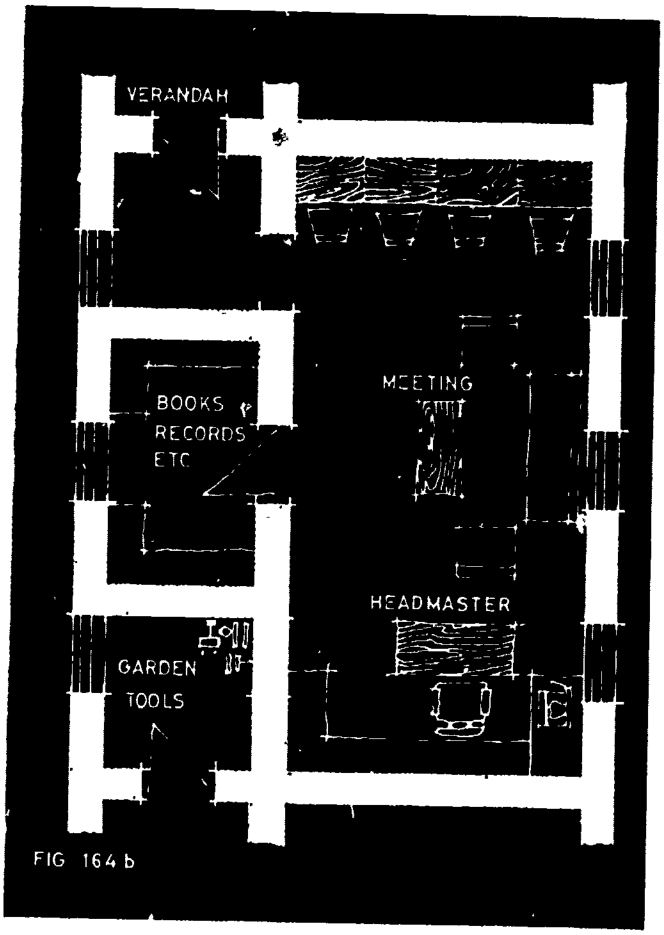

FIG 164 b

14.04 Facilities for Management/Administration of the Larger, Urban School

The urban school for which the facility for management is required is a secondary school, grades IX to XII with an enrolment of 500 girls and 900 boys. The staff comprises a principal and the following:–

Teaching staff (total 47)

- 4 heads of departments (one of whom acts as deputy principal)
- 6 subject heads
- 37 teachers (20 female; 17 male, two of which act as guidance counsellors)

Administration staff (total 3)

- 1 full-time clerk/secretary
- 1 part/time clerk
- 1 typist

Maintenance staff (total 7)

- 2 laboratory attendants
- 1 resident school keeper
- 3 cleaning staff
- 1 gardener

The relationship between the school and the education authority is as described in 14.03, above, for the rural primary school with the following differences:–

(i) There are public examinations conducted in the school at grades X and XII;

(ii) Students provide most of their own books and those not provided are kept in the school library;

(iii) Teaching materials for sciences, industrial arts, home economics and equipment for sports and other outside activities are kept in stores attached to the laboratories or in the sports pavilion, as

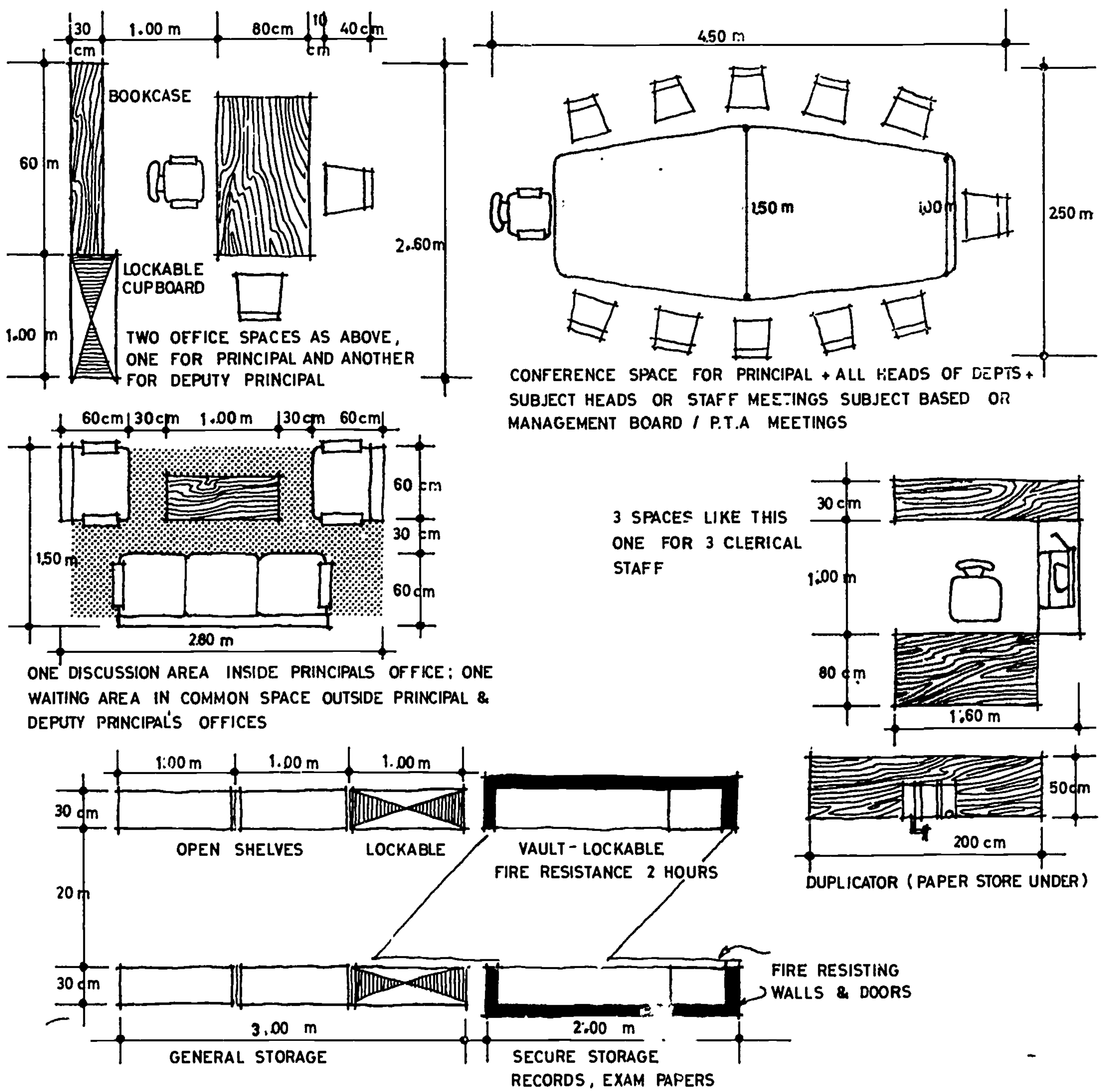

FIG. 165

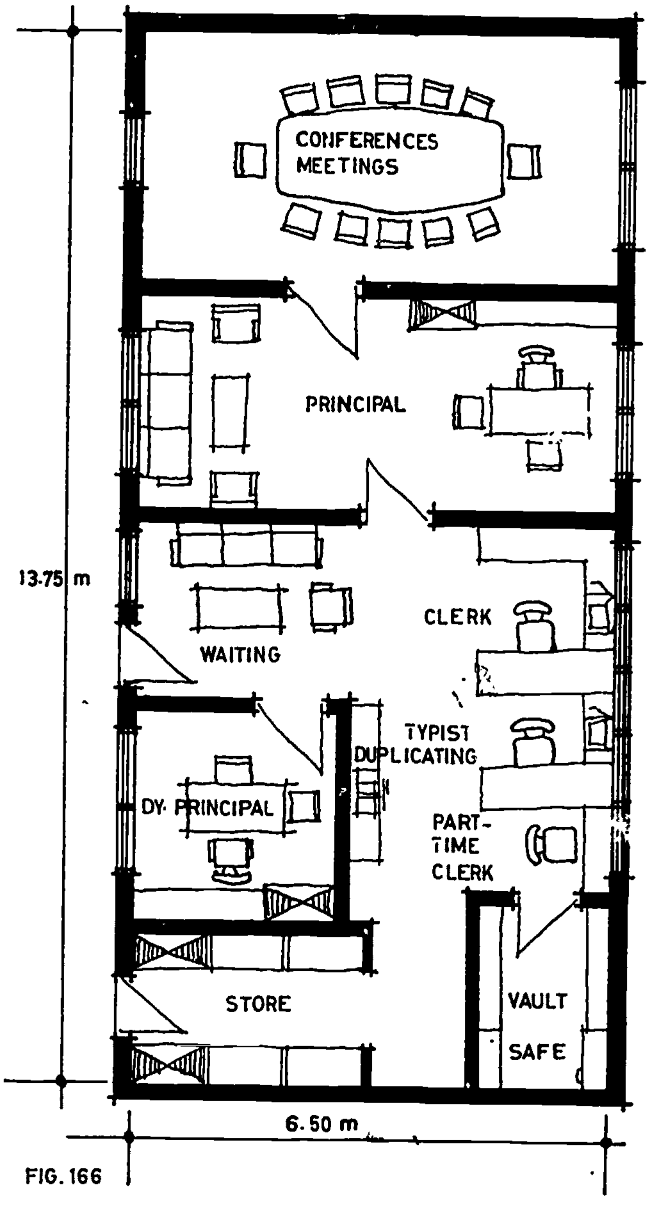

FIG. 166

appropriate. The need for central storage is thus confined to items of common use such as stocks of chalk, paper and the like;

(iv) For the students leaving school for employment, or further education or training, some at grade X and others at grade XII, separate guidance counselling facilities are needed for boys and girls;

(v) Heads of departments and subject heads all require offices in their departments with the exception of the deputy principal whose office has to be located close to that of the principal.

The elements of accommodation suggested by this description are discussed below. As the school is much larger than the primary school, described in 14.03 above, and as the nature of its management is more complex, involving a departmental structure, it will be evident that the facilities for management can be concentrated neither in one space, nor in one place in the building. The management accommodation required is as follows:–

(a) Suite of rooms for principal, deputy principal, administrative staff, waiting space, conference area and stores. The "gate-keeping" function of these rooms is somewhat more evident than is that of the single office in the primary school (14.03).

(Figure 165 suggests minimum elements for the main management facility and Figure 166 shows how they can be linked *ensuite*.)

(b) The teaching staff accommodation; in many, although not of course, all of the countries of the region, separate staff rooms will be required for male and female teaching staff. The functions of the staff room include provision of space for personal belongings, desks for preparation and marking and a relaxation area in which snacks can be taken. Such accommodation is rarely provided. This is regrettable as some 80% of the education budgets of most countries of the region are spent on staff salaries and, to put the matter at its lowest level, it would seem to be worthwhile to optimise on this investment by providing staff facilities which are likely to contribute to staff efficiency. Figure 167 shows the elements of a staff room. It should be noted that it will be quite adequate to provide seats for 60% of the staff as they are rarely all present together.

Thus, for the present example, seats and desks should be provided for about 12 female teachers and 10 males. Lockers should be provided for 35 of the staff in the staff room. The two guidance counsellors have their own rooms.

The combination of the elements in Figure 167 would, for the particular example under consideration, result in a women's staff room of approximately 40 m^2 and for men of 35 m^2.

(c) Offices for head of departments and subject heads can be small, as is shown in Figure 168 and, where possible, located adjacent to each other, separated by light partitions.

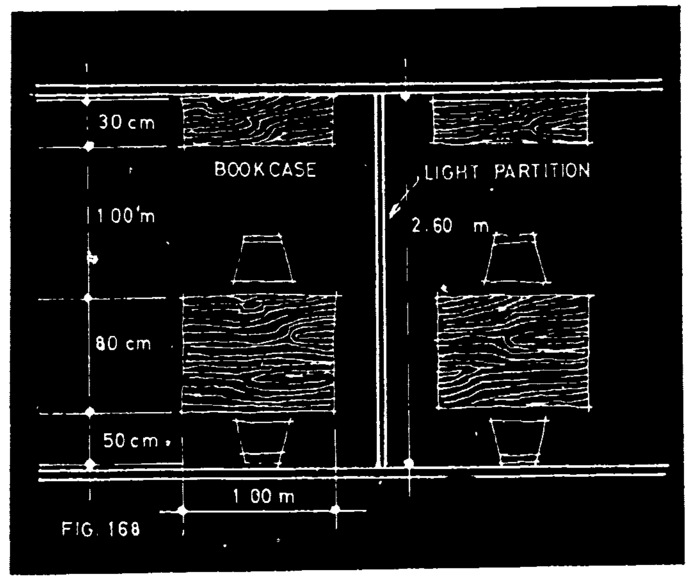

FIG. 168

(d) offices for guidance counsellors are shown in Figure 169. They should include, not only a desk and bookcase, but a small waiting area with display shelving for literature. A card index for details of individual students is an essential element of equipment.

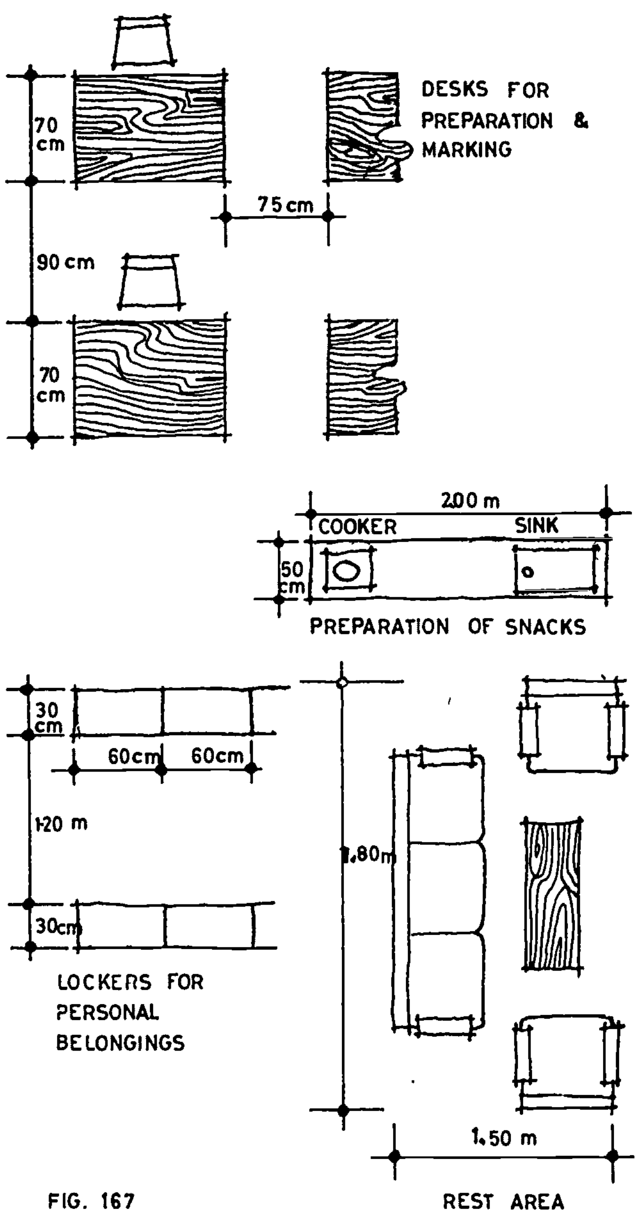

FIG. 167

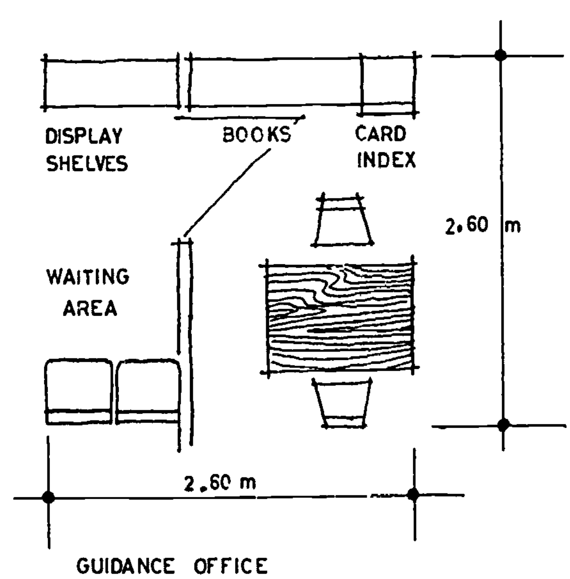

FIG. 169

14.05 Other Services

In the sense that one of the functions of management (14.02, f above), is the provision of services designed to improve the efficiency of the school as an educational unit, it is, of course, possible to extend the accommodation requirements greatly to include :-

(a) Canteens (and their kitchens, stores etc.) or other facilities for school meals such as tuck shops, steam heating chambers for warming food, brought by children in the colder countries of the region, etc;

(b) Special storage spaces for activities such as school cadets, scouts, guides and the like;

(c) Games and hobbies rooms and storage for clubs such as science clubs (which are recognised as forming an important informal aspect of science education) etc;

(d) Medical inspection rooms and dental clinics where there is provision for regular visits by doctors and dentists.

In providing for these activities, and at present they will usually only be found in the urban schools of the wealthier countries of the region, the approach followed by the designer should be that suggested generally throughout this book, namely, careful enquiry into the nature of the activities, their frequency and the average number of children and teachers involved per week, following which a space or spaces should be tailored as tightly as possible to provide for the needs. As much built-in furniture as is possible should be provided for, as a priority in most countries of the region, expenditure on activities of the sort listed above will be very low indeed and, if money can be found for spaces, it is possible that none will be left for furnishing them.

Where no money is available at all for building or furniture for administrative spaces, it will nevertheless often be well worth-while providing for these items in the overall design, so that subsequently the principal can use the drawings to raise money for construction through other sources such as the schools' Parent Teachers Association.

Figure 170 illustrates a guidance counsellor's suite for a school in Iran which was developed in co-operation with ARISBR. It should be noted that this unit includes a space for testing. A minimum facility would rely on the use of a classroom or other space for display purpose.

(e) About 4 beds should be provided in suitably secluded cubicles in a school of some 500 girls; at least four will quite commonly be in need of rest due to pain associated with menstruation. Two cubicles, each 3m x 2m will be adequate. If a medical inspection room is provided in the school, the cubicles could be adjacent to it, but with a private entrance;

(f) Storage for cleaning equipment will require a space of 1.80 m x 2.00 m.

The total minimum area required for effective management of the school is summarised below:

Main management unit (Figure 166)	90 m^2
Female teaching staff	40 m^2
Male teaching staff	35 m^2
Heads of departments and subject heads' offices (Figure 168)	24 m^2
Guidance counsellors office (Figure 169)	14 m^2
Girls' rest room	12 m^2
Cleaners' storage	4 m^2
Total	219 m^2

For a school of 1,400 places, this requires about 0.15 m^2 per place.

If we assume that the approximate per place area in teaching spaces for a school at this level of education is 4.5 m^2, then the total teaching area will be about 4,700 m^2 of which the area required for management represents about 5%.

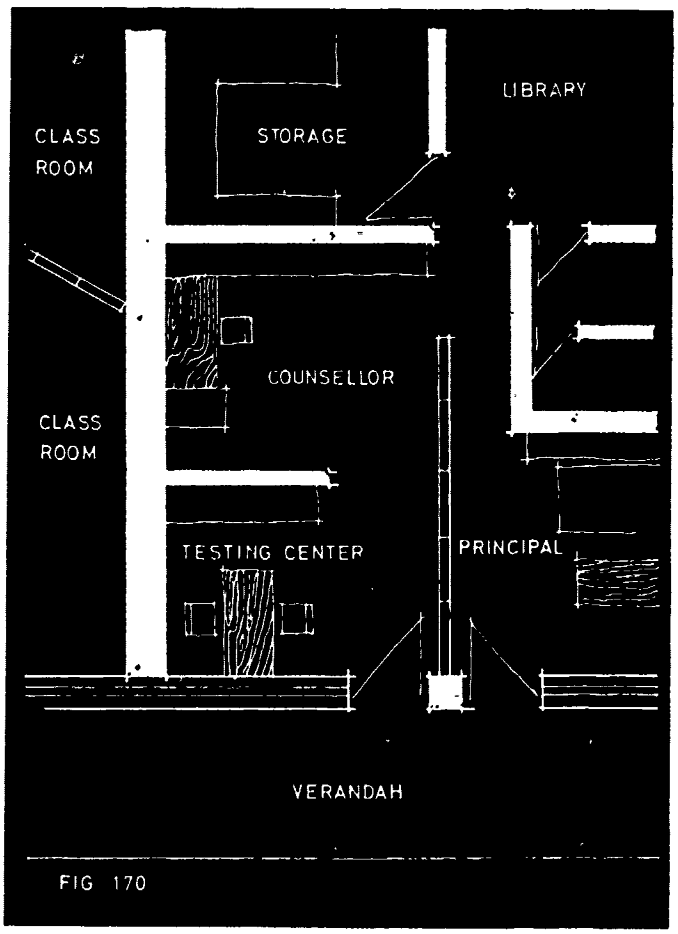

FIG 170

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Chapter 15

SERVICES FOR RURAL SCHOOLS

15.01 Scope

Services – that is the provision of water supply, sanitation, electricity and gas supply, telephones etc., is a wide ranging topic. This chapter is confined to a discussion of the provision of services in rural schools and to the two main problem areas – water supply and sanitation.

One of the main thrusts of the World Health Organisation's programmes during the past decade has been towards the improvement of water supply and sanitation in rural areas for small communities. This effort has been matched in the schools by the introduction of new curricula in health education. Unfortunately, health education often has had to be developed in rural school buildings, the facilities of which represent the antithesis of the content of the new curricula. Visits to hundreds of rural schools by the authors indicate that a great improvement in the existing situation could be made at very little cost in respect of water supply and sanitation and this chapter attempts to provide a few guide-lines for action in this respect. Those wishing for more detailed information than can be provided here are urged to consult the references (15.1) and (15.7) which contain a great deal of practical advice based on long years of experience of these problems in rural areas.

15.02 General

Services, as is suggested in Figure 171, involve continuing inputs, consumption and outputs. The provision of a service, such as water or electricity generally involves therefore, not only initial capital but also continuing or recurrent expenditure. Services are thus usually very expensive and it follows from this that a service should only be installed when it is absolutely essential. Attention has already been drawn in Chapter 9 :– Designing for Science, to the traditions of providing running water, gas and electricity in lower second level laboratories when, in fact, these services are not only totally unnecessary but, in the case of mains electrical supply, actually deprive children of opportunities to learn about electricity through the manipulation of dry or wet cells. The continuing investment in gas plants, so that children have their heat source at a Bunsen burner, is another example of wasteful capital and recurrent expenditure that, as has been mentioned in chapter 9, could be avoided through the use of simple spirit lamps or small primus stoves, both of which provide adequate heat sources for primary schools and lower second level science.

The question that has to be resolved in every situation is thus, "what are the *essential* services?" The answers will vary from place to place. Toilet facilities, which are regarded as necessary in some areas, are regarded as totally unnecessary in others; usually, it should be added, because they are not found in local homes, because they are thought to be expensive or, because their maintenance has been found to present insuperable problems. Several budgets for school building in the

SERVICES		
INPUTS ▶	CONSUMPTION ▶	OUTPUTS
SUPPLY OF :-	THROUGH :-	RESULTING IN :-
WATER	COOKING	WASTE WATER
ELECTRICITY	TAPS	SEWAGE
GASES	TOILETS	EXHAUST GASES
FUELS	LIGHTS / FANS	SMOKE
CHEMICALS	HEATERS	REFUSE
FOODS	TELEPHONES	
MATERIALS		

FIG. 171

Asian region contain no provision whatsoever for toilets or water supply to rural schools. Of course, local customs are an important consideration but, where costs or maintenance are the reasons given for not providing water or sanitation in a school, then, it is hoped this chapter will enable a more objective view of the situation to be taken. There can be little point in introducing subjects such as health education, home economics and the like in schools which have not even the most basic sanitary facilities. Water supply and toilets seem, to the authors, essential features of any school building in this day and age and these topics, therefore, receive the main attention in the following pages.

Whether or not to supply electricity, is a more difficult question, the answer to which depends on the activities planned for the school. If there is the possibility of regular use of the building for continuing education in the early evening, after dark, or, if there are boarding or residential facilities, then lights will be needed and electricity, if it is locally available, should be supplied, although not necessarily lavishly to the entire building. The curriculum of the school will provide the other guide as to needs for electrical power. At the first and lower second levels of education it will, more often than not, be unnecessary except in the rare case of schools having strong industrial arts/home economics courses, of which electrically powered equipment is an essential feature. At the upper second level mains electricity will usually be required, not only for these two subject areas, but also for science.

The important point about electrical installations is not only their high capital costs coupled with charges for consumption, but also that much maintenance is needed, such as replacement of defective light bulbs or tubes, fuses and the like. There are many rural schools as well as quite a few in Asia's urban areas today, where the administration of maintenance of electrical services has been unable to cope with repairs. The schools, it should be added – relevantly in this context – appear to continue to function as well without electricity as with it.

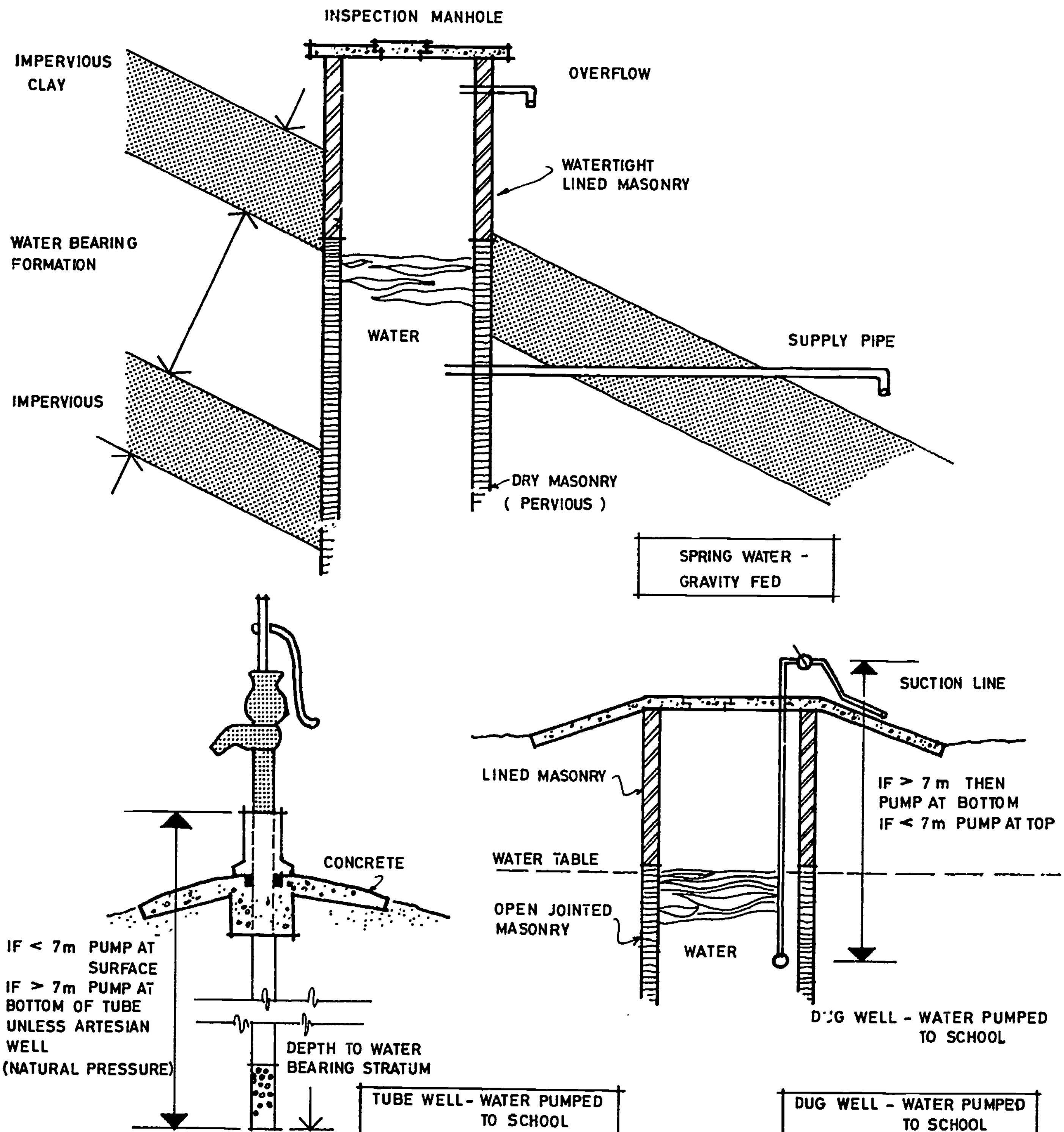

INSPECTION MANHOLE
IMPERVIOUS CLAY
OVERFLOW
WATERTIGHT LINED MASONRY
WATER BEARING FORMATION
WATER
SUPPLY PIPE
IMPERVIOUS
DRY MASONRY (PERVIOUS)
SPRING WATER - GRAVITY FED
SUCTION LINE
LINED MASONRY
IF > 7m THEN PUMP AT BOTTOM IF < 7m PUMP AT TOP
WATER TABLE
OPEN JOINTED MASONRY
WATER
D'JG WELL - WATER PUMPED TO SCHOOL
CONCRETE
IF < 7m PUMP AT SURFACE
IF > 7m PUMP AT BOTTOM OF TUBE UNLESS ARTESIAN WELL
(NATURAL PRESSURE)
DEPTH TO WATER BEARING STRATUM
TUBE WELL - WATER PUMPED TO SCHOOL
DUG WELL - WATER PUMPED TO SCHOOL

FIG. 172

There can be little if any case ever to be made for the supply of gas to rural schools, especially where electricity is available, for electrical energy can be converted into heat as easily as into light. Even in urban situations, the case against mains gas is strong, as the installation costs are likely to be very high indeed. Where gas is regarded as essential, then bottled gas, supplying Bunsen burners through loose rubber tubing, will save heavy installation charges and, moreover, provide a service which is compatible with the flexibility required in modern schools. The flexible use of spaces depends very much on the flexibility of the services.

15.03 Water Supply

The most authoritative work on rural water supply is that published by the World Health Organisation (W.H.O.) and the references should be used by those requiring more information on this topic (15.1;15.2).

Where main water supply is available, then, of course, it should be used. The laying of a water main is, however, an expensive business and the cost of distribution throughout the school building likely to be even higher. Moreover, wherever water is used, provision has to be made for its disposal as waste water through sinks, toilet fittings and the like. The provision of water to a single tap, therefore, costs more than might at first have been thought, for the real cost is given by the sum of

Water Supply Cost + Waste Water Drainage Cost

There is thus a strong case to be made for carefully examining the *real needs* for water. Reference has already been made in Chapter 9: Designing for Science, to this topic. One tap, sink and waste is quite adequate for primary and lower second level science laboratories. Even at the upper second level, the usual lavish provision of sinks in science laboratories would bear careful examination.

The real water supply problem exists, however, in areas where there is no main supply. In such situations, which are invariably in rural areas, the designer will have first, to check the available sources of natural water, decide which are suitable for consumption and which are not (these latter sources will, of course, usually be suitable for washing, toilets, gardening etc.) and, secondly, compare the costs of tapping the various supply alternatives that are available in sufficient quantity to meet the needs.

As important as quantity is the quality of the water supplied to schools. "Water plays a predominant role in the transmission of certain enteric bacterial infections, such as typhoid and paratyphoid fevers, bacillary dysentery and cholera" (15.1) (See also Figure 176).

Obviously a water source that requires no treatment to meet water quality standards will be the first of the alternatives to be considered. Spring water is usually potable and, where it can be delivered to the school by gravity then it will be preferred to a well from which the water must be pumped (Figure 172).

Other sources such as rivers, streams and lakes are to be avoided as sources of drinking water, as the water will require treatment (15.1; 15.2) and treatment is often unlikely to be maintained. Water collected from the roof of the building falls into this latter category.

Pollution of what appears to be a safe source must always be guarded against and obvious sources of contamination such as septic tanks and cess pits located well away from the point at which the water is drawn. In a recent survey of schools in one country of the region, the authors called for a *bacillus colli* count of a well located 15 metres from a full septic tank. The well water was found to be very heavily contaminated. Fortunately all water in this school used for drinking was boiled. Underground water sources should be tapped *at least* 35 metres from the nearest source of foul water (Figure 173) and there should be a test of the underground water before it is used for drinking.

Although in many areas there are good underground sources of water which are tapped by digging wells, the cost of pumps and their maintenance[1] and the cost of pipework to the school are excessive. As a result, water needed for sanitation, washing and in laboratories is often carried in buckets by the children from the well to the building. In one country of the region, the children carry the buckets up steps to a raised tank which feeds into the distribution pipes (Figure 174) to a formal laboratory, adjacent to the "water tower". Water carried in this way by buckets is *not* fit for consumption.

[1] *Attention is drawn to reference* (15.3) *"Bodek, How to construct a cheap wind machine for pumping* 100 *gal./hr. to* 10 *ft. head with a wind of 7 m.p.h."*

FIG 173

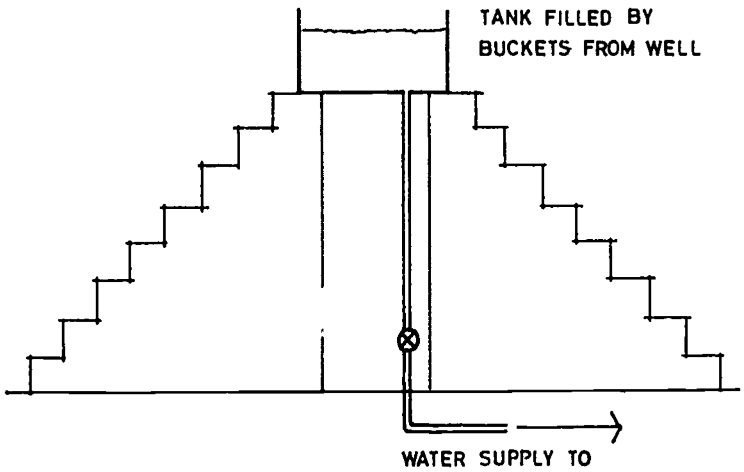


FIG. 174

Unfiltered rain water can be used for toilets, washing, watering the school garden during dry periods, for science (where it can be filtered in the laboratory), for crafts, arts and the like. Properly filtered and treated (as for example by boiling) it can be drunk (15.2). The storage of rain water should be in the locally cheapest tanks. These may be 180 litre (40 gallon) drums or concrete or plastic-lined wooden tanks. Figure 175 illustrates one such possibility using drums. It is important to cover the water storage unit to prevent it becoming a breeding place for mosquitoes.

Whilst in the dry inter-monsoonal periods of hot, humid Asia, the carrying of water from well to school building may sometimes be necessary, it will be seen that, with a rainfall of average 1500 mm (15.1), water collected directly from the roof of the school is the most convenient and inexpensive water source, although the water thus collected is *not* fit for consumption unless treated (15.2). A 200 place rural school with a roof area of 400 m² would receive 600,000 litres of water on its roof during the rainy seasons. Normally this water is allowed to run to waste; it filters through the ground and only some of it is drawn up from the well by the children for use in the school. Much of this expenditure of effort would be avoided if the rain water was delivered directly into tanks above the level of use, from which it could be directly tapped into the spaces where it was needed, such as the laboratories, toilets, special rooms etc. Assuming a somewhat liberal consumption of 10 litres (2.2 gallons) per place, per day, the annual rainfall will be sufficient for:-

$$0.8 \times \frac{600{,}000}{10 \times 200} = 240 \text{ days}$$

That is to say; if it were stored, for approximately the entire school year. *(Note:- the factor* 0.8 *allows for losses by evaporation etc.)*

But the problem of water supply in the humid tropics, with a rainfall of 1500 mm per annum, is infinitely easier to solve than that of the hot, dry zones where rainfall may vary from less than 220 mm (Pakistan) to 760 mm annually.

In parts of Sind and Punjab, 220 mm per annum on the roof of a 200 place school will produce 70,000 litres of water, after allowance has been made for losses due to evaporation. That is 350 litres per place per year or about 1½ litres per day per child. This is a small but useful quantity of water that is worth collecting and storing. As the rain falls in these Provinces at two different times of the year, a storage capacity of about 35,000 litres (35 m³) is needed. This can be provided by three covered tanks, set in the ground, each 3m (deep) x 1 m x 1 m on plan.

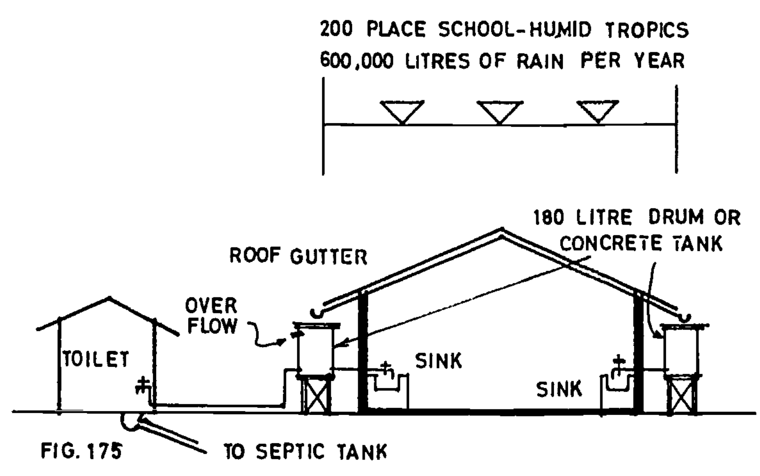


FIG. 175

The small cross-sectional area of the tanks will give a small surface area of water and thus reduce evaporation losses. The water, if it is to be used for drinking, must be filtered and treated (15.2).

Two other aspects of water supply are worth very brief mention. In schools with small industrial arts workshops and having teachers anxious to extend the interests of the students through practical projects, the construction of a very simple plant for provision of hot water for home science laboratories is possible using solar water heaters (15.4; 15.5: 15.6).

15.04 Excreta Disposal – the Problem

Excreta disposal in parts of Asia, especially in the South West, is made difficult due to social customs. In other parts of the region, the reverse is the case and human excreta is often valued as a fertiliser for crops. Where human excreta is regarded with repugnance, the task of cleaning and maintaining toilet facilities continues, rightly or wrongly, to be confined to certain groups of people and when these groups are not commonly resident in rural areas or where there is no provision for toilet cleaning in recurrent budgets, the maintenance of toilets in schools becomes virtually impossible. A dirty toilet will, in such circumstances, remain dirty and eventually fall out of use, the children reverting to the age-old practice of defecating in the fields. In many rural homes, of course, there are, in any case, no toilet facilities and the use of nearby agricultural land for defecation is the common social practice. Aware of this, the administrators in some countries do not provide for school toilets in their capital expenditure budgets for rural schools for they recognise the realities of the situation and prefer to invest often scant resources in other parts of the school building.

In urban areas, the situation is usually much more satisfactory, for not only is it possible to employ people for toilet maintenance, but the children have perforce to use the facilities as it is not possible to defecate either on the school site or in the nearby streets.

This section is thus confined to a discussion of the rural situation where problems of the sort, outlined above, are common in many, although by no means all of the countries of the region.

The importance of excreta disposal has been well described (15.7). "The inadequate and insanitary disposal of infected human faeces leads to the contamination of the ground and sources of water supplies. It often affords an opportunity for certain species of flies to lay their eggs, to breed, to feed on the exposed material, and to carry infection. It also attracts domestic animals and rodents and other vermin which spread the faeces, and it can sometimes create intolerable nuisance."

The following data (15.7) on the effects of insanitary disposal of infected human faeces are dramatic (even if somewhat out of date): "In India and Pakistan, faecal-borne diseases rank high among the most important communicable diseases. In the decade 1940–1950 the record shows that 27,438,000 persons died in India from enteric diseases. (Similar data are given in Figure 176 for Ceylon from 1964–1968) The incidence of hook-worm was between 40% and 70% of the population, and it was estimated that more than 200 million people were infected. In Ceylon, it was estimated in 1943 by the Health Department that 70% of the population was infested with hook-worm."

Most of the countries of the region recognise the importance of health education and include it in one form or another in their curricula. Children will be required in health education lessons to understand, *inter alia*, the implications of the statement made in the preceeding paragraphs. In urban schools, the school toilets will provide an automatic and important visual aid to the lesson on the topic of excreta disposal. In rural schools, having unusable toilets or no toilets at all, the lesson will have little point, especially when, as is so often the case, the teacher himself lives in a house without a toilet.

The main question is, "why are toilet facilities in rural schools so often unused?" The reasons, based on observation of hundreds of rural school toilets by the authors and confirmed by the World Health Organisation study (15.7) are:-

Inadequate Design

V

Leading to

V

Lack of Cleanliness

15.05 Design of the Closet Floor

Inadequate design will result in the child being unable to either urinate or defecate precisely into the squatting pan. This is caused by lack of understanding of the body sizes of children on the part of the designer which results in incorrect location of the foot pads on which the child squats and the subsequent deposition of excreta or urine, not in the pan, but on the edge of the pan or on the floor slab. Excreta, particularly when deposited on the slab close to the pan, is difficult to flush into the pan, especially where water is in limited supply. The child thus leaves the closet dirty. The next child entering the closet is thus faced with urine or excreta and prefers to defecate outside. The excreta then hardens and, as in most rural schools staff are not available for cleaning toilets, the closet falls out of use.

THREE YEAR MOVING AVERAGE MORBIDITY RATES FOR THE COMMON INFECTIOUS DISEASES COMPILED ON NUMBERS TREATED (INDOOR) AT GOVERNMENT HOSPITALS IN CEYLON

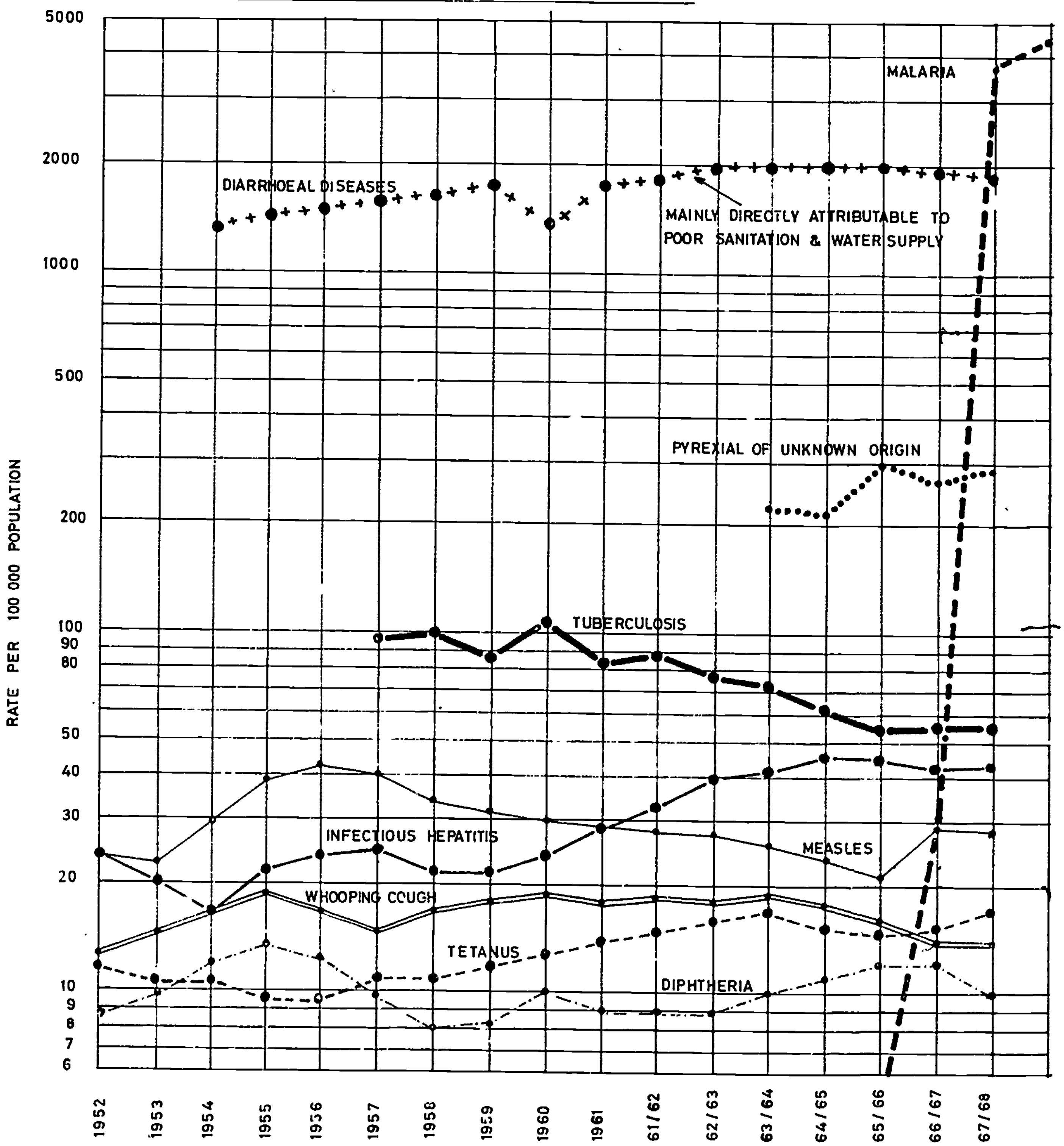


FIG. 176

What is worse, of course, is that the social milieu is often such that teachers are unwilling to relate health education to toilet practices and many designers will have experienced this when head teachers have requested that toilets, because they smell, be located as far from the main school premises as possible. (Noteworthy for a determination to grapple with this problem is Malaysia where in some standard secondary schools the toilets, which are meticulously cleaned, are close to both staffrooms and principal's office.)

Before considering the design problem in detail, mention must be made of the facilities required especially for boys in which it is the common practice to provide an area of wall, rendered in hard cement mortar, on to which the boys can urinate, the urine being collected in a channel at the base of the cement slab. The provision of a separate urinal enables a reduction to be made in the number of (expensive) closets that would otherwise have to be provided.

However, an effective urinal is one, the surface of which should be completely non-absorptive and, moreover, regularly and mechanically flushed with water. Rural school urinals in cement absorb urine, are not regularly flushed and thus smell very strongly. Reasonably, the boys usually prefer to urinate about the school site, rather than enter the toilet.

Paradoxically, it is the practice of rural males in many Asian countries to urinate in the squatting position. In view of this, there seems to be little point in providing rural school toilets with smelly vertical slabs on which to perform the function whilst standing.

Logically, where both urinating and defecating are functions that are commonly performed in the squatting position, by both males and females, and as privacy is important, it would seem that a single unit in a closet could serve both purposes.

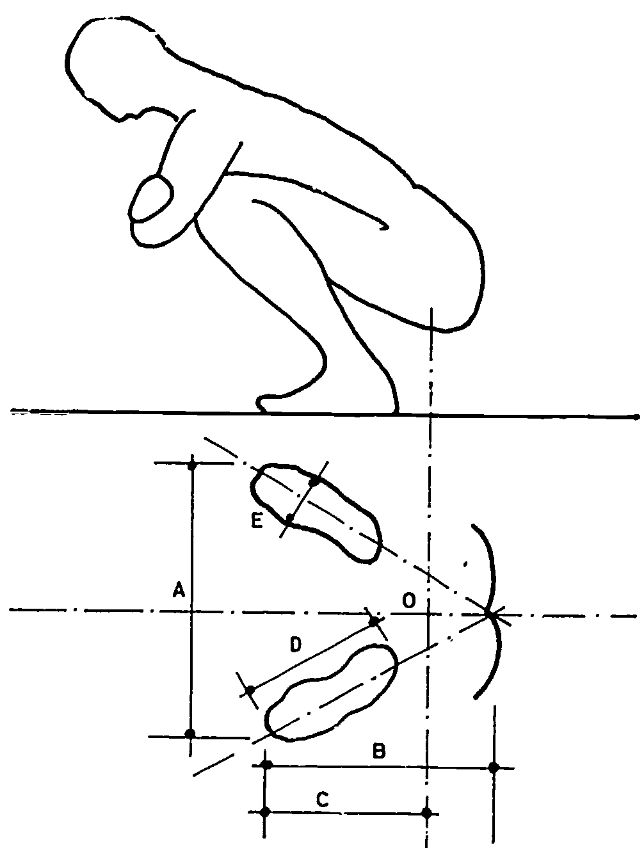
The main problems to be resolved are really in connection with the detailed design of the closet floor which, as has been mentioned above, should be easy for each child using the closet to clean, particularly the rural child who, either in a hurry or unfamiliar with the use of squatting fittings, has, as it were, missed the target and deposited excreta or urine on the floor at the edge of the pan, instead of in the pan itself.

Obviously, it will be easier for the child to deposit excreta/urine into the pan if the design of the pan and the location of the foot pads bear a proper relationship to the body size of the child.

The critical ratios with the standing heights of children are given in Figure 177. Note that in the squatting position, the knees of boys are further apart than those of girls. Relating these ratios to the body sizes of Asian boys and girls (Table XIII. chapter 6) the data required for the design of squatting toilets are as shown in Table XXIV.

TABLE XXIV

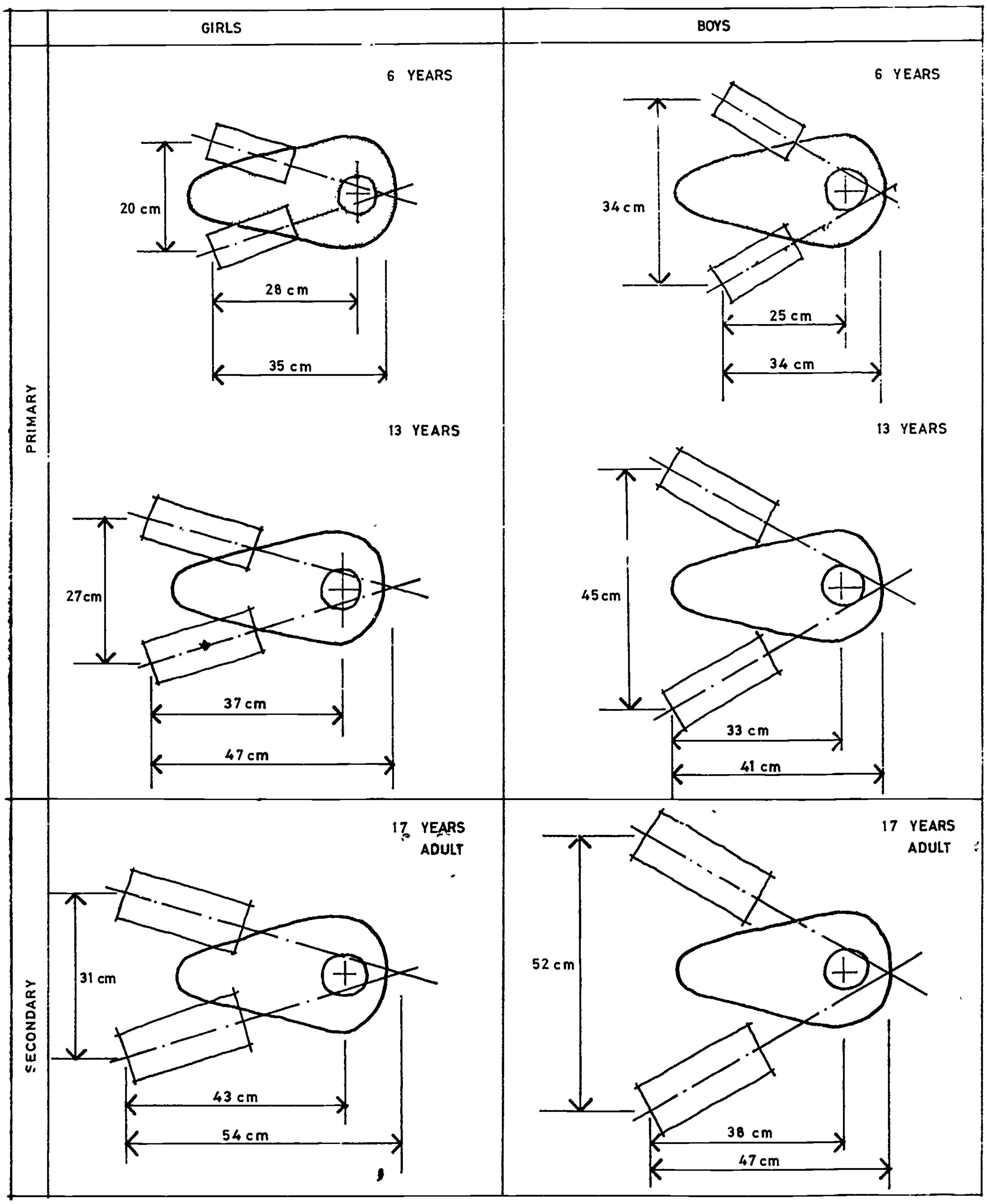
Dimension see Fig. 177	*Girls* 6 *yrs.*	13 *yrs.*	14 *yrs.*	*Adult*	*Boys* 6 *yrs.*	31 *yrs.*	14 *yrs.*	*Adult*
A	20	27	27	31	34	45	47	52
B	35	47	48	54	31	41	42	47
C	28	37	38	43	25	33	34	38
D	16	21	21	24	16	21	21	42
E	7	8	9	95	7	8	9	9.5
Educational Level	Primary		Secondary		Primary		Secondary	



note: THE EXCRETA IS DEPOSITED FROM THE ANUS WHICH IS APPROXIMATELY ONE INCH TO THE RIGHT OF POINT 'O'

DIMENSION	RATIO OF DIMENSION BOYS	STANDING HEIGHT GIRLS
A	0.319 S.H	0.187 S.H
B	0.290 S H	0.33 S.H
C	0.232 S.H	0.26 S.H
D	0.146 S.H	0.146 S.H
E	0.058 S.H	0.058 S.H

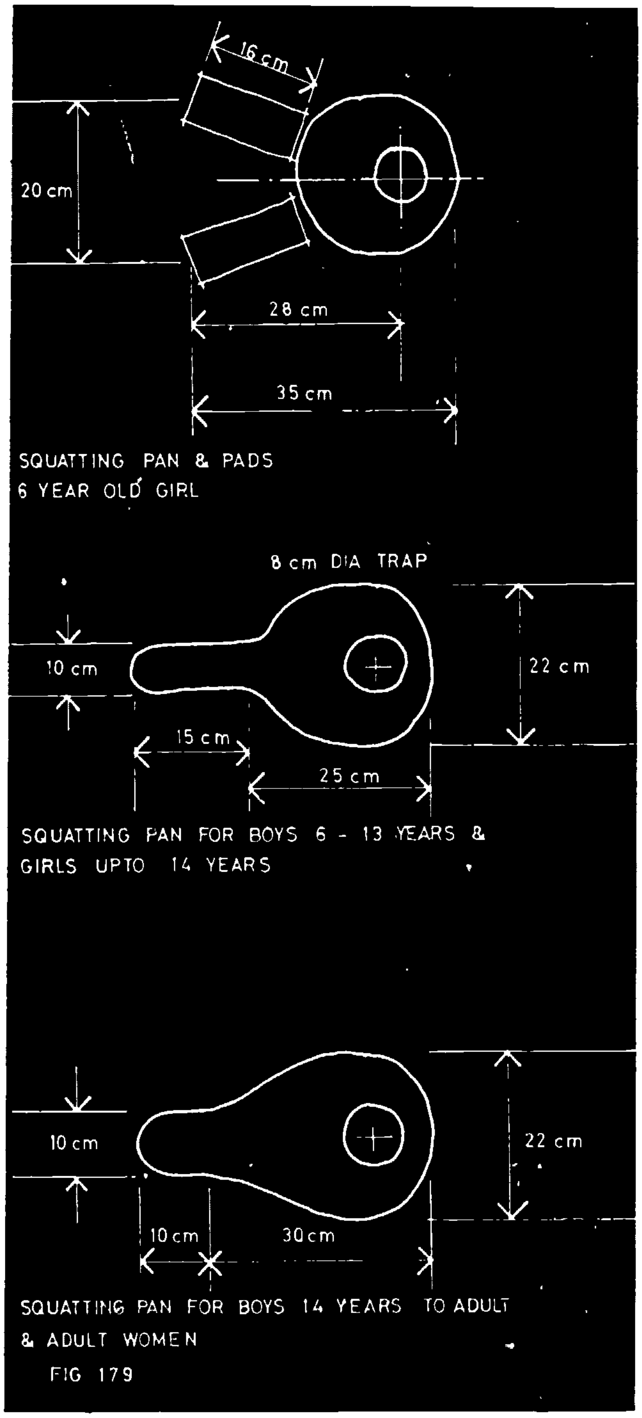
FIG. 177



GIRLS
BOYS
PRIMARY
SECONDARY
6 YEARS
20 cm
28 cm
35 cm
6 YEARS
34 cm
25 cm
34 cm
13 YEARS
27cm
37 cm
47 cm
13 YEARS
45cm
33 cm
41 cm
17 YEARS
ADULT
31 cm
43 cm
54 cm
17 YEARS
ADULT
52 cm
38 cm
47 cm

FIG. 178

Figure 178 is a scale drawing of the data given in Table XXIV and on each drawing has been superimposed a plan of the only standard squatting pan manufactured in one of the countries of the region. It is evident from the Figure that the pan has been designed to be suitable for males and it could, with a little rounding of the heel of the foot pads, be used by adult females. The pan is unsuitable for girls below 17 years of age and barely suitable for 6 year old boys. The figure provides, dramatically, one of the reasons why, in the country concerned and in others like it, toilets rapidly become foul and unusable.



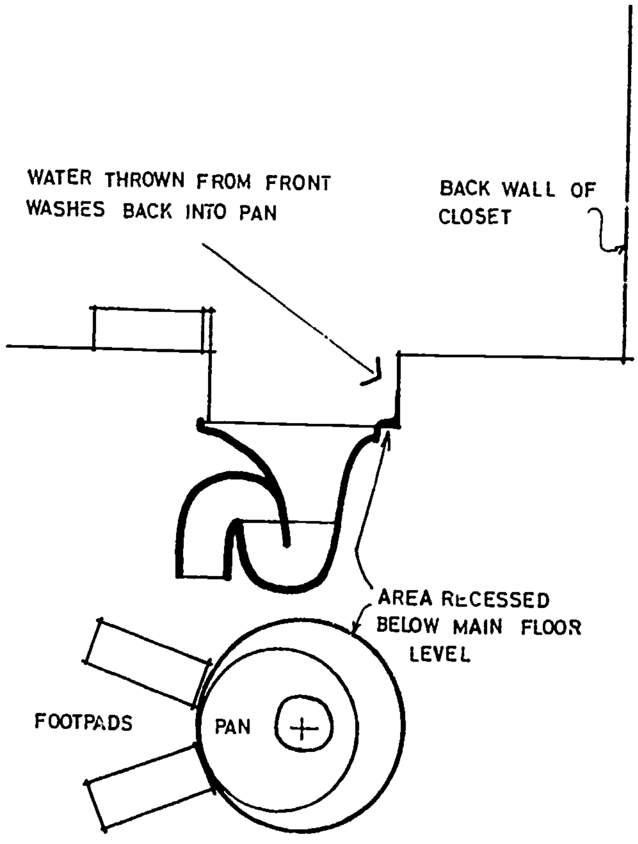


FIG. 180

TOILET FLOOR FOR 6 YR. OLD GIRL

Figure 179 suggests dimensions for squatting pans that would be suitable for use in the Asian region. No one pan is suitable for all age groups – this is an important point.

But even if squatting pans are manufactured in various sizes and shapes, related to the body dimensions of the children using them, there will probably always remain either the problem, as has already been mentioned, of the child who is unfamiliar with such a fitting and deposits excreta on its edge or, of the child who in a hurry, uses the toilet back to front (a common occurrence in girls' schools with fittings designed for sitting rather than squatting).

As the toilet fitting is normally near the back wall of the closet, water to wash excreta forwards into the pan has to be thrown from behind the fitting – a difficult feat which, if not skilfully done, will wash the excreta away from rather than towards the fitting.

To prevent this happening, the best arrangement is to sink the pan below floor level leaving a small 10 cm upstand at the back and sides to deflect water thrown from the front of the pan forwards so that it carries excreta over the edge into the trap (Figure 180). The idea is, of course, far from new. Toilets in some parts of the world have the entire floor sunk below pan level and a strong flush from a cistern will carry excreta from wherever it is deposited into the trap of the pan. An example from Algeria (15.8) is given in Figure 181.

The remaining design feature which is important in relation to the problem of keeping the closet clean is the position of the back wall in relation to the pan. "When this distance is too small, the back of the user will rest against the wall, which may not at all times be very clean and free from ants and other insects". (15.7)

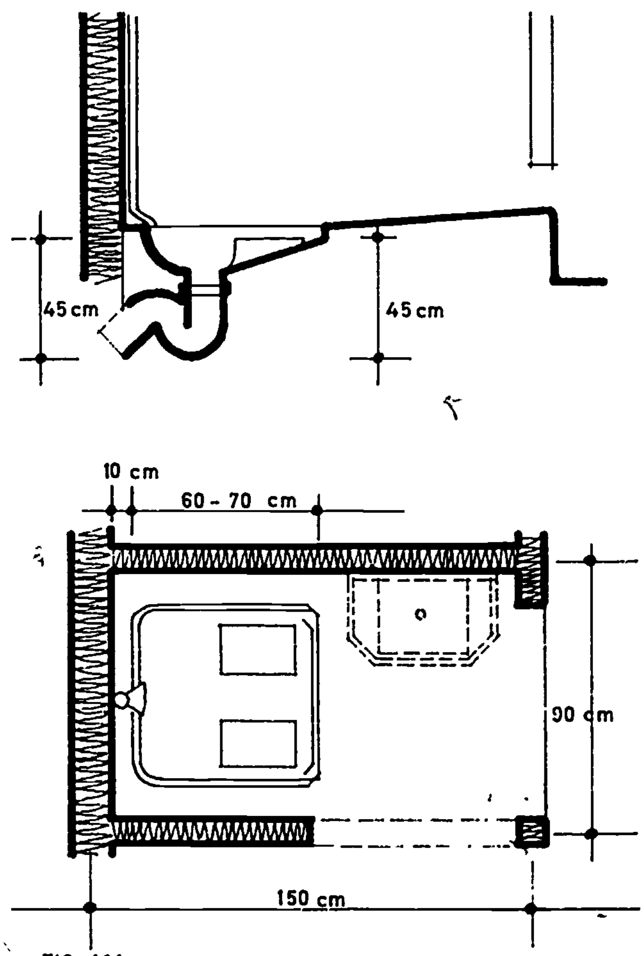


FIG. 181

Figure 182 shows key dimensions of closet lengths based on the body sizes of Asian children. The width of the closet should be sufficient to accommodate the squatting user (width 0.34 of the standing height) plus 15 cm clearance on either side. The minimum internal dimensions of closets for school children summarised, using these data, as follows:

6 year olds – closet length		118 cm
	,, breadth	66 cm
14 year olds – closet length		139 cm
	,, breadth	80 cm
17 year olds – closet length		148 cm
(adult)	,, breadth	85 cm

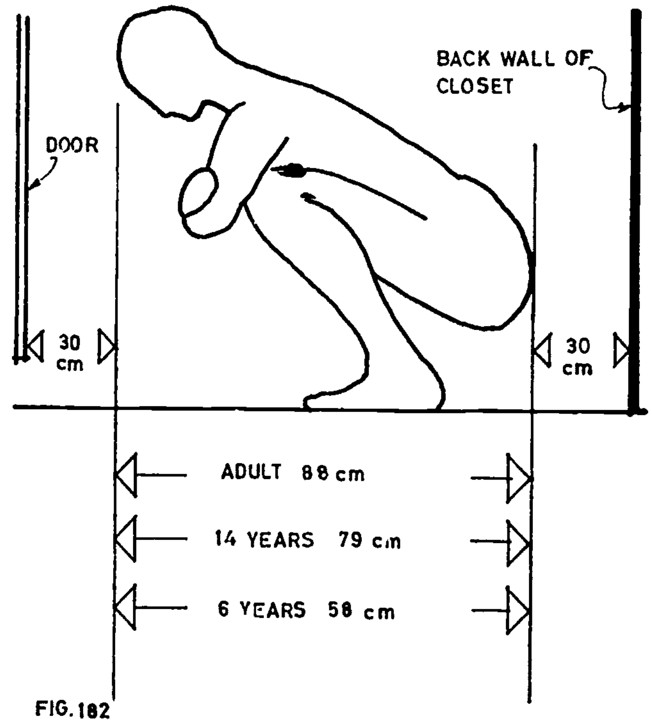


FIG. 182

From this, it will be seen that the traditional closet 1 m x 1 m in plan, bears little, if any relation, to the body sizes of the users in the squatting position and this is probably another reason for fouling of the floor. As the internal area of the adult closet is almost twice as large as that for 6 year olds, there are also evident cost disadvantages too, in using a standard closet design for all schools.

15.06 Methods of Excreta Disposal for Rural Areas

The methods of excreta disposal in common use in the region are very briefly described below; much fuller detail may be found in (15.7). The method of disposal depends whether or not water is available, and on local customs of anal cleansing which may involve the use of water, water and dry material, and dry material only. Dry material may include grass, stones, mud balls, coconut husk, or similar solids.

The problem is complicated by the fact that, many of the systems which have proved satisfactory for individual houses with a family, are unlikely to be suitable for schools where the very much larger number of users would soon fill the pit designed to hold the human wastes of from 5 to 10 persons.

(a) Dry disposal methods

The pit method of disposal isolates and stores human excreta in such a way that bacteria cannot be carried away from it by flies and other insects. Effective pits are about 1 metre wide and from 2 to 8 metres deep depending on the stability of the subsoil. The deeper the pit the better, as a good depth ensures that flies do not enter the pit and reach the excreta if the lid is left off the hole at the squatting point. Of importance from a cost viewpoint, the deeper the pit, the more it will store and the less frequently it will require emptying (Figure 183).

In wet pits for dwelling houses in a situation where anal cleansing involves the use of small quantities of water, the volume of sludge (digested or broken down waste) per person per year is 0.025 m^3 (measured in W. Bengal, India (15.7)). A class of 40 children might thus require 1.0 m^3 of storage per year, although this seems unlikely, as a survey in urban Colombo (15.10) shows that of a class of 44 boys, the toilet was used only 32 times in the whole day and this included 14 uses for urination. Schools also are used for an average of 230 days of the year, the rest being holidays. A reduction of 50% of the domestic storage capacity when designing pits for schools would thus seem realistic. With wet pits, a capacity per class of 40 per annum, of 0.5 m^3 is proposed.

In the Philippines, where dry cleaning material is often used, the volume of storage required for domestic use is greater (about 0.06 m^3 per person per annum). A class of 40 children would need a pit storage capacity of 1.20 m^3 per annum.

It is evident, where pits are used for excreta disposal, that the time for which the pit can be used is limited and that, eventually, it will be necessary either to empty the pit or to move the toilet building to freshly dug pits.

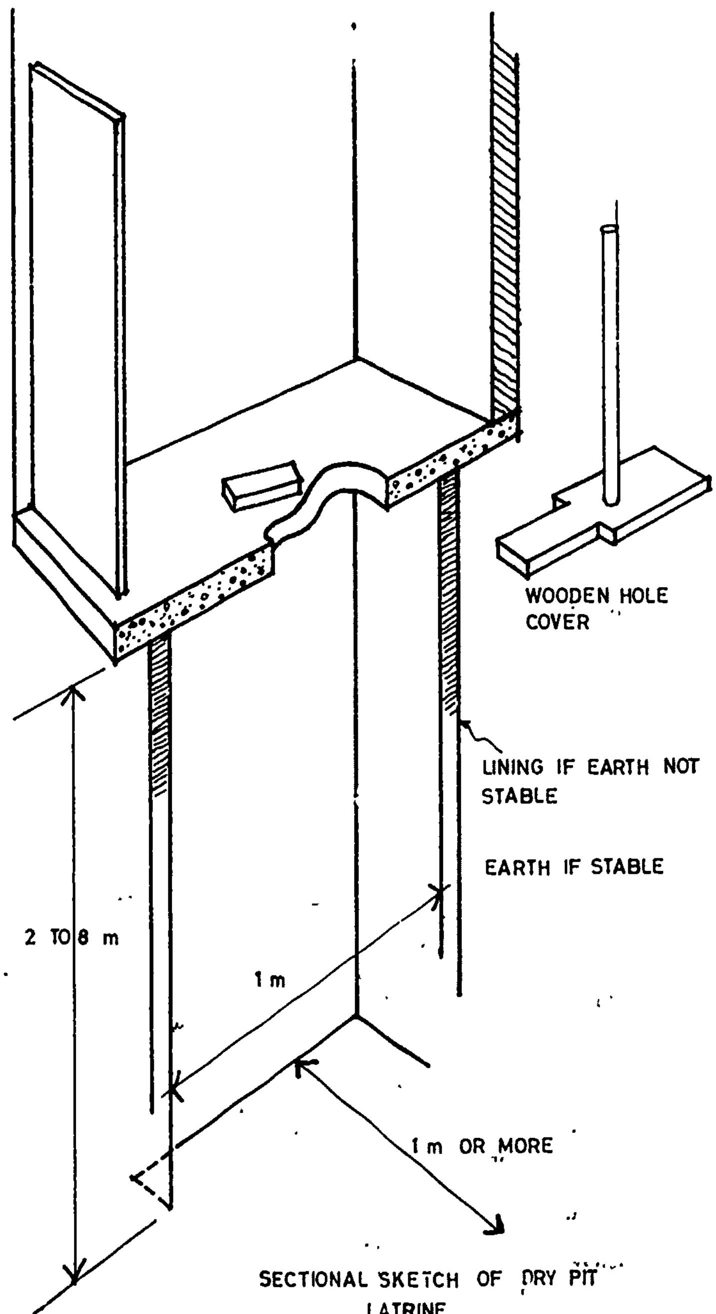
The designer has thus either to design a permanent building with access to the pit so that it can easily be emptied (15.11) (15.12) or to design a temporary building that can be taken to pieces and re-erected elsewhere.

A pit that is one metre square on plan and 6 metres deep will last for 12 years where water is used for cleansing and 5 years where dry material is used.

The authors of the W.H.O. publication (15.7), "Excreta disposal for rural areas and small communities", expressed the view that, "...out of the heterogeneous mass of latrine designs produced over the world, the sanitary pit (privy) emerges as the most practical and universally applicable type".

(b) Wet disposal methods

Wet disposal methods, of which there are several, consist essentially of tanks filled with water into which the faeces and urine are deposited and digested. As with dry methods, the sludge (comprising digested waste) has to be removed at regular intervals or the tanks will become in-operative.



SECTIONAL SKETCH OF DRY PIT LATRINE

FIG. 183

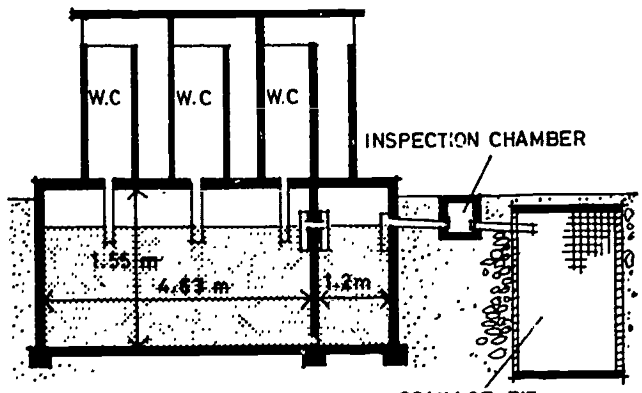


FIG. 184

(i) *The aqua privy method*

The aqua privy method is, after the pit method, the most successful method of disposal. Figure 184 illustrates the method and shows how the excreta and urine drop directly into the water through a drop-pipe which acts as a seal against smells and ensures that the tank below is closed so that anaerobic bacteria can break down the waste as in a septic tank. The disadvantage of aqua privies is that, although they can be successfully operated with very little water, the cost of construction which includes tanks and soakage pits, is very much higher than dry pit toilets. Of the wet methods of disposal, they are, however the cheapest.

(ii) *Water-seal latrines*

The water-seal latrine (Figure 185) comprises a closet with a pan which includes a water-seal. Depending on the type of seal the wastes may tumble into a pit below the closet in much the same way as in the aqua privy, or may be led away into a soakage or cess-pit which will need occasional emptying. The difficulty with the water-seal latrine is that it can only be used where water is used for anal cleansing, (dry material would not pass the trap and there would, moreover, be no seal) and experience shows that water-seal latrines are not suitable for use in public conveniences as they require an understanding of their operation. In schools, where there are active programmes of health education, this understanding will easily be achieved.

15.07 The Provision of Toilets

The provision of toilet closets is regulated in many Asian cities. The regulations show there to be a wide variety of opinions as to the number of units required, ranging from one closet per 25 to one per 100 children. There would be some virtue from both the view points of needs and the maintenance of cleanliness, if one closet was provided per class. It is very evident (15.7) that toilet facilities used by a single family, are invariably kept clean. If the family was enlarged to become the class, then it might be possible, in rural areas, to improve the quality of cleanliness in the "class toilet". This is a matter of management which could influence design.

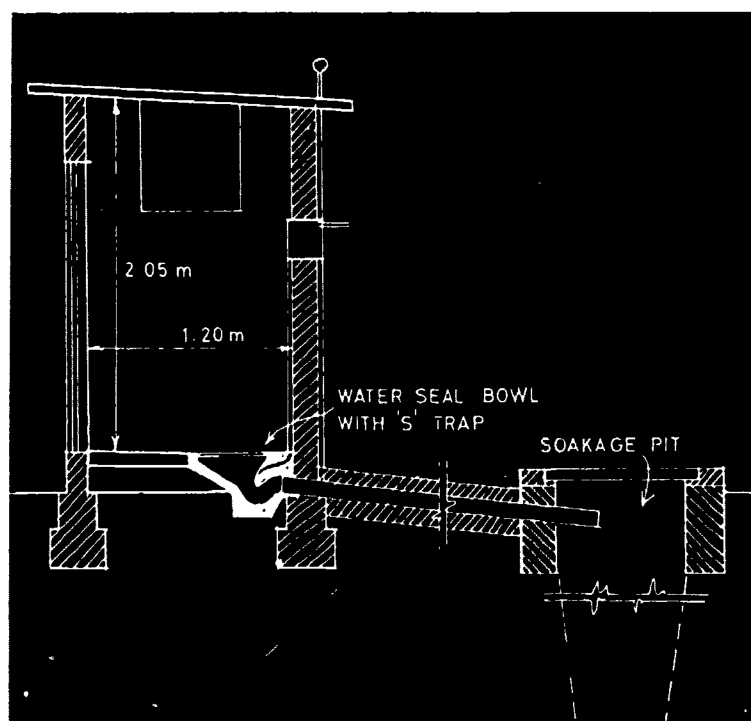


FIG 185

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15.5 **Great Britain. Department of Scientific and Industrial Research.** Overseas Building Notes. 103. *Performance tests on solar water heaters.* Garston; Building Research Station, Tropical Building Section, 1964.

15.6 **New Zealand. Building Research Association.** Information Service. 102. *Solar water heating for domestic use.* Wellington, 1968.

15.7 **Wagner, E. G. and Lanoix, J. N.** *Excreta disposal for rural areas and small communities.* Geneva; World Health Organisation, 1958.

15.8 **Algérie. Ministère des Enseignements primaire et secondaire.** *Constructions scolaires recueil de normes.* Alger, 1971.

15.9 **Great Britain. Department of Scientific and Industrial Research.** Overseas Building Notes. 70. *The pour flush latrine in Malaya.* Garston; Building Research Station, Tropical Building Section, 1960.

15.10 **Asian Regional Institute for School Building Research.** *A survey of the utilisation of first and second level school toilet facilities in urban Colombo;* by. O Burston. Colombo, 1969. (unpublished).

15.11 **Moorcraft, Colin.** *Clivus.... A system for the biological degradation of organic waste.* In: Architectural Design. Sept., 1971. p. 589.

15.12 **Murray, Hubert.** / letter and photograph describing *Reed's Odourless Earth Closet used for school toilets in Mbabane, Swaziland.* In: Architectural Design. October, 1971. p. 656.

Chapter 16

SOME SPECIAL PROBLEMS IN THE DESIGN OF SCHOOLS

Plate 39

Asia is a region of extremes – a region with very sparse and dense distributions of population; a region more subject than any other to natural disasters (earthquakes and cyclones) and finally, a region of widely varying financial resources. These extremes all have their effect on the design of some of the school buildings in the region. Where population is sparse, very small schools with a single teacher are common, whilst in densely populated urban areas where land is expensive, multi-storied, or high-rise schools provide a solution to the accommodation problems. A shortage of money may mean that new schools cannot be afforded and existing urban schools have to be used for two or more shifts.

With the exception of Ceylon, West Malaysia, Thailand, the Khmer Republic and the Republic of Vietnam, thirteen of Unesco's Member States in the Asian region are subject to earthquakes, often of very severe intensity. The danger to children and teachers in remote rural schools, built by the local community and with no understanding of earthquake resistant design, is obvious.

Countries bordering the Bay of Bengal and the Pacific Ocean and China Sea between about 15 and 30° North are subject to violent cyclones (or typhoons as they are called in East Asia) with destructive winds and often deep flooding.

Cyclones unfortunately occur in many of Asia's most densely populated areas whilst earthquakes are associated with volcanic activity and these often occur in areas where the soil is exceptionally rich and the farming population consequently very high indeed.

This chapter makes brief reference to all these phenomena in the context of school building design.

16.01 Small, rural multi-grade schools

The situation regarding small, rural multi-grade schools in a selection of countries from the region in 1961, is summarised in Table XXV. (1.16)

Single teacher schools, are, it should be mentioned, by no means a phenomenon peculiar to Asia. In Latin America, several countries have from 30 to 40% of their primary school teachers in single teacher schools, whilst in some of the cantons of Switzerland there are from 4 to 29% of the teachers in similar one teacher schools.

In short, wherever the population is sparse due to a physical environment that is unlikely to change, such as desert, mountains and poor savannah country, the small rural school is likely to continue. What may, however, change with time, are the resources for learning. As more teachers are trained and as more teaching material such as books, radio, possibly television, and the like become available, the quality of education that can be provided in the small rural school will be raised. Examples of some of the possibilities are provided by Mexico (16.2) and India (16.3; 16.4).

The main problem of the single teacher school is the heterogeneous grouping of children. Most schools of this type provide primary education and the teacher has thus to work with up to 50 children of from 6 to 11 or 12 years of age whereas in a more conventional school the teacher works with up to 50 children, certainly of differing abilities but of approximately the same age.

The building, housing a single teacher school and its furniture, has, therefore, to be designed to take into account the need for storage of a wide range of teaching aids and a wide range of desks and chairs to fit the greatly differing body sizes of the children.

TABLE XXV

SMALL. MULTI-GRADE SCHOOLS, TEACHERS AND PUPILS IN 1961

COUNTRY	*PRIMARY SCHOOL TEACHERS*			*PRIMARY SCHOOL PUPILS*		
	Teachers in Primary Education generally	*One-Teacher School*	*%*	*Pupils receiving primary education*	*Pupils in one-teacher schools*	*%*
Afghanistan ..	2.818	606	21.8	123,117	26,761	21.7
India ..	710,139	116,263	16.4	25,964,808	4,221,501	16.3
Iran ..	27,716	3,527	13.0	978.810	133,161	13.0
Japan ..	372,556	566	0.2	13,423,482	5,674	0 1
Malaya ..	37,596	496	1.3	1,072,552	15,026	1.4
Thailand ..	95,981	893	0.9	3,434,207	41,766	1.2
Vietnam (Rep.) ..	14,819	1,169	6.6	1,001,757	76,579	7.6

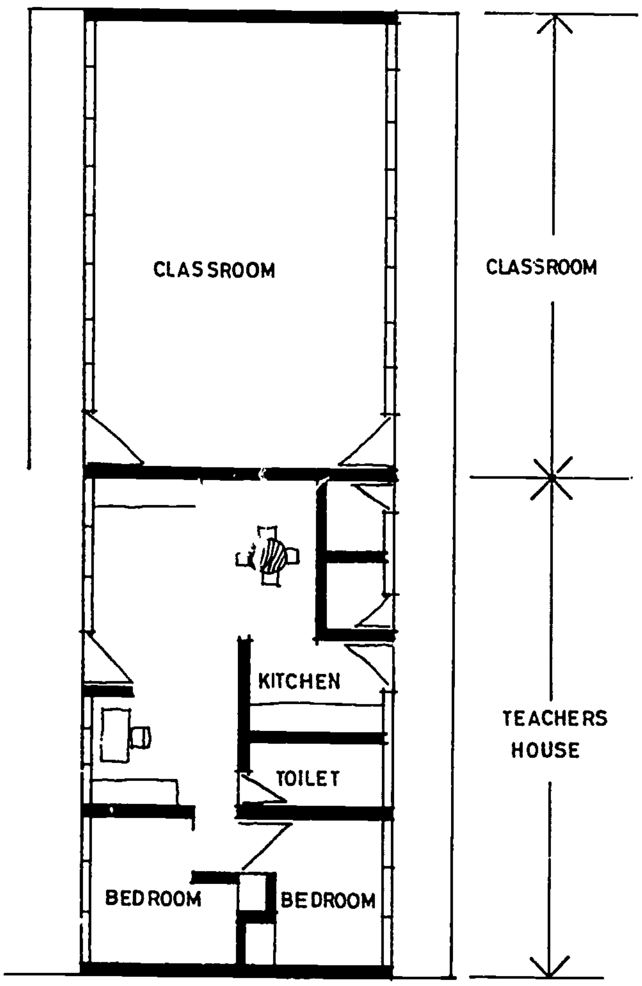


FIG. 186 MEXICO RURAL SCHOOL

A six year old has (Chapter 6) a standing height of 107cm; a 12 year old at 136cm is almost 20% taller. A six year old requires much more of the teacher's attention; a 12 year old, carefully guided, can learn alone. Often the older child may help the teacher with the younger children.

No less important than the educational problem posed by the small, rural multi-grade school are domestic difficulties of its teacher or teachers and the administrative problem of arranging for the initial construction of the building as well as its continued supply with education material. Arranging to pay a teacher's salary or to provide a supply of chalk to a school that is two or three days walk from the education office (as is often the case in the Himalayan or Hindu Kush areas) requires as much administrative thought as it does energy.

The teacher in such a situation, is of more than usually critical importance. The first difficulty to be resolved is often that of housing. Mexico (16.2) long ago decided that, if the quality of education depends on the quality of the teache. and taking into account that rural areas were as entitled to good teachers as urban, than a *sine qua non*, was the provision of good accommodation for the teacher of every remote, rural, single teacher school. Figure 186 illustrates the classroom and the attached dwelling facility for the teacher (and, very important, his or her family) in a Mexican prefabricated school of which thousands have been built during the past decade. When the teacher is single, however, this may not be the best arrangement in relation to the problems of loneliness, of social difficulties, of sickness and of the function in relation to education.

What are the alternatives? One solution, which meets many of the difficulties mentioned above, is that of grouping teachers together in a central place from which, each day, they walk or cycle or ride to school. Figure 187 indicates this situation for a typical group of small villages in a sparsely populated area.

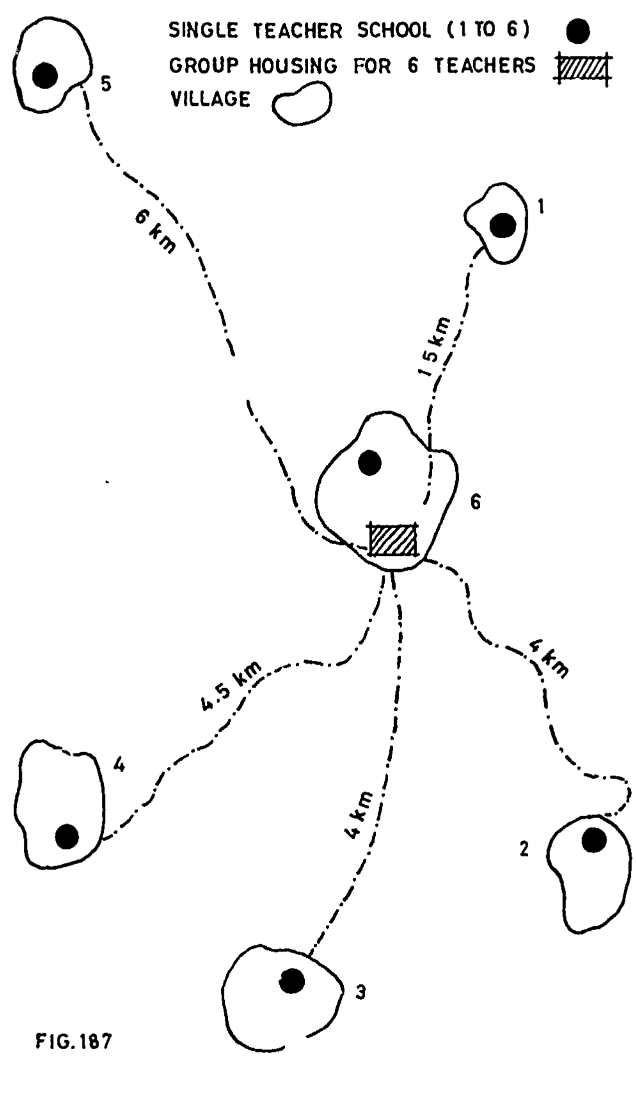


FIG. 187

The arrangement ensures that teachers are not alone in a strange social context, a sick teacher can be cared for and finally, if the qualifications of the teachers are considered in making appointments, a group of 5, 6 or 7 teachers could include perhaps science, handicrafts and other specialists who would, in the course of the week, rotate around all the schools. For example, if the staff for the five schools comprises three general teachers, a science and a handicrafts teacher, they could rotate as is shown below:

School / *Day*	1	2	3	4	5
1	Sc.	H'crafts	Gen. 3	Gen. 2	Gen. 1
2	Gen. 1	Sc.	H'crafts	Gen. 2	Gen. 3
3	Gen. 1	Gen. 2	Sc.	H'crafts	Gen. 3
4	Gen. 1	Gen. 2	Gen. 3	Sc.	H'crafts
5	H'crafts	Gen. 2	Gen. 3	Gen. 1	Sc.

Sc. = Science teacher
H'crafts = Handicrafts teacher
Gen. 1, Gen. 2, Gen. 3 = general, trained teachers

Of course, if a spare teacher can be assigned to the group then he or she can work for one day in each school, converting the school on that day into a two teacher school and, when a teacher falls sick, he can act as the replacement.

The cost of such an arrangement would be substantially cheaper than that of building five separate quarters, attached to each of the five schools. A common toilet and possibly two common kitchens with a common well are the main elements on which savings can be made in this context. Figure 188 illustrates a typical arrangement for group housing.

The construction of schools and housing in sparsely populated rural areas poses two main problems – design and communication.

The design problem itself has two facets – first, that of the provision of spaces suitable for the unique teaching situation and, secondly, the design of construction so that the building can be built by unskilled labour in a rural situation. More will be said on this point below. The communication problem is that of telling the villagers how to construct the school in some simple way that they can understand.

Studies in the Institute suggested that the best form of building for rural multi-grade schools probably comprises a single space, square or nearly square in shape and providing a teaching area of about 1.5 m², per pupil place. Normally, of course, the per place requirements for primary school classrooms would be about 1 m², but the need for the main space to be divided into various sub-spaces makes 1 m² far too small for effective teaching and learning in a multi-grade school. Figures 189 and 190 suggest possible arrangements.

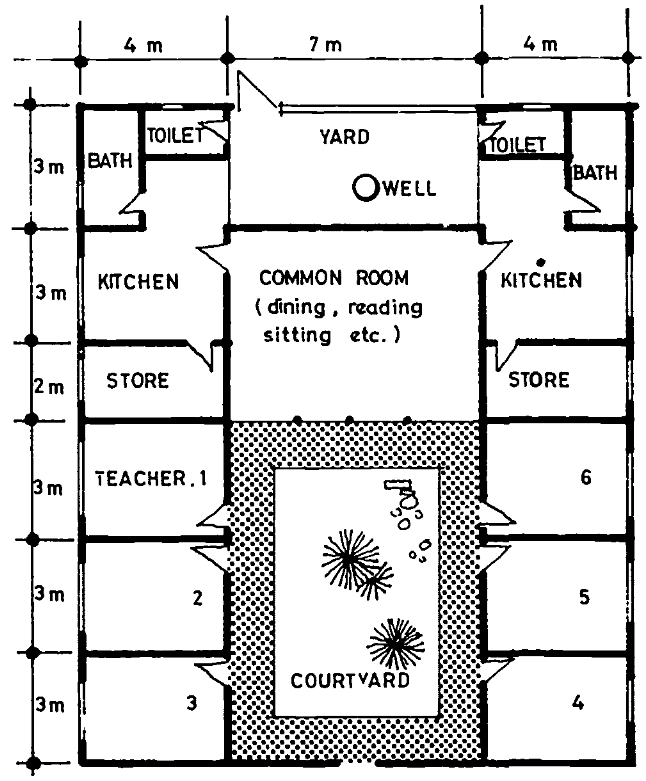


FIG. 188

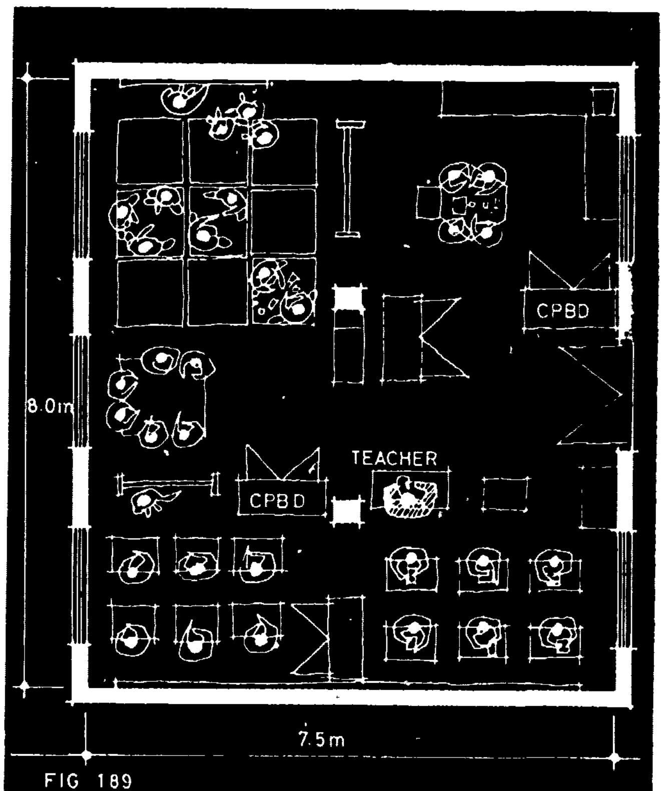


FIG 189

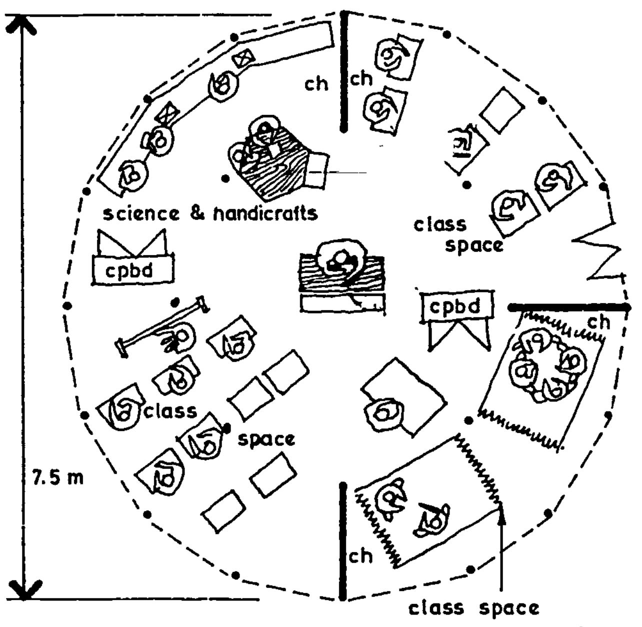


FIG. 190

But, whatever the design for the rural school, the most important aspect is that of *constructability*. The builders in rural areas will often be the villagers themselves and where this is the case, they must first clearly understand what it is they have to build and, secondly, the construct on used must be such that they are able, using their own, rural skills, to deal with it.

The Institute has devised means of presenting information on building to villagers through the medium of perspective sketches coupled with simple orthographic drawings. Figures 191 and 192 are examples from a booklet of 36 drawings that are to be used by villagers constructing schools in a remote, rural part of Nepal. These drawings have already been discussed in detail with the villagers who showed, by the questions they asked, a ready understanding of the construction intended.

Of course, in some situations, as in the southern border area of Nepal, the local building material which is timber, is available in abundance and can be supplied to the villagers free of charge and cut to size from nearby State forests. This then forms the Government contribution to the new building. In other situations where only mud, stone or poor brick are available for walling and the local traditional roof is designed for dwelling houses perhaps 4 metres wide, there is considerable difficulty on spanning the 6 or 7 metres width needed to form one convenient teaching space to house and teach several groups of children. In such cases, one of the possible solutions may be the design of a prefabricated roof and prefabricated columns in small pieces that can easily be carried by bullock cart, camel, mule or boat from a central manufacturing point over the bad roads, tracks or rivers to the site of the school. The villagers can then construct the walls using local materials.

This means that the designer has to design his structure with the following points in mind:

(i) The weight of each component must be such as to be easily handled by 3 or 4 men to a height of about 4m above ground level, i.e., it must be possible to lift the component onto a cart or animal and also to handle it above ground level on a simple scaffold.

At 36 kilos (50 lbs.) a man, 146 kilos (320 lbs.) would be about the maximum convenient weight for a single component, (A 15cm x 10cm concrete member, 4m long, weights about 150 kilos).

(ii) Whilst a structural member such as a column or a part of a roof truss, when it is erected in position, is only subject to easily determined and well defined static loads, when the member is being loaded onto a bullock cart or being thrown off the cart into the ground, it will be subject to often quite high stress under which it may crack or break. This is especially so when the handlers are village people who perhaps do not realise that concrete can be fairly easily cracked if mishandled.

The designer thus has to take these possibilities into account and make sure that the components he designs can take rough handling.

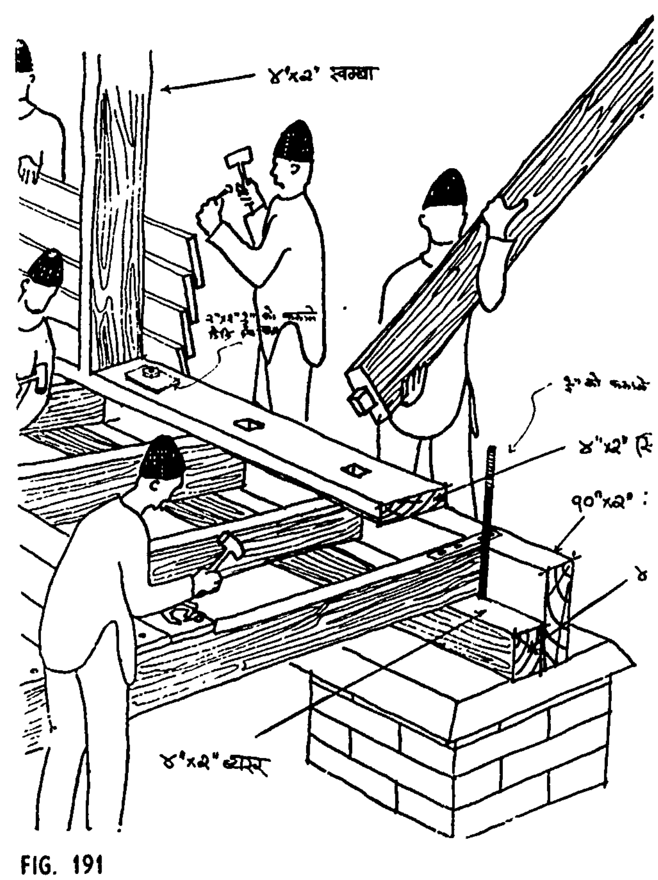


FIG. 191

(iii) Components that are difficult to fit together will cause trouble when the villagers try to erect them. Thus there should be as few joints as possible and these joints as simple as they can be. The pin joint used in Bailey Bridge construction is of a type that has much in general to commend it, whether used with concrete, timber or steel.

One of the interesting aspects of design for small rural schools is that there is no objection to locating columns supporting the roof in the teaching space itself, for the space will in any case be divided by the arrangement of grades. Indeed such columns may assist in the conceptual division of the larger space. In rural areas, one of the constructional problems is to provide a roof to span large widths. A column in the middle of the floor may help in overcoming this difficulty. (16.5)

There are many types of prefabricated structures already available which, with some modification, could usefully be adjusted for rural school building. The best structure, however, is likely to be one especially designed for the materials, means of transport and skills of the locality in which it is likely to be used.

Good examples of this point are the Mexican schools (16.2), and the single-teacher prefabricated schools designed for Maharashtra, India, by the Central Building Research Institute, Roorkee. The Indian school components have been specially designed for bullock-cart transport. (16.4)

Plate 40 shows a single teacher rural school in Goa, India, which was designed by the School Building Development Group of Goa, Daman and Diu in co-operation with the CBRI, Roorkee. The annexed verandah offers additional space for handicraft, arts or games. The storage problem has been somewhat ingeniously solved as shown in Plate 41.

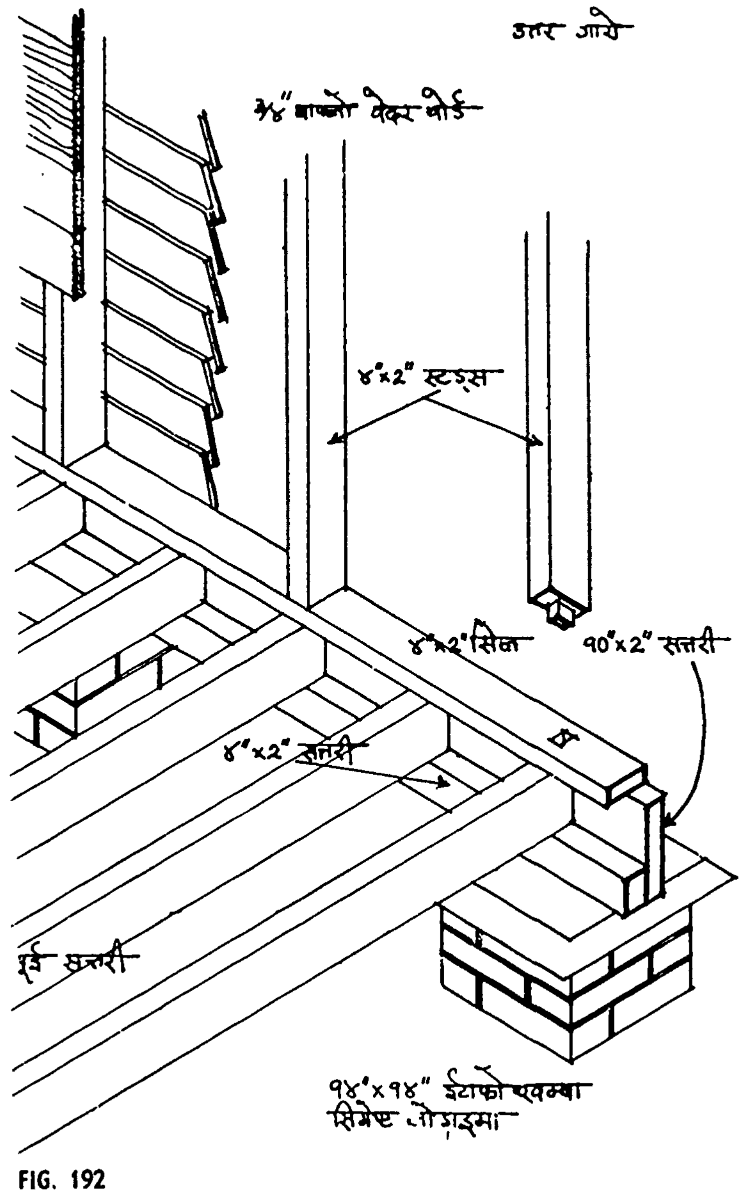


FIG. 192

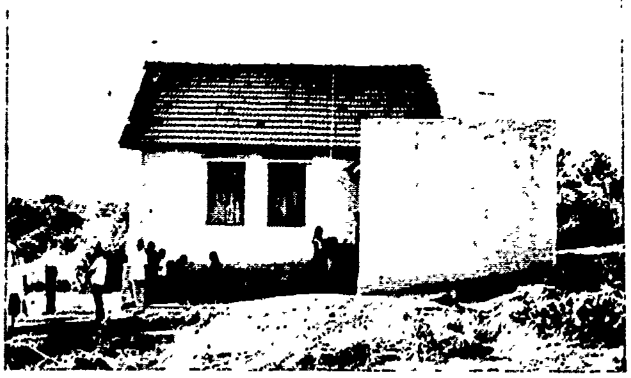


Plate 40

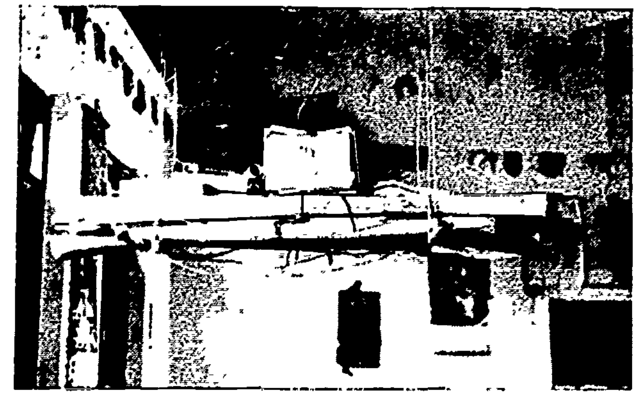


Plate 41

16.02 Shift Schools and Extended School-day/year

(a) Shift Schools

The shift school has been introduced into the Region as an expedient to accommodate an ever increasing number of children of school going age in a limited number of schools, either where the funds available for new school buildings are limited, or where the school building construction programme cannot keep pace with the expanding school enrolment. Although the shift system has been introduced into the region as a matter of expediency, present trends indicate that it will remain a permanent aspect of education in many countries.

The use of the shift system, is, of course, not peculiar to the region, nor is it only seen in the "poor" countries. Even in a "rich" country such as the U.S.A. where concern is expressed over the continuing rising costs of school building, it is now being suggested that greater use should be made of the school facilities, either in the form of double sessions or by extending the school day or year (16.5). The use of the school building for night classes or adult education is also widespread and a long established practice in many countries.

The concept of using the school building in shifts is thus not new. It is perhaps a logical development in maximising the use of an expensive educational facility.

The purpose of using school buildings in shifts is simply to accommodate a greater number of pupils in the same school building. A school building used in two shifts could, for example, theoretically accommodate twice the number of pupils than it would if it were used as a single shift school (Figure 193). This will in effect reduce the expenditure on capital works, as fewer schools, together with equipment and furniture, will be needed.

Useful as this devise might be in reducing capital costs, it rarely brings about any reduction in the recurring costs which represent generally between 80% to 90% of the total expenditure on education. Perhaps the next logical step is thus to consider whether, through curricular reform and the development of educational technology, the class period time can be reduced, thereby allowing the teacher's week to be "extended" which, in turn, will allow the teacher to come into contact with a greater number of pupils and result in a consequent saving in the recurring expenditure on teachers' salaries.

Most of the shift schools in the region are run in two sessions – one in the morning and one in the afternoon. There are, however, a variety of ways in which a shift school can be organised, some of which are shown in Figure 194. In many instances there is no clear separation, the composition of the morning and afternoon shifts being decided upon, either by districts or by preference. In Singapore, a surprisingly large number of teachers and pupils expressed a preference for one or the other of the two shifts.

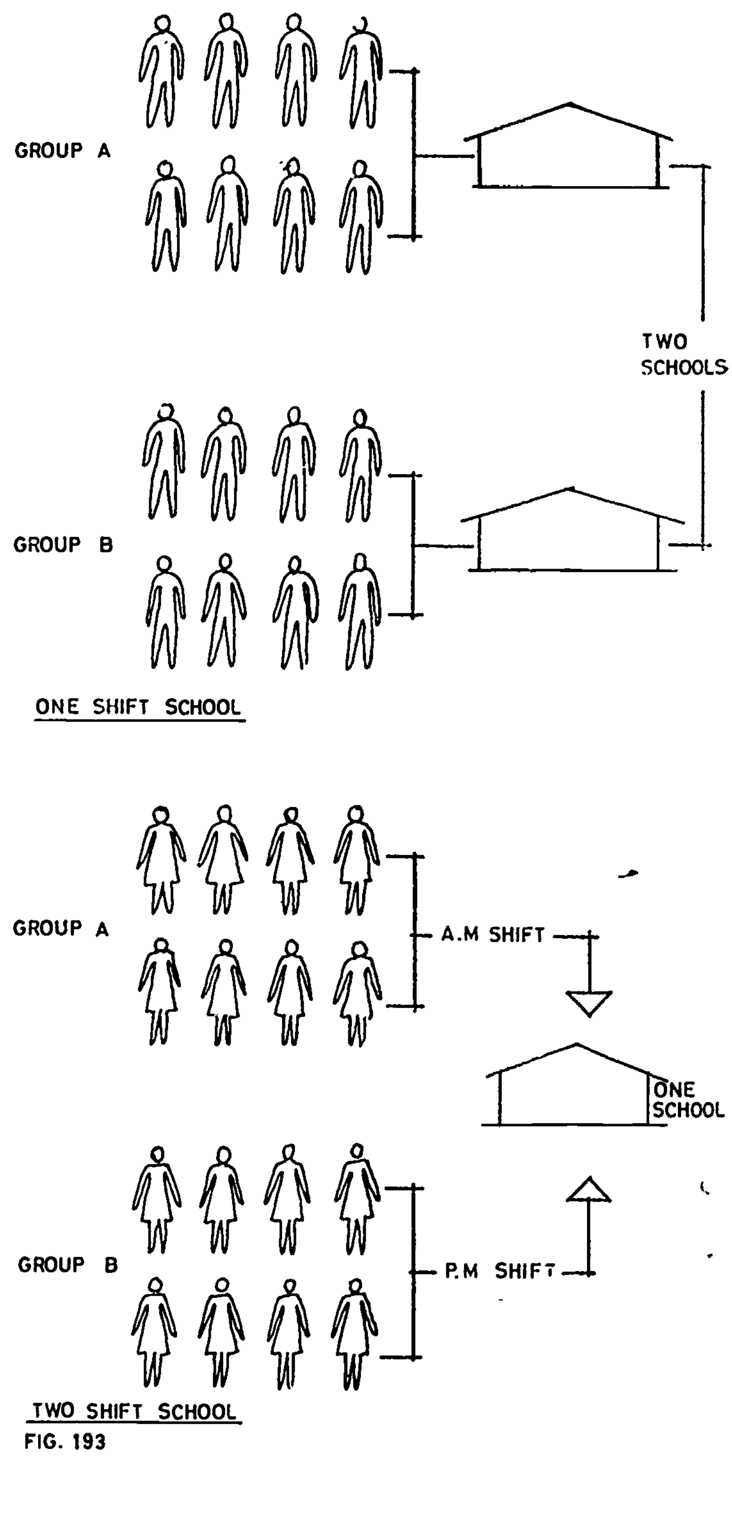


FIG. 193

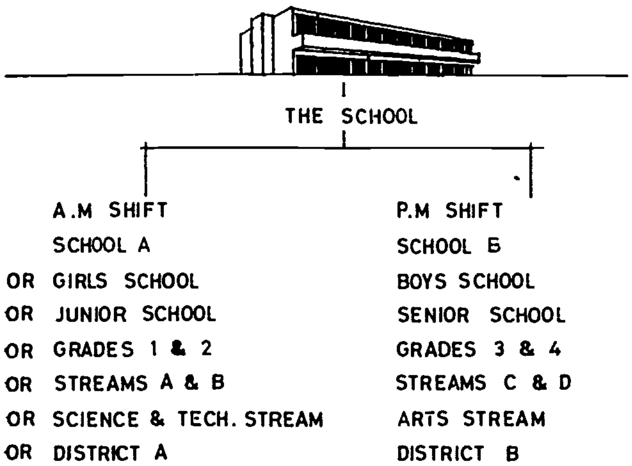


FIG. 194 ARRANGEMENT OF SHIFTS

Obviously in this situation the administrative regulations should be changed to free the teacher from this personal responsibility. but examples can be quoted where. to overcome this situation. not only have two sets of equipment been provided. but also two specialist teaching spaces both of which. more often than not. are grossly underutilised. Decisions of this nature completely nullify the concept of the double shift school. when presumably. they have been introduced to make the maximum use of all resources and to reduce costs.

Another criticism often made against the shift school is that little or no time can be found during school time for organised games, athletics and the like and for co-curricular activities. Time could, however. be found quite easily if the morning shift conducts these activities in the afternoon and the afternoon shift in the morning (Figure 196).

But no matter how the shift school is organised it is essential that the school be under the control of *one Principal* so that there is proper co-ordination between the teaching staff as regards use of equipment and the specialist teachers and adequate supervision of the administrative staff and cleaners (Figure 195).

An argument often used against the suggestion that only one principal should be in control of the shift school is that it will bring about a long working day. It is possible that the principal of a two shift school will spend more hours in the school than the principal of a single shift school, but providing the principal is given supporting staff by way of senior assistants or deputies, his working day need not be longer than that in a single shift school. The senior assistant should also have a reduced number of teaching hours.

There are instances in the region where two separate schools share the same school building, and particularly where the schools are separate girls' and boys' schools. In such instances, not only are complete and separate academic and administrative staffs provided but also separate administrative accommodation. Apart from the additional capital and recurring costs involved in these cases, the standard of daily maintenance falls off rapidly, with the staff of each school either refusing to accept responsibility for its share of the work, or attributing the low standard of the maintenance to the other school.

Another aspect of administration adding to the difficulties and frustrations of the shift school is, where (and this is by no means uncommon in the region), the teacher is made personally responsible for equipment and other supplies under his charge, and in certain circumstances, is required to replace broken or damaged equipment out of his own pocket. In such cases it is not surprising to find the teachers opposing the concept of the shift school when it means sharing equipment or supplies.

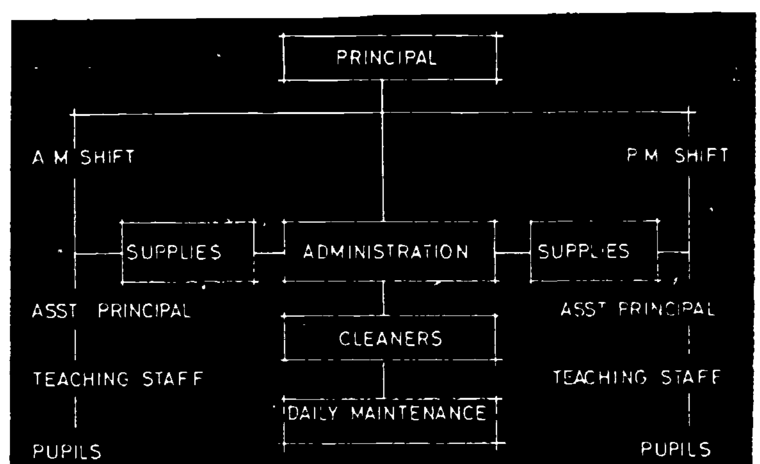


FIG 195

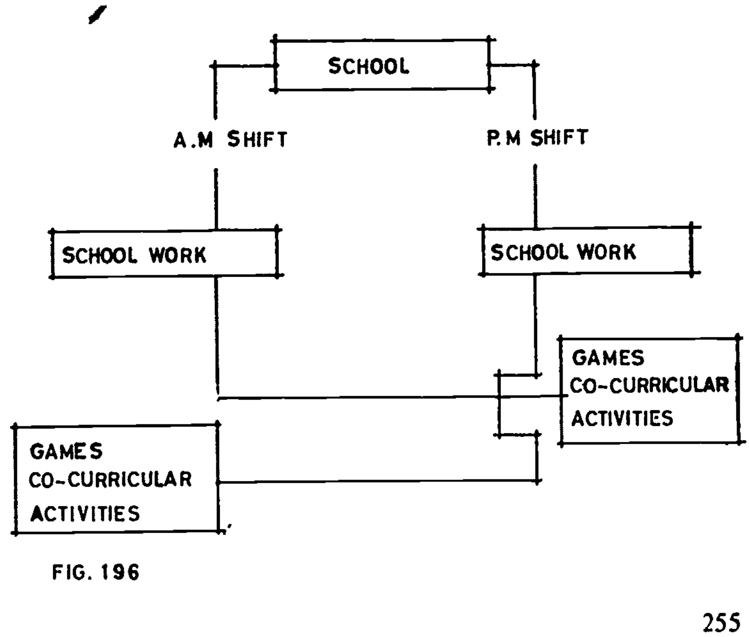


FIG. 196

Objections are usually raised against this arrangement mainly on the grounds that the noise generated by these activities disturbs pupils of the alternate shift at their lessons. This can be overcome by locating the games area away from the teaching blocks (Ref. Chapter 5: Sites for Schools) provided that the site is sufficiently large. If the site is very cramped, it is difficult to see how these activities can in any case be conducted without causing a disturbance. In such cases it is perhaps sensible to select the least noisy activities. On the other hand, if the school has a 5-day week, then the students can use Saturday morning for games and other co-curricular activities.

(b) The extended school-day and -year

There are other ways of accommodating more students in the school besides that of the shift system. Two such methods are the extended school-day and the extended school-year (16.6; 16.7; 16.8). These two methods do not allow the same number of pupils to be accommodated as the shift school, but they have the advantage of providing more time for co-curricula activities and what is perhaps more important, provide a full, working school-day.

The extended school day involves simply adding two or three periods of instruction to the existing school programme. For example, if the present school-day consists of eight periods, the addition of two periods will increase the capacity of the school by 25%.

However, in timetabling for the extended day it is more than likely that all students will have two or three free periods during the school-day and unless the school administration makes provision for places for the students to study privately – these might be the cafeteria, or the library – or fails to organise other out-of-school activities, such as visits to museums or institutions or if the school administration tries to exercise too tight a control on the comings and goings of students and staff during their free time, the students are likely to become bored and frustrated, thereby creating additional problems. Staggered scheduling of classes, the freedom for students to leave the school when not scheduled for class work and supervised private study, are some of the ways by which this particular problem might be overcome.

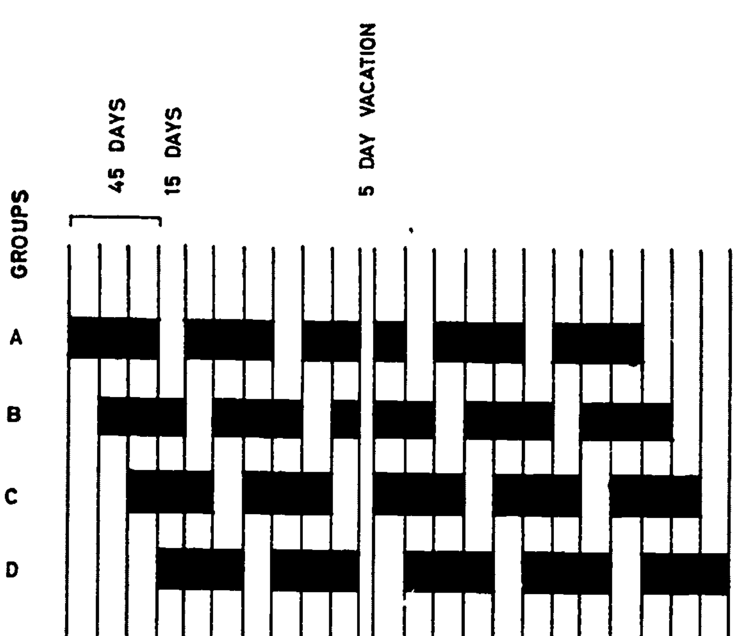


FIG. 197 STAGGERED FOUR TERM YEAR

A growing interest is being shown by many authorities in ways of extending the school-year and thereby reducing capital and operating costs through greater utilisation of facilities. Basically these methods fall into two categories: 1) that of operating the school throughout the year, and of staggering the point of entry of each group of students in the school-year, (Figure 197) so that additional students can be accommodated; 2) that of extending the school-year, thereby leading to a reduction of one or more years of schooling. (16.8)

No large scale programme, introducing one or the other of these methods, has, as far as is known, been introduced into the school system of any country in the Asian region. There are a few isolated cases, where it is claimed that a reduction in capital investment has been or can be achieved, but generally, these methods do not offer the same capital cost savings as the double shifts school.

The staggered schedule shown in Figure 197 has been introduced in one district of the U.S.A. with some success (16.6). The student population is divided into four groups with each group attending school for 45 class days (nine weeks) followed by 15 class days (three weeks) of vacation. Pupils are allocated to the groups district wise. The allocation is compulsory and is done by the school authorities. Parents are not allowed to select groups.

As the starting dates for the four groups are staggered at 15 class day intervals, the fourth group attends school as the first group starts its vacation. This means that only three of the groups are in school at any one time. In addition to the four, 15 class day vacations, students have a week's holiday at Christmas, Easter and around July 4.

Each group attends school for a total of 180 days – based on a five day week. The number of school-days per year in the second level schools in the region (16.9) varies from 180 days with 26.66 teaching hours per week, to 240 days with 30 teaching hours per week. Thus, if this plan were to be introduced into the region, then in some cases, either the school-day will need to be longer, or, a $5\frac{1}{2}$ or 6 day week will be required, if the equivalent number of teaching hours are to be provided.

Operating the school in this manner allows the capacity of the school to be increased by 30%. The administrators, in this particular case in U.S.A., believe that the plan has been so successful that it will be applied to all future schools in their district. Where previously four school buildings would have been needed, in future only three will be required to house the same school population. The administrators also anticipate some savings in operating costs.

Obviously the implementation of a scheme as that described above calls for some careful planning and may well render necessary considerable changes in administration and the setting of public examinations will present some difficulties.

It is also apparent that the savings in capital expenditure brought about by the extended school-day or the extended school-year are not as great as the savings effected by using the school in double shifts. They should be considered as alternative methods of maximising the utilisation of plant and facilities and as requiring a study in some depth before adoption.

Many of the criticisms of the shift school, it is felt, stem from the fact that the schools are housed in buildings which were designed for single shift schools and that the same curriculum has to be taught in a reduced number of hours. It would seem that, although the shift system is in operation in almost every country of the region and is likely to remain in operation for the next one or two decades, no conscious effort has been made either to design the buildings to facilitate the functioning of the shift school or to introduce any curricular reform to take into account the reduction in the number of teaching hours, although in some cases, the school-year is extended by shortening vacations between terms.

(c) Design considerations

Where the school has to rely entirely on daylighting for its illumination within the buildings, there are limitations to the starting and finishing times. In rural areas, where material resources often restrict the size of window openings (Chapter 6), and where the level of illumination is never very good at the best of times, the finishing time of the school-day becomes critical as there is little point in keeping pupils in school when they cannot see to work.

Plate 42

In urban areas, where electric lighting is available, the schools can of course be kept open much later. In Singapore, the afternoon shift finishes between 6.00 and 6.30 p.m. for both first and second levels. But in some countries, it is considered unseemly for girl students to return home at this late hour and thus they must either be accommodated in the first shift, or the school-day must be shortened so that they can return home at a reasonable hour.

The designer then, must be informed at the outset on the organisation of the shifts and the length of the school-day. If the rural school is to be kept open until late in the evening the problem of providing a satisfactory level of illumination must be solved. A school building to accommodate separate boys' and girls' schools must have sufficient toilet accommodation for both sexes. A building to house separate schools will probably require additional storage space for the two sets of school records and supplies, and for student projects. Laboratories for example, will require additional space for long standing experiments undertaken by each school. Additional land for agricultural activities will be needed. The designer must also be aware of the longer school-day when considering designs for sun control (Chapter 6).

The change-over period also presents problems and the noise and confusion generated at this period is often a major source of complaint by the teaching staff (Plate 42). Care must be taken in planning the circulation areas; additional staircases and additional space on staircase landings may be needed so that congestion caused by the change-over of students is avoided. (16.10)

Separate entrances and exits may also be required. An assembly area should be provided for the second shift to assemble without undue disturbance of the first shift and provision made for some students to remain in school to do their homework. (Chapter 3.01). The situation shown in Plate 43 should be avoided whereby the second shift is made to wait outside the

Plate 43

school grounds, thus creating a hazard for pedestrians and motorists. Additional area for bicycle and car parks may be required. (Plate 44).

Plate 44

Undoubtedly, these additional facilities will add to the initial cost of the building – possibly between 10% to 20%: but these additional facilities will cost very much less than the provision of another school, and will measurably improve the working conditions of both the staff and the student. If the shift school is to become a more or less permanent aspect of the educational system in Asia, or if other innovations to improve the utilisation of the plant facilities are introduced, then a proportion of the savings must be ploughed back into the design and construction of these newer types of schools if they are to function effectively.

16.03 The High Rise School

The continuing expansion of the population is causing acute land shortage in urban areas. In this situation it can be expected that schools will become larger, the available sites smaller and the buildings needed, taller. Even now in the Asian region, school buildings of three and four storeys are common. Hong Kong has schools of six storeys and at least one of fourteen storeys. Singapore has many first level schools of seven storeys and one is ten storeys high. (This ten storey building formed the basis of a study of high rise schools). (16.10; 16.11; 16.12)

The question to be asked is simply "*How tall* will schools be in the future?"

Perhaps the most startling feature in this scene is the rapidity with which the general urban scale of buildings is changing, and it would seem that school buildings will, in future, reflect this same rapidity of change.

Considering the question of "how tall?", the main reason which forces the school building to "go up" is the combination of small sites and large school populations. In this context it may be worth while looking at the two examples given in Chapter 5.

The ten storey building (Figure 43, Plate 5) was something of an experiment. It might be that another architectural solution would have provided the same accommodation for the same number of children in a six storey building, possibly by reducing the vertical circulation through making a more effective use of the lift installation.

In the case of the school, shown in Figure 42, the Ministry of Education fixed the maximum height of the building at four storeys, (limited funds and maintenance problems precluded the installation of lifts). This decision limited the total floor area that could be provided, which in turn limited the number of students that could be accommodated in the school. A further limitation was imposed by the decision not to rely on electricity for lighting and mechanical ventilation. Had it been possible to use artificial lighting and mechanical ventilation, the width of the building could have been increased and the height of the building reduced. Thus, a third factor is introduced, that of cost limitations and material resources.

There is in fact no ready answer to the question "how tall". The school authorities may limit the height by regulations, either of the maximum height or of land use: they may reach a decision that the height of a school building without lifts shall not exceed four storeys, and, as in most countries of the region it is not an economic proposition to install lifts, *ipso facto*, the maximum height is fixed at four storeys; or they may reach a decision, as in Singapore, that, as a result of the lesson learned from the experience in the ten-storey building, future first level school buildings shall be limited to seven storeys.

There is no technical reason why high rise schools should not function satisfactorily. If existing high rise schools do not work as well as they might, is it due to the fact that they are multi-storied, or to other causes? – Lack of money? Inadequate architectural briefing? Lack of co-operation between administrators and designers? (16.11)

There cannot be any doubt that in heavily populated areas schools will need to be built on small sites. But "how small?" Chapter 5 gives examples of play areas incorporated into the building, thus reducing the need to allocate part of the site for this activity. Chapter 5 also gives an example of a school in Hong Kong which is being integrated in new housing development schemes (Figure 45) and of schools forming part of a multi-storied block of flats. In this situation the small site ceases to be a problem, in fact the site does not exist in the traditional sense and the need for a high rise solution may not arise.

To provide play space within the building may seem to be an expensive planning solution, but in the case of the Singapore school, the unit building cost per m² was

US $ 36.80 as against the unit land cost of US $ 184,40 per m^2. To provide land in this locality for play would cost almost six times as much as providing built-in play space. (16.11)

The main issue in the design of high rise schools is that of circulation. The trend to greater specialisation in course curricula suggests that more special teaching spaces will be required. This in turn suggests that there will be a considerable movement of the student body from one teaching space to another.

Class scheduling, particularly with regard to shared teaching spaces, is the key to many operational situations. It is the peak loading, resulting from an unevenly applied workload, that results in demands for excess space and overburdens the circulation area (16.13) and it would seem that in high rise schools, a new approach to time-tabling is required.

It is also possible to divide the multi-storey building horizontally by allocating one or more floors to each course or department. Thus, each department might become a self-contained unit having its own resource centre and possibly recreation area, thus, localising the movement of the student body in the school building.

Another aspect to be considered is that of "flexibility". Not only have educational changes to be considered,

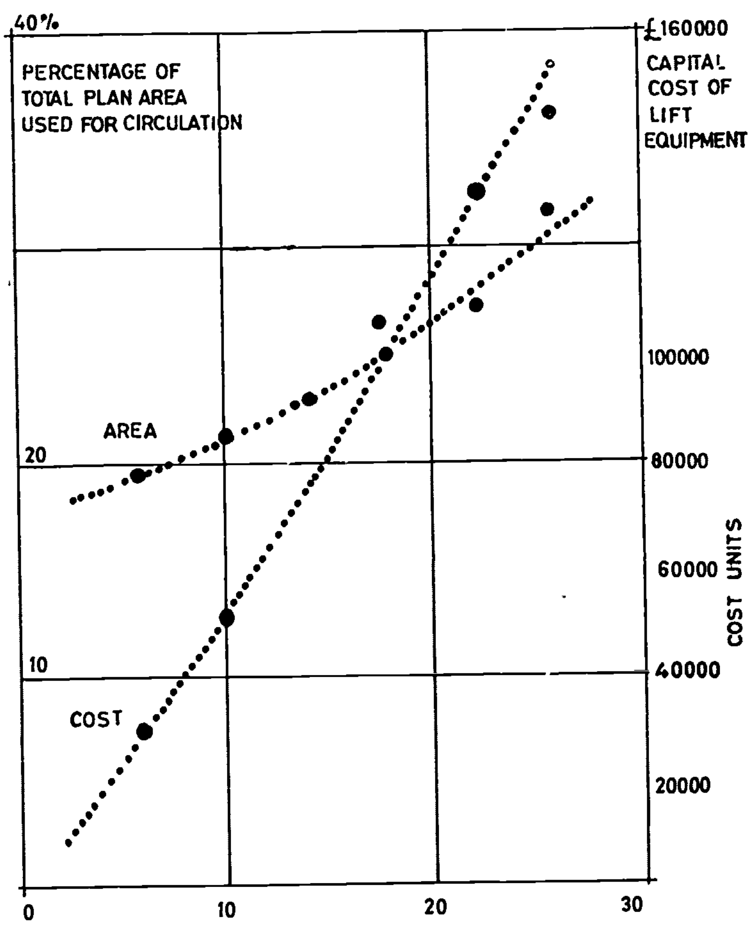


FIG. 198

which may well call for extensive re-modelling of the interior of the building at some time in the future, but there may also be a change in the environment of the neighbourhood and since the high rise school in the central urban area requires a high capital investment, its design should allow that its land and buildings be put to a use other than that of a school.

The trend in very large cities is for the population to move to the outskirts. If this happens, then a high-rise school might eventually, for lack of population, be used as office space. Its design should be permissive enough for such a conversion to take place.

To achieve this flexibility the requirements have been stated as:– (16.11)

"i. plan areas sufficiently large to permit a wide range of sub-division within them.

ii. location of major vertical and horizontal circulation routes permitting future augmentation.

iii. a method for integrating services into the structural system, allowing for future re-location and augmentation."

These requirements suggest that the city school may well follow the pattern of the modern office block in providing large open spaces which can be sub-divided to suit the requirements of the occupants of each floor. The division units can then be easily removed on the change of occupancy. This thinking might be extended to cover the problem of expansion of the high rise school. Why should not additional floors be provided initially, which could be rented out and the income used to offset the extra cost of construction? Should the school require additional space, the leases can be terminated and the requisite floor area taken over.

There is very little doubt that construction costs increase with the height of the building (see Chapter 4). This increase in costs is mainly due to the provision of lifts, additional circulation area and ducting for vertical services. The external walls and windows and the ventilating system also affect the cost, but to a lesser degree. However, it can be shown that, as the multi-storey school building requires a smaller area of land and if the true value of the land is included in the total capital costs, the multi-storey building will cost less per pupil place than the low-rise building. (16.13; 16.14; 16.15)

As the installation of lifts is one of the main reasons for increase in costs of multi-storey buildings, the decision to install lifts needs very careful consideration from the viewpoint of economy and utilization. In Hong Kong, schools six storeys high are constructed without lifts, and four-storey school buildings without lifts are common throughout the region. There seems to be a consensus of opinion, that above six storeys, lifts are a necessity.

The cost of the lift installation increases with the height of the building (16.16) (Figure 198). This is due to the higher speed of the lift and to the higher percentage area of circulation space (lift shafts and lobbies) to usable floor area. The effect of increasing the speed and

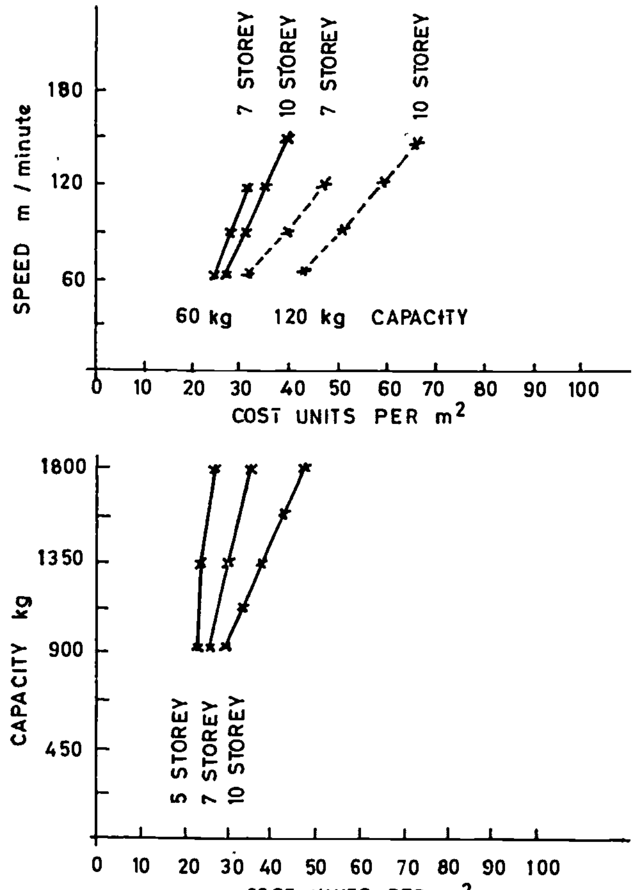


FIG. 199

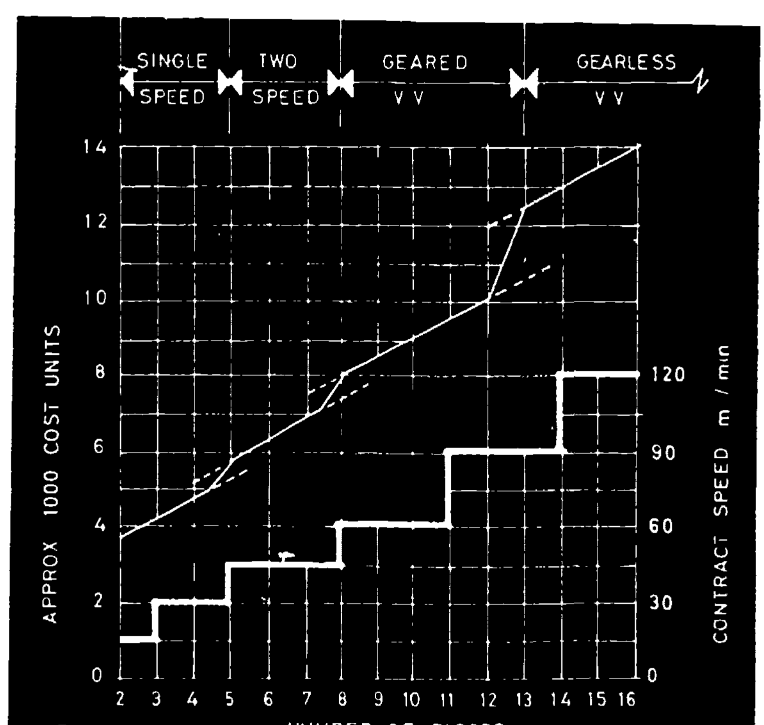
capacity on the total cost of the installation is shown in Figure 199 (16.17) and typical cost factors for various types of installations are shown in Figure 200. (16.18)

There may be a temptation to effect some economies in the cost of the lift installation. One such method is described in (16.11), where the lift serves two floors by stopping at half landings between floors, the pupils then proceeding to their respective floor levels by the stairway. In addition only the floors above the 4th floor are served by the lifts. But a note of caution should be sounded. The relative small savings achieved by this method will need to be weighed against the added circulation problems. The main savings on the lift installation are in the omission of the lift shaft doors – the lift shaft itself must be constructed for the full height of the building and the lift motor room, the machinery and the lift car must be provided, whatever the arrangement of travel.

Widths of corridors and stairs are generally governed by regulations and are usually directed to providing adequate means of escape in case of fire. The flow on staircases is about half of that on corridors, which may suggest that initial economies in the provision of staircases will add problems in the running of the school. The optimum flow along corridors would seem to be achieved with a concentration of 1.6 – 1.8 pupils per m² (16.12), (16.16). Corridors should be free from obstruction with a minimum width of 1.40m and the width should be increased in increments of 0.60m. It is suggested that, where columns and the like project into the corridor, a guard or barrier rail is fixed to the corridor face of the columns to prevent pupils colliding with the column or other obstruction.

The width of staircases should not be less than the width of the corridor and the landings should be of sufficient size to permit easy transition from the corridor to the stairs. Inadequate size of landings can cause congestion in the flow of traffic along the corridor. Where the width of the staircase exceeds 1.60m a central handrail should be provided. Overwide staircases can be a hazard in times of emergency.

Large floor areas will require artificial lighting and possibly mechanical ventilation. As the high rise school is most likely to be built in urban areas there should be no difficulties in providing these installations, except where the supply of electrical power is unreliable. The cost of illuminating a unit area of floor by windows is almost equivalent to that of illuminating the same unit area of floor by an electrical lighting installation.



Associated with the provision of large open floor areas is the problem of some reverberation, which will require the ceiling and possibly the floor to be covered with a sound absorptive material.

One other aspect which should not be overlooked in developing these small sites for high rise schools is the need to ensure that fire-fighting engines can get on the site so that they can use their appliances. Car parking, if this is to be provided. should be so arranged that the parked cars will not stop the engines getting in close to the buildings.

It is necessary then, to consider high rise school design and construction in the general urban context and not in isolation or by ad hoc solutions similar to that of the school which formed the basis of the highrise study (16.11; 16.12;) If the overall conditions are thoroughly investigated, it may be possible to avoid being forced into adopting solutions of expediency. If schools are integrated in housing development schemes, and that is what they should be, the need for high rise schools may not be as great as is thought. There will of course exist the isolated examples and these should be dealt with as special cases.

16.04 Cyclones or Typhoons

In the Asian region, a system of winds rotating round a moving centre of minimum barometric pressure is known in the Bay of Bengal as a cyclone and in the Pacific Ocean and China Seas, as a typhoon. The direction of movement of a cyclone in the Bay of Bengal and near Japan is usually northwards and parabolic with the winds rotating anti-clockwise. Typhoons crossing the Philippines from the Pacific, usually move roughly East-West. blowing themselves out on the China coast.

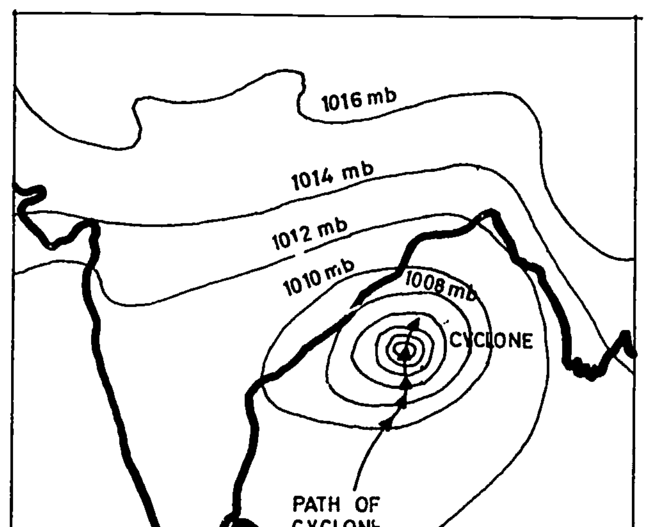


FIG. 201

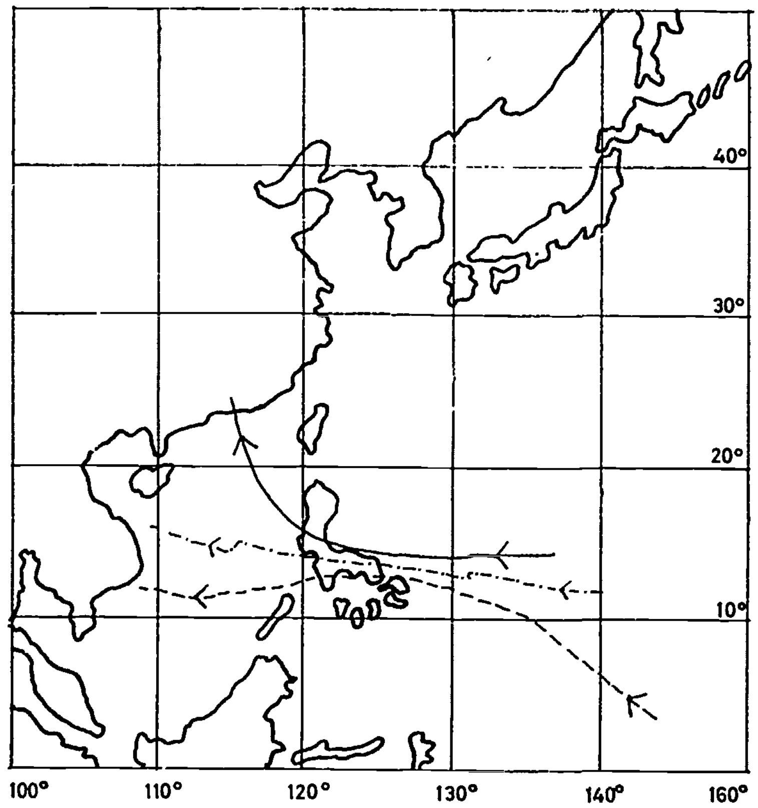


FIG. 202

Apart from the characteristic strong winds in excess of 160 k.p.h., the tropical cyclone, due to very low atmospheric pressure commonly lifts up a circular mass of sea water of about 16 km in diameter at the eye or centre of the cyclone to a height of from three to four metres. This mass of sea water appears to move forward at the same speed as the eye of the cyclone – usually at about 50 km/p.h.

If the land mass at the coast is a delta area, such as that at the head of the Bay of Bengal, the water sweeps inland. and not only are buildings destroyed, but much life is lost. Where the land mass at the coast is a few metres or more above mean sea level, then, although there may be extensive local flooding due to heavy rains, the main hazard is the destructive cyclonic wind.

Figure 201 illustrates a typical cyclone in the Bay of Bengal (that of the 11th/12th November, 1970(16.19)) and Figure 202, the area of the Philippines, Japan and the South China Sea and adjacent mainlands with the paths of a few typical typhoons selected from the twenty recorded in 1970. (16.20)

Where the cyclone impinges on delta lands, such as the mouths of the Brahmaputra, Ganges and Meghna rivers, the rapid flooding of the totally flat land makes it necessary for the population of rice farmers, and

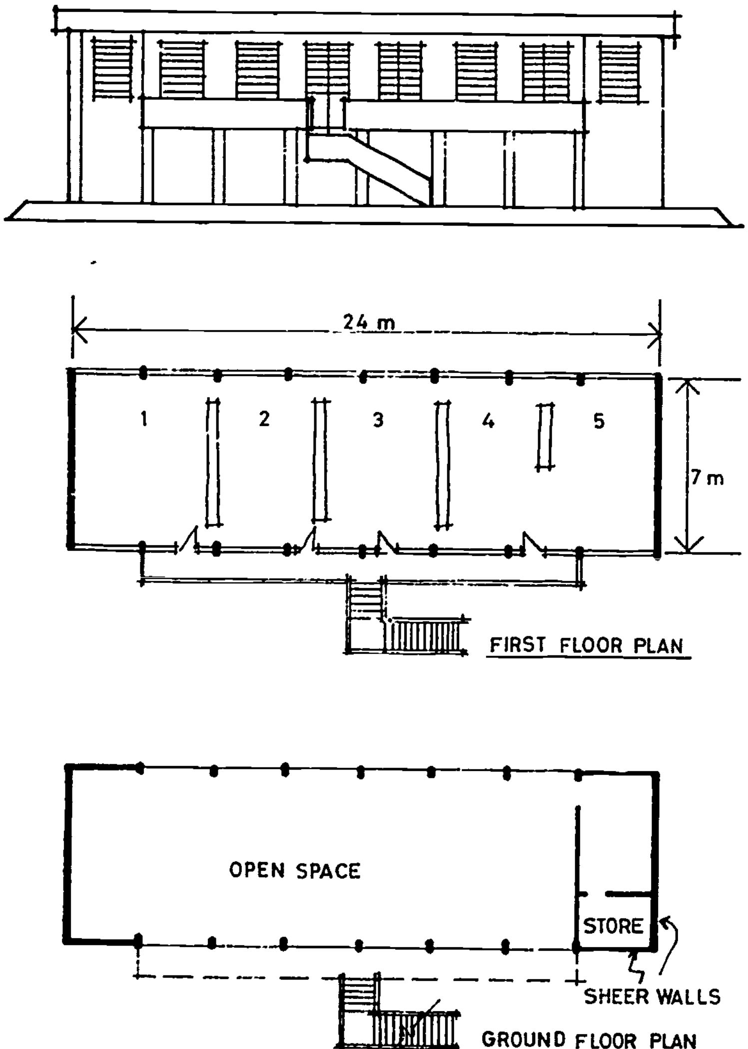


FIG. 203

fishermen and their families to find a ready place of refuge above flood level. But most buildings in the delta are single storied, and constructed on low earth mounds. Even in the infrequent villages and towns, two-storied buildings are the exception rather than the rule.

It would seem sensible, in the face of this situation, to design all schools as two-storied buildings, the uppermost floor and flat roof of which can act as a place of refuge for the population when a cyclone approaches and, for the rest of the year, as a place for education. The suggestion, in most areas will be compatible with general programmes of educational development for in the remote delta areas near the Bay of Bengal, there are often not more than from 16 to 20% of the children of primary school age receiving education.

Clearly the cost of schools, built to withstand very high winds and the force of the water inundating the land, is likely to be higher than that for schools built for more normal conditions inland. Costs can, however, be kept to a minimum, even in the cyclone affected areas by providing the maximum amount of usable space above flood level, leaving an open space at ground level which can be used either as a covered play area for the children or by the local community for its various activities. In this way, the cost for building can be kept as low as U.S. $ 40 per place (16.19). Figure 203 illustrates the type of school building that one authority is considering constructing, and Plate 45 the sort of land on which the schools will be constructed, photographed not long after a cyclonic tidal wave had swept over the area.

Plate 45

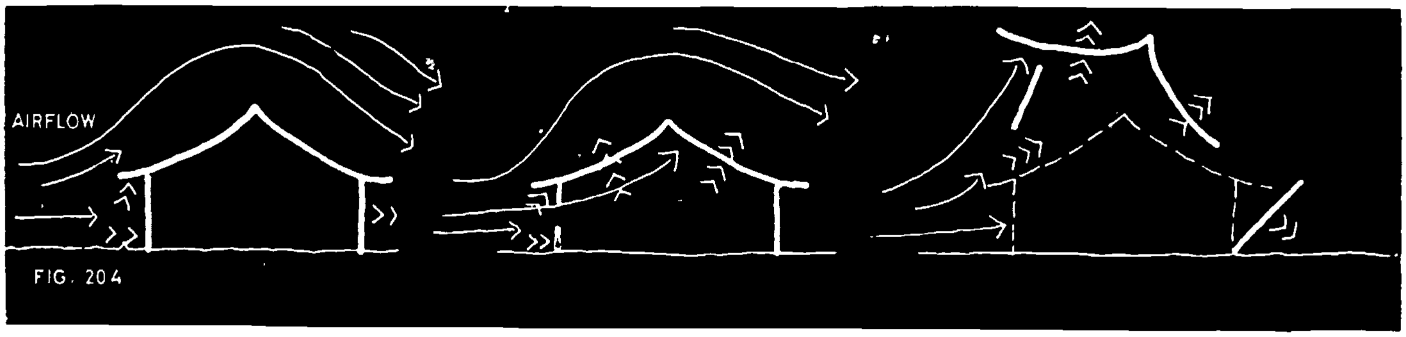


FIG. 204

In the Philippines, as has been mentioned above, the main problem associated with cyclones – or typhoons as they are known locally – is the damage caused by very strong winds and very heavy rainfall. A study of the effects of two Philippines cyclones (16.20) classifies structures in the following descending order of frequency of damage:

(i) Large neon-sign and billboard structures

(ii) roofs of school buildings

(iii) roofs of houses

(iv) glass breakage

(v) large trees

(vi) tall antenna masts

(vii) service station canopies

(viii) roofs of industrial and commercial buildings.

The school buildings damaged were generally single storey structures with structural and non-structural components prepared to size in a factory and assembled on site with semi-skilled labour. In contrast, single-storey dwellings survived well, (probably due to better control of design and construction) and even certain types of schools, where workmanship appeared to be of higher quality, had suffered less damage. Thus, there would appear to be no objection to the use of prefabricated methods of construction, provided that the design of the components and supervision of erection are carefully controlled.

The effect of very strong winds on a single storey building is shown in Figure 204 (16.3). The measures taken to restrict the effect of these wind forces on buildings should include:–

(a) selection of sheltered sites

(b) avoidance of roof overhangs or canopies (such as verandahs)

(c) provision of strong shutters to all windows and strong anchoring of window frames to the surrounding structure

(d) strong anchorage of:

(i) structural frame to foundation

(ii) roof to main structural frame (16.22)

(iii) roof sheeting and purlins to roof.

(e) stability bracing of structural frame and roof (Figure 205).

Model Regulations for small buildings in hurricane areas are suggested in (16.23).

It is very clear that site supervision to ensure that the intent of the design is not vitiated by indifferent workmanship is a major factor in the provision of typhoon resistant school buildings. The danger is evidently greatest with low-cost single storey schools, for in multi-storey urban school buildings where engineering supervision is mandatory and forms part of normal building practice. the risk of major damage is much less.

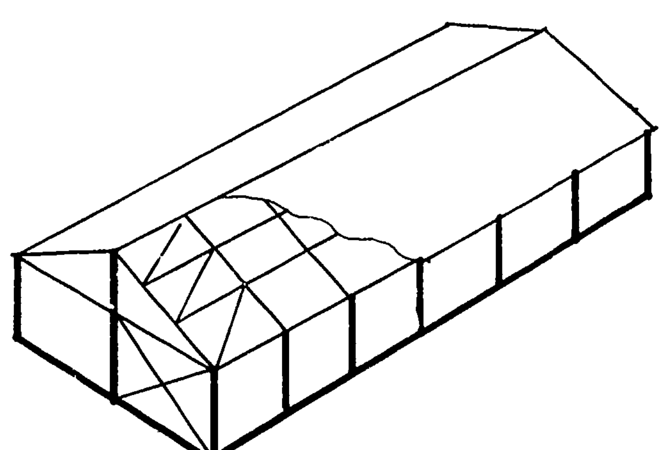


FIG. 205

16.05 Schools in Earthquake Areas

The areas of Asia, subject to earthquakes, are shown in Figure 206. They include, in part or in whole, Iran, Afghanistan, India, Nepal, Indonesia, the Philippines and Japan. An earthquake from the view-point of the building designer, takes the form of complex vibrations of the site on which the building stands. The vibrations may be thought of as horizontal forces acting at foundation level and tending to move the foundations. In this sense an earthquake presents a similar design problem to that posed by strong winds which tend to move the super-structure of the building whilst the foundation remains stationary. Figure 207 illustrates the similarity. Many buildings, designed to resist cyclones, have withstood earthquakes (but others have failed). Of course, all earthquakes are not of the same intensity and some countries publish maps showing zones of forecast intensity of earthquake shock (16.24). The question is one of ensuring "a reasonable amount of safety". (16.24)

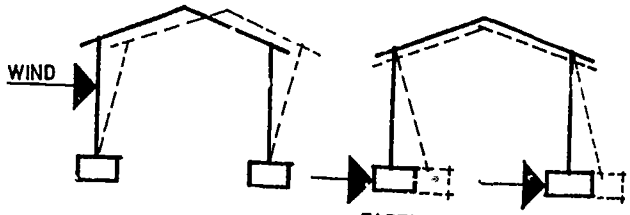


FIG 207

One of the difficulties experienced on several occasions by the authors of this book, has been to persuade people responsible for designing and constructing schools in known seismic zones, of the dangers of failure to design their buildings to resist earthquakes. In one instance, villagers, about to construct a school in a remote Himalayan area, denied the existence of earthquakes for, as they said, "we have never experienced one here!" Yet, "...it is when there is no movement in a dangerous area and stress builds up over a long period, that there is a sudden disastrous rupture which is called a strong-motion earthquake". (16.25)

The design problem is most easily dealt with in the cities where engineers, familiar with the seismicity of the country in which they work, are guided by regulations and design codes for earthquake resistant construction. The rural areas are, as is evident from recent earthquakes (16.26), those in which ignorance of the construction of simple earthquake resistant buildings, leads to the greatest loss of life. It is thus to those, responsible for rural school programmes in remote areas, that this section is mainly directed.

A badly constructed rural timber school can, of course, collapse in a strong earthquake with possible loss of life, but light, single storey timber buildings with light roofs "are fundamentally earthquake proof structures..." (16.17). The greatest danger is in areas where the materials available for construction are bricks, stone, mud and short lengths of timber. The Dasht-e-Bayaz area of Iran, in which between 7,000 and 12,000 people were killed in the 31st August, 1968 earthquake, was one in which mud and adobe were the main local building materials (16.26). Izume (16.27) states that in Japan, "...from bitter experiences of the collapse of brick masonry structures no masonry structures are allowed to be built... (unless heavily reinforced)..."

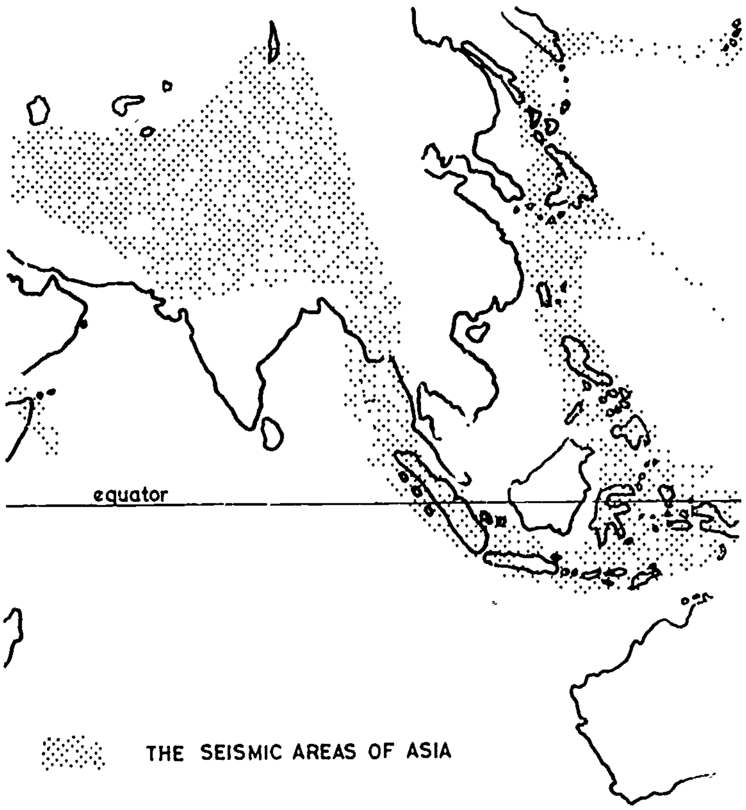


FIG. 206

However, even in situations where it is not possible to obtain the services of an engineer to design aseismic buildings, and the local materials are not very suitable, the observations of certain simple rules may reduce the damage, should an earthquake occur. Education officers who are usually the only officials likely to visit the hills and valleys of the Hindu Kush, Himalaya and the remoter areas in the many islands of Indonesia and the Philippines, can, if they learn these rules, advise rural communities who are constructing their own schools, on the safest way to build. The rules, which relate to small, single storey buildings, are as follows:-

(i) Build in small rectangular blocks, strengthened by constructing rigid cross walls (between classrooms) well tied to the external walls. Avoid 'L' or 'U' shaped buildings (Figure 208). (16.25)

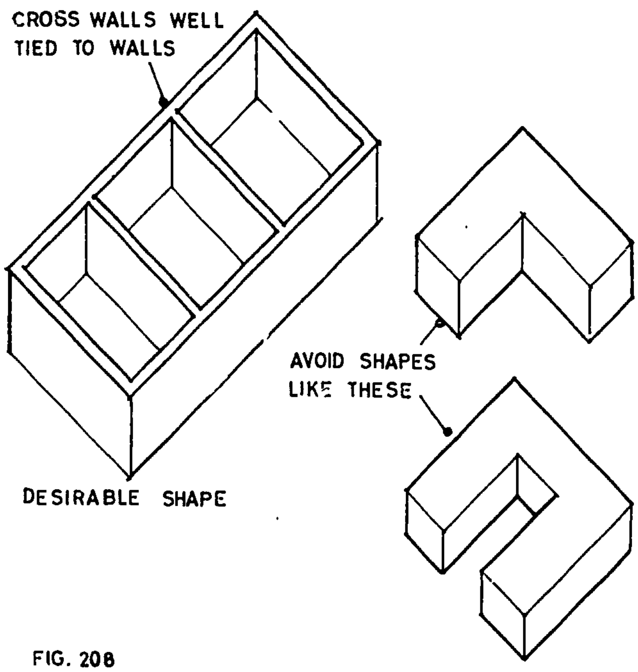


FIG. 208

(ii) Avoid building on pillars which allows air flow under building. Take foundations to the same depth all round the building – even on sloping ground. (16.25)

(iii) Pay attention to the bonding of all brick work and masonry and use as much cement in the mortar as possible when it can be carried to the site. Where mud is the only local walling material and bamboo is available, reinforce the walls by building in a diagonally arranged meshwork of thin or split bamboo (16.28) and reinforce the mud with straw. (16.26)

(iv) Where timber is available in sufficient quantities then a well joined frame filled with stone, brick or mud panels should be encouraged (16.28) (Figure 209).

(v) Large openings in walls should be avoided and, if possible, there should be no openings at all near the corners of buildings. This poses an illumination problem in schools which can be overcome by making the ends of each building small, unlit stores.

(vi) Parapet walls, or any other external features which could be shaken down, should be avoided.

(vii) Roofs should, if possible, be of well framed timbers and have a light covering. This is poor advice for the Himalaya, Hindu Kush and part of Iran where short lengths of tree trunk, mud and stones are the only materials available. In these areas the roof is necessarily flat and very heavy indeed Moreover, in bitterly cold weather, such a roof helps to keep the building warm. Where there are traditions of dome construction, then quasi spherical domes have been found to offer a greater degree of safety against horizontal thrust. Diagonal bracing in an otherwise flat, heavy roof may also help in respect of horizontal thrusts.

For small buildings in situations where engineering control can be exercised, a good guide is provided by (16.23).

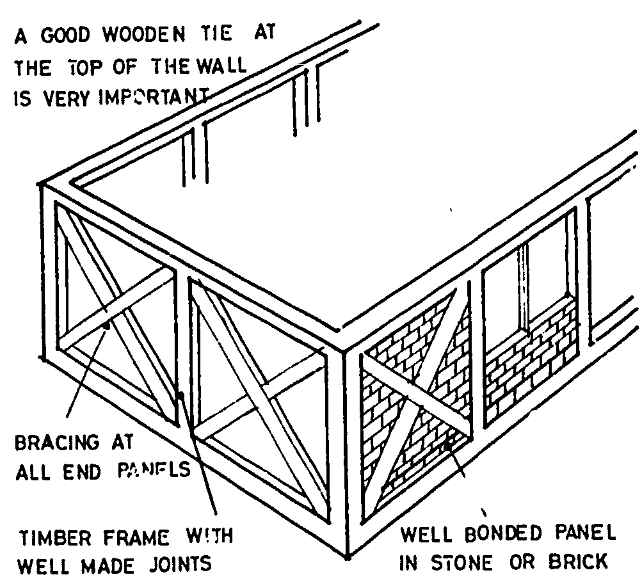


FIG. 209

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Chapter 17

A QUESTION OF CHOICE

One can think of no educational situation in the world which completely satisfies either those that have planned or those that benefit from it. Symptomatically the educational scene in recent years has been one of experiment and innovation in respect of virtually every component of the world's educational system. Attention, indeed, is increasingly being focussed even on the systems themselves. With learning needs rapidly outdistancing attainments, it can and has been argued that ignorance increases in the face of more formal education and better communications (17.1). Learning to learn remains the catch-phrase which best expresses the approach to education in a world where information outputs are increasing exponentially. But the concept of learning to learn is fundamentally related, not to the group, but to the individual and, moreover, not to school but to life itself. Much educational innovation reflects a realisation of this. Programmed learning – essentially an individual activity – and the rapid development, in many forms, of life long education in a number of countries of the world are evidences of future trends.

In Asia, for the present, the broad stream of conventional education continues and innovation takes other forms, mainly directed towards planned improvement of the quality of teachers, curricula, methods and facilities, leaving open the door for the introduction of the changes presaged by new educational technology.

Education as it used to be conceived, was academic in character and designed to produce literates who would become clerks or potential students of the humanities in universities. The buildings were not of great significance in this context and some of the world's greatest schools were housed in what would now be regarded as the most appalling conditions. Education, particularly in the present technological age, depends, to a greater extent on the quality of buildings, furniture and equipment which match the planned changes that will lead to the desired improvement in educational quality. Building programmes depend on resources.

Whilst the magnitude of resources and the priority allocated to education vary considerably from one country to another, the pressure is bound to grow in all countries calling for serious consideration of new methods of financing education and better allocation of available money. There is a need to explore ways and means of enhancing the capability of educational systems in general. (17.2)

The climate for change in resource allocation and improvement in educational quality is, in many countries of the region, characterised by parental expectations which would often perpetuate the aspirations of an older generation, by overworked and often underpaid teachers to whom change represents an additional and often unwelcome burden and by administrators made cautious by the political and other pressures of their environment. An understanding of this climate is extremely important to the designer in the context of the preceding chapters, most of which contain material that, if applied to the design of schools in many of the countries of the region, would be wholly innovative in character.

Perhaps the most important aspect of the matter is that, in many people, there is, despite the changing world around them, an in-built resistance to change in respect of those things with which they have an intimate connection. Most people have such a connection with education, either as a result of their own experience in school or through their school going children. The introduction of the extended school-year mentioned in Chapter 16, has to be seen in the context of a country where a proposal to advance the school-day by one hour was greeted by a public outcry of astonishing intensity. The introduction of demonstrably improved yet new furniture into classrooms where the old desks and chairs are falling to pieces, is invariably accompanied by design criticisms which, had they been applied to the existing furniture, would have long since led to the introduction of improvements. Attempts to calculate the schedule of classroom accommodation with the object of economising in the numbers of teaching spaces needed, are frequently resisted by administrators who do not want the pattern of "one classroom – one class" disturbed, although they are well aware that, if a class is in a special room for 20% of the week, the classroom is empty for that period. It should not be assumed that a person, who is prepared to argue over a cent when bargaining for a pineapple in the market place, is necessarily going to bring the same sense of values into dealings with public money. And for good reason too. In a public situation, other criteria operate.

Thus, the wide range of innovations suggested in the preceding chapters have all to be considered in the special context in which it might be desired to introduce them. The question is one of choice which may be exercised at "grass-roots" level in the design of a standard school or by educational planners deciding on the overall allocation of resources. Sometimes the extremes may meet as, for example, in the educational facilities sector of a plan of one of the countries of the region which read as follows:–

New Schools

Classrooms	$ X
Verandahs	$ Y
Libraries	$ .Z

In this case, the choice of the educational planner was expressed in unusual detail - almost a wedding between the "grass-roots" and "overall" approaches.

It may be assumed that the resources available for allocation to this sector of the plan were $\$ (X + Y + Z)$. The question is, why was the choice made to spend money on these three items? Conversely one might ask why the following items were omitted?:–

Toilet accommodation;
Administrative accommodation;
Multi-purpose room for sciences;
Storage.

In this case, the educational planner could much more wisely have indicated the total sum to be spent and the number of new places to be provided. From this it would then have been possible to calculate the per pupil place cost and hence the money that could be spent on a school of a known number of places. In turn this would have left the designer in collaboration with the educationists, free to design schools of far better quality than those proposed in the original educational plan. Reference to the preceding chapters will show that libraries can be arranged in a variety of ways, not always requiring a separate space; that by careful calculation, classroom needs can be determined not only to ensure 90% utilisation, but classrooms also can be tailored to fit known drop-out patterns; that verandahs, normally unused except for a few minutes between lessons, can either usefully be drawn into the teaching spaces, or used for libraries and so on.

In short, where the constraint is the per pupil place cost, the designer and educationists have far more room for manoeuvre and for making choices than where expenditure is allocated to specific accommodation elements as in the case cited above.

The facilities sector of an educational plan can only, of course, be as good as the data on which it is based. (17.3). In the case cited, if the only cost inputs available were for libraries, verandahs and classrooms, then the planner, who is rarely familiar with building technology, can be excused the use of these data directly in the final plan document. It is in this connection that Chapter 4 of this book – School Building Costs – is of such importance, for it suggests ways in which costs can be analysed for use, *inter alia*, by educational planners who will then be in a better position to allocate resources for schools.

Cost and space analyses also provide data for choices in detailed resource allocation. Many of the analyses undertaken by the Institute have shown, for example, that over 30% of area of new schools are in the form of corridors and other circulation elements such as stairs. When resources are very limited, the choice between 30% circulation and 20% circulation and a library, is a fairly easy one to make.

Choice, in respect of educational building can, in fact, be made at many levels as is suggested in Table XXVI.

The making of choices involves many people including educational planners, educationists (of various disciplines), cost specialists, designers and parents.

Choice should be by concensus of opinion, and, of course, based on the data available. The establishment of channels through which opinions relating to choices can be heard would seem to be one of the most important tasks to be undertaken in the field of school building in the Asian region. Where such channels have already been established, there is a noticeable change in attitudes to design and a consequent change in the quality of the resulting buildings. Many administrative devices for consultation on choices have been tried and experience suggests that no single method is adaptable for all countries. What is not in doubt, however, is that where mechanisms for the discussion of choice have not been established, school buildings leave much to be desired in respect of quality and cost.

Plate 46

TABLE XXVI

CHOICES IN THE PROVISION AND DESIGN OF EDUCATIONAL BUILDINGS

LEVEL	*CHOICE*	*COMMENT*
POLICY	Allocation to:–	
(Decision by educational planner)	(a) construct new schools;	
	(b) enlarge existing schools;	if feasible on sites existing.
	(c) improve existing schools;	
	(d) use existing new schools in shifts;	may require expenditure to modify designs of buildings.
	(e) extend school year;	favourable concensus of teacher/parent opinion vital.
POLICY	Provide schools of:–	
(Decision by educational planner)	(a) conventional number of pupil places;	will probably result in under-utilization of some accommodation.
	(b) pupil places per school designed to give optimum utilization of all accommodation elements;	may result in very large schools and in children travelling longer distances to school.
	(c) pupil places per school to give optimum utilization of teachers;	not necessarily compatible with (b).
POLICY	Per place costs:–	
(Decision by educational planner)	(a) to provide fewer good schools;	some very contented parents; many dissatisfied parents.
	(b) to provide more schools with initially inadequate accommodation but which can be improved in successive years;	many dissatisfied parents, teachers and politicians.
POLICY	Per place costs allocated to:–	
(Joint decision by educational planner, educationist, designer and cost engineer)	(a) site works	
	(b) building:–	
	(i) teaching areas	A notional division of costs is useful. Non-teaching areas such as staff rooms, help to optimise teacher utilisation.
	(ii) non-teaching areas	
	(iii) furniture	
POLICY	School organisation :–	
(Joint decision by Educational Planner and Educationist)	(a) classroom based;	liked by teachers but uneconomical in space.
	(b) non-classroom based;	disliked by principal and teachers but cheaper.
DESIGN	Building design:–	
(Joint decision by educationist and designer and cost engineer)	(a) Flexible;	facilitates curriculum method changes as they occur.
	(b) Inflexible;	probably liked by average teacher.
	(c) Special rooms or multi-purpose rooms;	
	(d) Type of materials/construction etc.	

REFERENCES

17.1 **Marien, M.** *Higher learning in the ignorant society.* In: The Futurist. Vol. VI, no. 2, April 1972. p. 49–54.

17.2 **Unesco. Regional Office for Education in Asia.** Bulletin. Vol. VI, no. 2, March 1972. *Education in Asia.* (special number).

17.3 **Asian Regional Institute for School Building Research.** Study. 16. *Educational buildings – space and cost norms for the educational planner: a workbook;* by D. J. Vickery. Colombo. 1971.

APPENDICES

APPENDIX I

EDUCATIONAL BRIEF (SCHOOLS) – OUTLINE OF INFORMATION TO BE PROVIDED TO DESIGNER

(Adapted from a document, reference 2.1)

No.	Aspect	Information
1.	Scope	Building type; desired life span; relationship other buildings.
2.	Category	Nursery; primary; secondary; comprehensive; all-age; special; vocational; community; other.
3.	Responsible Authority	Central government; State government; Municipality; private agency.
4.	Limit of Expenditure	Cost per place or cost per m^2 (sq. foot); total capital cost; budget voted by responsible authority; cost of furniture; site works cost; prescribed methods of calculation.
5.	Users	Students (age ranges, sex, numbers, handicapped students, multilingual classes); teaching staff (sex, numbers, pupil-teacher ratio prescribed, demonstrators, laboratory assistants); maintenance staff (cleaners, gardeners, caretakers); visitors (inspectors, parents, doctors, dentists); other users (from other schools using joint facilities; community or other use within or outside school hours – numbers, sex).
6.	Activities in School	Curriculum; subjects; periods per week; periods in classrooms; special rooms; laboratories; on-site; extra curricular activities; examinations, assembly; parents' day exhibitions; dining and meals; breaks between periods; possible changes in activities.
7.	Use Pattern	Period of use (hours per day, times, holidays); sample timetable; teaching methods (by subject areas); flexibility desiderata (fixed spaces, infrequent changes in spaces; frequent changes in spaces); multi-purpose spaces; shared use; organisation of school (home rooms, houses).
8.	Space Requirements	Student grouping (numbers; subject areas); sub division of groups (sex; numbers; subject areas); sub division of groups (sex, numbers, subject areas; frequency); prescribed per place areas (for the whole school, for individual types of teaching space, administrative areas, toilets).
9.	Space Enclosure	Partitioning (specify special needs, permanent, movable, storage partitions); special shapes of spaces (alcoves, recesses, heights, raking or flat floors); dais or platforms.
10.	Furniture and Fittings	List student requirements space by space (seating, working surface areas, finishes, storage at student station – drawers, lockers, other storage); teacher requirements (seating, working surface, working area, storage – wall, cupboards, drawers, racks, shelves, preparation).
11.	Teaching Aids (general classrooms and special rooms)	Space by space description of chalkboards (colour, marking, fixed or movable, location, storage for chalk and cleaning materials); maps, globes, tracing tables; projection screens; display equipment; sound equipment (radio, television, tape-recorder); projection facilities (direct, back projection, overhead projector); teaching machines; programmed learning machines; language laboratory.
12.	Teaching Aids (laboratories and workshops)	Space by space description of chalkboards, projection screens, display equipment, sound equipment, projection facilities (as above); list of prescribed equipment with sizes; charts.
13.	Internal Environment	Thermal environment; lighting (describe space by space) noise control and acoustics; colour.
14.	Communications	Clocks; loudspeakers; bells; microphone; telephones.
15.	Services	General (refuse disposal; water points; water rooms; showers; site services – water, power); space by space description of requirements (water, hot, cold) (electricity – 1,2 or 3 phase; voltage; amperage) (heating or cooling) (gas – welding gases, laboratories, cooking); fire-fighting.
16.	Circulation	Vertical; horizontal – relationships between spaces.
17.	Site use and access	Circulation to site (biology garden, agriculture, physical education and other); site areas required by functions (as for circulation but add parking cycles, cars, animal housing, stores).
18.	Security and Protection	Against theft and cattle (fencing, windows, doors, storage), against fire.

APPENDIX II – NOTES

Notes

Col. 1

Each function in Column 2 is given a reference number here which is used throughout the study.

Col. 2

A short description of how the Subject of the Study works to achieve the purpose set out on a list of functions. The list must be comprehensive. Every activity must be covered by one or other of the functional group headings. A list of activities in Column 4 must be cross-referenced to each functional heading. Therefore: work out the analysis first and then complete the entry in Column 4 against each functional heading in this column before writing down here the next heading.

Col. 3

Each activity in Column 4 is given a reference number here which is used throughout the study.

Col. 4

A complete list of activities should be entered against each functional heading in Column 2.

Col. 5 (a)

Opposite each entry in Column 2, enter here the number of persons engaged in each *function.*

Col. 5 (b)

Describe here the persons engaged in each function, opposite their number given in Column 5 (a).

From: RIBA: **Handbook of Architectural Practice and Management, London 1963 – 65**

APPENDIX II

Statement: Function and activities

Subject of Study:
Residential College of Outside Broadcasting

1 Ref. No.	2 Analysis of function	The purpose is achieved by organised activities summarised by 4 main functions, namely: Living, Feeding, Training, Servicing.		3 Ref. No.	4 Activities forming part of each function	5 Analysis of community (a) No. of persons	6 (b) Type of people
1	**LIVING**					240	Male and female students and staff (50% staff are married and live out) (30% students are female) (overseas students include Commonwealth visitors from tropical countries)
1.1		**dormitory**					
1.11			rest and recuperation	1	sleeping		
				2	dressing		
				3	changing clothes		
				4	storing clothes		
				5	private pastimes		
1.12			recreation	1	reading		
				2	writing		
				3	watching television etc.*		
1.13			study	1	work relating to duties		
				2	private study		
1.14			utility	1	drip-dry laundry		
				2	drying clothes		
				3	airing and ironing clothes etc.*		
1.15			hygiene	1	maintaining personal hygiene		
				1a	shaving etc.*		
1.2		**social**					
1 21			refreshments	1	taking snacks		
				2	taking drinks		
1.22			social functions	1	meeting friends		
				2	club and social events etc *		
1.23			pastimes	1	quiet games		
				2	active games etc.*		
2	**FEEDING**					280	Male and female students and staff
2.1		**taking meals**		1	being served		
				2	eating		
				2a	breakfast		
				2b	luncheon		
				2c	dinner etc.*		
2.2		**catering**		1	delivery		
				2	storage		
				3	preparation		
				4	cooking etc.*		
3	**TRAINING**					240	Male and female students and staff (professional and technical)
3.1		**theory**					
3.11			lectures	1	talking		
				2	writing		
				3	using visual aids etc.*		
3.12			seminars	1	talking etc.		
3.13			tutorial	1	looking at notes		
				2	talking etc.*		
3.2		**practice**					
3.21			sports commentaries	1	athletics		
				2	team games etc.*		
3.22			state/civic occasions	1	processions		
				2	ecclesiastical etc.*		
3.23			special tasks	1	cliff-hanging		
				2	parachuting		
				3	rally driving etc.*		
4	**SERVICING**					40	Male and female executive, clerical and technical staff
4.1		**administration**					
4.11			communication	1	dictation		
				2	typing		
4.12			storage	3	lithography etc.*		
4.2		**general**					
			etc.*				

**Note:*
For the purpose of this illustration, the list of activities has been curtailed, so that the sample may give a comprehensive view of the analysis of function.

APPENDIX III

AN EXAMPLE OF A SHORT, EDUCATIONAL BRIEF IN A FORM SUITABLE FOR USE IN MANY COUNTRIES OF THE ASIAN REGION

1. LOCATION OF SITE

2. SITE AND CATCHMENT AREA

3. SITE PLAN

4. PLANNED POPULATION OF SCHOOL BY GRADE AND AGE

Total population 660 as follows:

(a) Grades 1 - 8

One stream, 8 classes of 40 each = 8 x 40 = 320

(b) Grades 9 & 10

Grade	9 a	Technical	= 1 x 40	= 40
	9 b	Commercial	= 1 x 40	= 40
	9 c	Science	= 1 x 40	= 40
	10 a	Technical	= 1 x 40	= 40
	10 b	Commercial	= 1 x 40	= 40
	10 c	Science	= 1 x 40	= 40

(c) Grades 11 & 12

Grade	11 a	Technical	= 1 x 25	= 25
	11 b	Science	= 1 x 25	= 25
	12 a	Technical	= 1 x 25	= 25
	12 b	Science	= 1 x 25	= 25
		Total	=	660

360 boys
300 girls

EDUCATIONAL PROGRAMME OF THE SCHOOL
GRADES 1 - 5

SUBJECT	*GRADES* 1	2	3	4	5
Religion ..	2	2	2	2	2
First Language ..	13	13	10	10	10
Second Language ..	—	—	5	5	6
Mathematics ..	5	5	6	6	6
Physical Education ..	3	2	2	2	2
Music ..	4	4	3	3	3
Handwork ..	4	4	3	3	3
Gardening ..	3	3	2	2	2
Social Studies ..	6	7	7	7	6
Total periods per week ..	40	40	40	40	40

EDUCATIONAL PROGRAMME OF THE SCHOOL
GRADES 6 - 8

SUBJECT	*GRADES* 6	7	8
Religion ..	2	2	2
First Language ..	6	6	6
Second Language ..	5	5	6
Mathematics ..	7	7	6
General Science ..	3	3	3
Social Studies ..	4	4	6
Physical Education ..	3	3	3
Gardening ..	3	3	2
Art & Music ..	3	3	2
Handwork ..	4	4	4
Total periods per week ..	40	40	40

EDUCATIONAL PROGAMME OF THE SCHOOL
GRADES 9 & 10

SUBJECT		*Science*	*Commercial*	*Technical*
Religion	..	2	2	2
First Language	..	5	5	5
Second Language	..	5	5	5
Mathematics	..	6	6	6
+ Physics	..	6		
+ Chemistry	..	6		
+ Biology	..	7		
Agriculture	..	2	2	2
Economics	..		6	
Shorthand & Typing	..		6	
Accountancy	..		7	
Home Science	..			6
Needlework	..			6
Health Science	..			7
Physics	..			6
Wood/Metal work	..			6
Technical Drawing				7
Physical Education	..	1	1	1
Total	..	40	40	40

+ Minimum 4 periods in laboratory.

EDUCATIONAL PROGRAMME OF THE NEW SCHOOL
GRADES 11 & 12

SUBJECT		*Science*	*Technical*
Religion	..	1	1
Second Language	..	5	5
Physics	..	7	
Chemistry	..	8	
Botany	..	8	
Zoology	..	8	
Commerce	..		8
Economics	..		8
Accountancy	..		8
Mathematics	..		7
Physical Education	..	1	1
Agriculture	..	2	2
Total	..	40	40

SCHEDULE OF TEACHING ACCOMMODATION

TYPE OF SPACE	*No. of spaces*	*Area per place m²*	*Total Area m²*	*Utilisation %*
Classrooms (40 places)	13	1.5	780	87.5%
Classrooms (25 places)	3	1.6	120	90%
Social Studies Room	1	2 0	80	35%
Social Studies Room	1	2.0	80	35%
Physics Laboratory	1	2.5	100	53%
Chemistry Laboratory	1	2.4	96	40%
Botany Laboratory	1	4.0	100	50%
Zoology Laboratory	1	4.0	100	50%
Shortand/Typing Room	1	3.0	120	60%
Home Science Laboratory	1	3.6	144	30%
Workshop	1	6.0	240	76%
Total Area			1,880m²	

Per Place Area	2.95m²

SCHEDULE OF NON-TEACHING ACCOMMODATION

(a) TOILETS (Staff & Students)

Boys	(360)	10 WC'c 12 Urinals 10 Washhand basins
Girls	(300)	16 WC'c 7 Washhand basins
	Total area	65m²

(b) STAFF

Headmaster	12m²
Staffroom	20m²
Stores	10m²

(c) OTHER

Library	140m²
Canteen & Kitchen	100m²
Garden & Games Store	10m²
Total	357m²
Allowance for circulation at 10% floor area	230m²
Total area of school	2,532m²

Area per place	3.84m²

APPENDIX IV

AMPLIFIED COST ANALYSIS
640 place Senior Secondary School

Ref. 56,01 M 70
Tender Date 21.11.70

	Element	*Total Cost of Element*	*Element Cost m² of Total Net Area*	*Element Unit Quantity*	*Element Unit Rate*	*Specification*
1 0	Excavations & foundation work (Note:- Element unit quantity taken as area of ground floors)	$ 5,656.51	$ 2.18	939 m²	$ 6.02	Excavate to levels and for foundation. Sand filling under ground slab. Brick foundation walls and concrete plinth apron. Area single storey 387 m² Four storeys 2,206 m² Total net area 2,593 m² Bearing pressure 11 tonnes m² Depth of bearing strata 1.50 m² Water table – none encountered Nature of soil – clay
2.1	External load bearing brick walls Ratio $\frac{\text{External wall area}}{\text{Floor area}}$ $\frac{3{,}832 \text{ m}^2}{2{,}593 \text{ m}^2}$ 1.47	6,159.00	2.37	3,832 m²	1.59	Second class bricks in cement lime mortar; fair faced.
2.2	Internal load bearing partition walls	4,463.75	1.71	2,415 m²	1.83	Second class bricks in cement mortar Structural — Area of wall 22 cm – 45 cm — 2,165 m² Non-structural 10 cm — 250 m²
2.3	Doors and windows Ratio $\frac{\text{Area of doors and windows}}{\text{Total net floor area}}$ $= \frac{639}{2{,}593} = 0.24$	7,630.60	2.94	639 m²	11.94	Second class teak, flush sheeted doors with louvred transomes; glazed windows in casement sashes includes hardware and painting. Doors No. 80 Windows No. 156
2.4	Sun screens	409.19	0.16	—	—	Concrete hoods
3.1	Ground floor	1,274.22	0.49	939 m²	1.36	152 mm concrete on filling
3.2	Intermediate floors	12,082 60	4.65	1,821 m²	6.63	152 mm reinforced concrete suspended slabs including beams
3 3	Vertical circulation (stairs)	770.03	0.29	—	—	Reinforced concrete open well staircase – 2m wide in 6 straight flights between ground and third floors. Total rise 11.40m. Teak hand rail on steel supports.

AMPLIFIED COST ANALYSIS
640 place Senior Secondary School

Ref. 56/01 M 70
Tender Date 21.11.70

	Element	Total Cost of Element	Element Cost m² of Total Net Area	Element Unit Quantity	Element Unit Rate	Specification
3.4	Roof	8,528 00	3.29	1,083 m²	7.86	152 mm r c suspended slab including beams water proofed 10 mm lime concrete clay brick tiles bedded in cement mortar. Asbestos cement rain water pipes *Cost* Construction 7.197.00 Water proofing and covering 1,331.00
4.1	Wall finishes	3,970.20	1.52	5,765 m²	0.58	Cement plaster Terrazzo dado to toilet. Including painting. *Quantity* *Cost* Terrazzo 338 m² 448.00
4.2	Ceiling finishes	835.50	0.32	3,002 m²	0.28	Lime plaster and paint to concrete soffits.
4 3	Floor finishes	2,272.75	0.88	2,384 m²	0.95	38 mm cement and sand paving 38 mm Terrazzo paving to toilets *Quantity* *Cost* Terrazzo 170 m² 335.00
4.5	Built-in furniture	3,028.15	1.17	—	—	Shelving, pin-up boards, chalkboards, cupboards. *Quantity* *Cost* Cupboards No 24 978.00 Pin-up boards 1,182 m² 1,819.00 Shelving 200 m² 231.00
5.1	Sanitary installation	3,168.32	1.22	670 persons	4.73	White glazed fireclay Terrazzo urinal. WC's No. 23 Urinals No. 18 Wash basins No. 20 Cast iron soil and waste pipes; galvanised steel tubing to water supply; G.E.W. drains
5.2	Fittings and plumbing laboratories	1.059.74	0.40	—	—	White glazed fireclay sinks; Terrazzo wash troughs Lab sinks No. 13 Wash troughs No. 7 Plumbing as above.
6.1	Electrical installation	8,808.54	3.40	—	—	Work includes light fittings, overhead fans and power outlets. Lighting points No. 229 Power points No. 48 Fan points No. 75
	Total Net Building Cost	70,117.00	27.04			
7	Additional works	5,432.00	—	—	—	External services 3,508 Boundary wall 1,924 No site development undertaken.
8	Design charges	8,870.00	—	—	—	Departmental charges for design and supervision.
9	Total gross cost	84,419.00	32.56	—	—	—

APPENDIX V

PRELIMINARY ESTIMATE AND COST PLAN for a 840 place second level school for boys based on cost data in Table X and Appendix IV.

Prepared 1.10.71
Date of cost data 21.11.70
Price increase 6%
Ref. 56/03/B/123

	Initial solution	*Net Cost* m² $	*Revised solution*	*Net Cost* m² $
	Target net floor area 2,578 m² Target net building cost per m² $ 29.23 A reserve should be provided to cover trends in rising costs and for unforeseen difficulties that might arise during the design stage. This is a matter of judgement and calls for experience. In this example the following allowances are made:– Increased costs 3 % Design margin 3 % Total reserve 6 % Target cost per m³ $ 29.23 Less 6% margin 1.75 Allowable cost per m²	27.48	Summary Total cost m² Revised solution 28.53 Add "Reserve" 1.75 Total preliminary cost per m² 30.28 Target net floor area 2,578 m² Preliminary net building cost 2,578 x $ 30.28 = $78,061.00 Preliminary net building cost per place $ 92.92 Cost limit per place $ 88.00 Preliminary cost per place exceeds cost limit per place by $ 4.92	
1	Contingencies, allow 2½% of $ 27.48	0 69	Leave at this rate	0.69
1.1	**Excavation and foundation work** The cost per m² of this element is $2.18 for a part single and 4 storey building having a complex foundation layout. The proposed building will be partly 3 storey and partly single storey with straight forward foundation plan. It is calculated that a saving of 15% will be made.	0.69		0.69
	The building analysed in Table X, has a ground floor area of 952 m² and a total net area of 2,953 m². The proposed building has a ground floor area of 1,158 m² and a total net area of 2,578 m². Updated cost of foundation work will be $ 2.18 plus 6% less 15%. This elemental cost = $\frac{\$\ 1.97 \times 2{,}593}{952} \times \frac{1{,}158}{2{,}578} = 2.40$	$ 2.40 3.09	Adjust rate for framed structure see item 2.1 Increase by 25%	$ 3.00 3 69
	NOTE *This element should be checked in the early part of the design phase.*			
2.1	**External walls** The external wall plan of the example was exceedingly complex as will be seen from the high wall to floor ratio of 1.47. It is proposed to reduce the storey height in the proposed building. Wall/floor ratio this building 0.84 Updated cost 2.37 + 6% $= \frac{2.51 \times 0.84}{1.47} = 1.43$	1.43 4.52	To allow for greater flexibility it has been decided to use a reinforced concrete framed structure for the three storey block. Preliminary estimates indicate that the cost will increase by 25%. Comparative cost estimates will be required at the early design stage. Revised element cost 1.43 x 1.25	1.79 5.48

APPENDIX V

PRELIMINARY ESTIMATE AND COST PLAN for a 840 place second level school for boys based on cost data in Table X and Appendix IV.

Prepared 1.10.71
Date of cost data 21.11.70
Price increase 6%
Ref 56.03/B/123

	Initial solution	*Net Cost* m^2 \$	*Revised solution*	*Net Cost* m^2 \$
2.2	**Internal Walls** The element unit rate in Appendix IV is \$ 1.83 for an area of wall of 2,415 m^2 in a floor area of 2,593 m^2. The area of internal walls in the proposed building is 1,957 m^2 in a floor area of 2,578 m^2. Updated cost of element rate = \$ 1.94 This element cost $\frac{1.94 \times 1{,}957}{2{,}578}$	1.47	Revised rate 1.47 x 1.25	1.84
2.3	**Doors and windows** Ratio in Appendix IV 0.24 This ratio 0.27 Updated cost of element 3.11 Revised cost $\frac{3.11 \times 0.27}{0.24}$	3.49	Use adjustable louvre windows, estimated 20% cheaper; windows represent two thirds of cost of element. Revised rate Doors 3.49 x 0.33 = 1.16 Windows 3.49 x 0.66 x 0.80 = 1.85 3.01	3.01
2.4	**Sun Shades** Leave as for Table X	0.16	Leave as is	0.16
		9.64		10.49
3.1	**Ground floor** The element unit rate in Appendix IV is \$ 1.36 Updated cost \$ 1.44 Element cost Floor area of this building 1,226 m^2 = $\frac{1.44 \times 1{,}158}{2.578}$ =	0.64	Leave as is	0.64
3.2	**Intermediate floors** This element cost m^2 is \$ 4.65 for a floor area of 1,821 m^2 in a building of 2.593 m^2. (Ref. App. IV) This building will have a floor area of 1,552 m^2 and a total floor area of 2.578 m^2. Updated element cost = \$ 4 93 Element cost $\frac{4.93 \times 2.593}{1{,}821} \times \frac{1.420}{2.578}$	3.86	Preliminary estimates show that use of deformed bars will reduce cost of r.c. work by 3%. Revised cost	3.74
		14.14		14.87
3.3	**Vertical circulation** The cost of this element (Table X and Appendix IV) is \$ 0.29 for staircase m wide rising 11.40 m in a building of 2,593 m^2. It is proposed in this building to have 2 stairways each 1.40 wide rising 9m in a building of 2,578 m^2. Updated cost \$ 0.30 Element cost $\frac{0.30 \times 2{,}593}{11.40} \times \frac{18.00}{2.578}$ = 0.476 say	0.45	Leave as is	0.45
3.4	**Roof** The cost of this element can be adjusted as for item 3.2 or the element unit rate in Appendix IV can be used directly. Area of roof in proposed building 1,262 m^2 in area of 2,578 m^2 Element unit rate \$ 7.86 Updated \$ 8.33 Element cost $\frac{8.33 \times 1{,}262}{2{,}578}$	4.07	To reduce costs it has been agreed to substitute a pitched roof for the flat roof using steel trusses and asbestos cement covering. Estimated unit rate \$ 4.58 m^2. Area of roof 1.425 m^2 (measured on plan to eaves line) Element cost $\frac{4.58 \times 1.425}{2.578}$	2.53
		18 66		17.85

APPENDIX V

PRELIMINARY ESTIMATE AND COST PLAN for a 840 place second level school for boys based on cost data in Table X and Appendix IV.

Prepared 1.10.71
Date of cost data 21.11.70
Price increase 6%
Ref. 56 03 B 123

	Initial solution	*Net Cost* m² $	*Revised solution*	*Net Cost* m² $
		18.66		17.85
4.1	**Wall furnishes** This element is best adjusted by using approximate quantities. In this example there are 4,750 m² of wall finishes. Updated cost of element unit rate is $ 0.61 Cost of element $\frac{0.61 \times 4{,}750}{2{,}578}$	1.12	Leave as is	1.12
		19.78		18.97
4.2	**Ceiling finishes** The ceiling areas are more or less the same in both examples. The element cost as in Appendix IV can be used directly after up-dating.	0.34	Allow for increased cost of ceilings to underside of pitched roof Element cost 1.79 Add cost of plastering 0.20 1.99	1.99
4.3	**Floor finishes** The floor area in the proposed building is 2,578 m² as against 2,384 m² in the building described in Appendix IV; therefore use the element unit rate after updating.	1.00	Reduce thickness of paving and omit terrazzo Savings 5%	0.95
4.5	**Built-in furniture** Use same element cost m² after updating	1.24	Leave as is	1.24
5.1	**Sanitary installation** The element serves 670 persons in a total floor area of 2,593 m². The new units will serve 872 persons in 2,578 m² Updated element cost $\frac{1.29 \times 2{,}593}{670} \times \frac{872}{2{,}578}$	1.67	Leave as is	1.67
5.2	Laboratory fixtures and plumbing Use same rate after updating	0.42	The facilities are to be improved. Increase element cost by 50%	0.61
6.1	**Electrical installation** This building needs 10% less lighting and fan points including fittings, making a total of 335 points in 2,573 m² as against 352 points in 2,593 m². Up-dated element cost = $ 3.60 Element cost $\frac{3.60 \times 2{,}593}{352} \times \frac{335}{2{,}573}$	3.45	On examination it is considered that the overall cost of the eletrical installation can be reduced by 10%	3.10
	Initial solution total	27.90	Revised solution total	28.53
	Target cost m²	27.48		27.48
	Initial solution exceeds target cost by	00.42	Revised solution exceeds target cost by	1.05

SCHOOL BUILDING DIGEST 19.

APPENDIX VI

Asian Regional Institute for School Building Research
(sponsored by Unesco)
P. O. Box 1368, Colombo, Ceylon.

PHILIPPINES-MANILA: DESIGN FOR DAYLIGHT IN SCHOOLS

This Digest can be used to :-

(a) assess the illumination levels on tops of desks and other working surfaces as provided by a given arrangement of windows;

(b) calculate window sizes to give desired illumination levels on desks and other working surfaces in schools.

The sections that follow give a simple, stage by stage explanation of the method of calculation.

Metric units are used throughout and in this connection:-

1 foot candle	=	10.76 lux
2 feet	=	60 cm

Introduction

The Digest includes a grid on which is marked a number of dots and crosses. The grid represents the outside wall of a classroom or other teaching space *above* desk level. By drawing the shapes of the windows in the wall on the grid and simply counting the number of dots and crosses within the window outlines, the illumination can be found. If, on the other hand, the desired illumination is known, then the size of windows can be determined by making them big enough to enclose the number of dots and crosses that give the illumination. Figure 1 illustrates the idea in principle.

Using this method, of which several practical examples are given below, window design for daylight need take only a matter of minutes instead of the hours sometimes taken using other, more cumbersome methods.

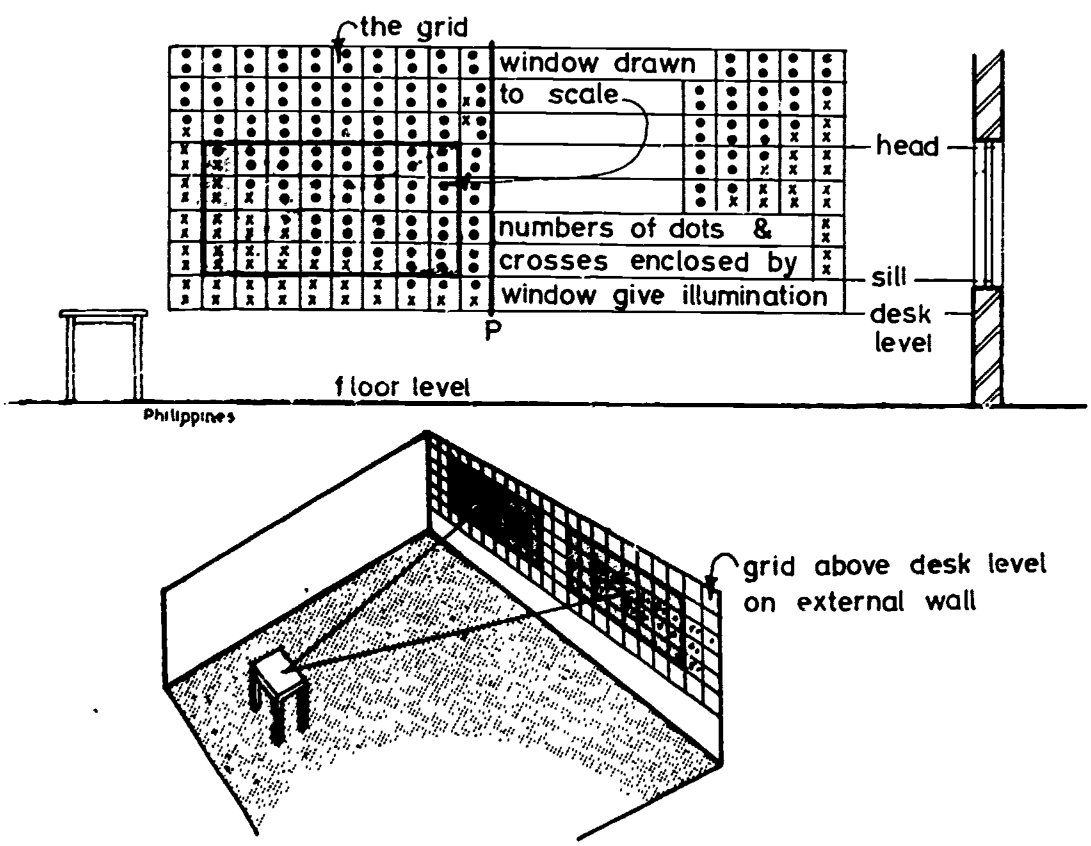


FIGURE 1

The Grid

It will be noticed that the grid representing the wall has no scale and thus the first step is to decide on the size of one square of the grid so that the window outline can be drawn on it. Table 1 and Figure 2 show how this is done.

Suppose that it is decided to use a window of size 2.40m x 1.20m high (8ft x 4ft high) and it is desired to check the illumination this window will give on a desk which is 600 cm (20ft) from it. Take a piece of tracing paper and lay it over the grid and sketch on the window shape remembering (from Table 1) that the size of one square of the grid is 60cm x 60cm (2ft x 2ft). Figure 3 shows the window in position.

If it was desired to know the illumination at a desk only 300cm from the window, then, from Table 1, it will be seen that the size of one square of the grid becomes 30 x 30cm. The window drawn on the tracing paper overlay would then appear, as shown in Figure 4, to contain many more dots and crosses. This is to be expected as, the closer the desk is to the window, the better the illumination on it.

Sill height of window

The illumination on a desk only comes from that part of the window that is above its surface. The desk receives no illumination from any part of the window that is below its surface. Normally then, the sill of the window will be arranged either at or above desk top height. Where, for some reason or other, the sill of the window is *below* the surface of the desk, then the dots and crosses in the grid below desk height *should not be counted.* Figure 5 explains this.

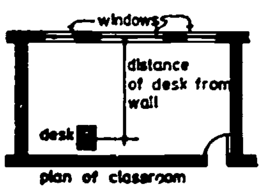


FIGURE 2

distance of desk from wall in cm	width of one square of grid, cm
600	60
450	45
300	30
150	15

TABLE 1

The value of the dots and crosses

The value of the dots and crosses has to be known if the illumination on the working surface is to be expressed in units of illumination or Lux units:

One dot has a value of 2 lux
One cross has a value of 1 lux

Thus, in Figure 3 below, the illumination on the desk 600cm from the wall is :

14 dots	=	28 lux
2 crosses	=	2 lux
TOTAL	=	30 lux

Similarly for the situation in Figure 4, where the desk is 300cm from the wall in the same room, the illumination is :-

48 dots	=	96 lux
16 crosses	=	16 lux
TOTAL	=	112 lux

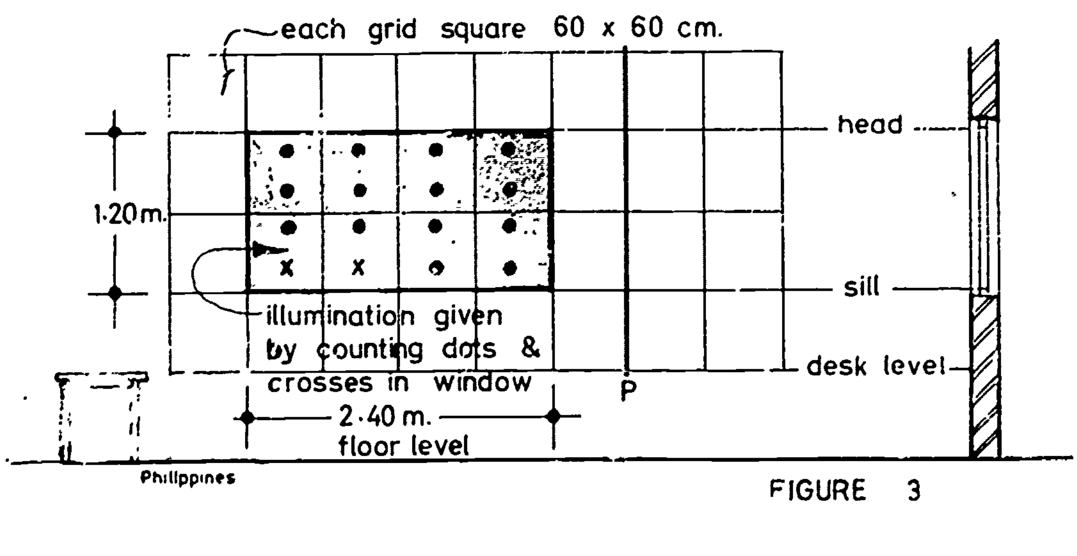
Of course, as the desk in Figure 4 is nearer to the window than that in Figure 3, it receives more illumination.

The interior finish of the room

The illumination on a desk or other similar horizontal work surface is affected, not only by the size of the windows, but also by inter-reflections of light within the room itself. If the internal finishes are dull and dark, then the inter-reflections will be less and the illumination on the desk somewhat lower, than if the rooms had been finished in lighter colours. This Digest shows how to correct the lux calculation, given above, for two sorts of interior finish, namely:

Finish A — Walls and ceiling unfinished wood; floor of cement.

Finish B - Walls above sill level - white, Walls below sill level - dark; floor of cement.



Philippines

FIGURE 3

TABLE 2 gives the correction factors.

Distance of desk from wall in cm.	Correction per grid square in lux	
	Interior Finish A	Interior Finish B
600	0	+1.5
450	-1.2	0
300	-1.8	-1.5
150	-2 0	-1.8

How is the correction factor applied?

Consider the example shown in Figure 3 – that is of a desk 600cm from the wall. Assume that the room in which the desk stands has Finish B - that is, the room has light finishes -

The method for applying the correction factor for this case is as follows :

Count *the squares* enclosed by the outline of the window.... there are eight. Multiply the number of squares by the correction factor for Finish B which from Table 2 with a desk at 600cm from the window is + 1.5

the correction is thus: 8 x 1.5 - 12.0

Now add this to the lux value as calculated by counting dots and crosses.

From dots and crosses, illumination	= 30 lux
correction (see above)	: 12 lux
TOTAL ILLUMINATION	= 42 lux

If the correction factor is negative, then the result of the correction calculation must be deducted from the illumination estimated by counting dots and crosses.

Consider the example in Figure 4 of a desk 300cm from the window wall and assume in this case that the room has Finish A – that is, wood walls and ceiling and cement floor.

The number of squares enclosed by the window in Figure 4 is 32. The correction factor for this example is, from Table 2, shown to be -1.8.

The correction is thus:

(-1.8 x 32) -= minus 57.6 lux

and the illumination of the desk is thus –

from dots and crosses, illumination	= + 112 lux
correction (see above)	= -- 57.6 lux
TOTAL ILLUMINATION	= + 54.4 lux

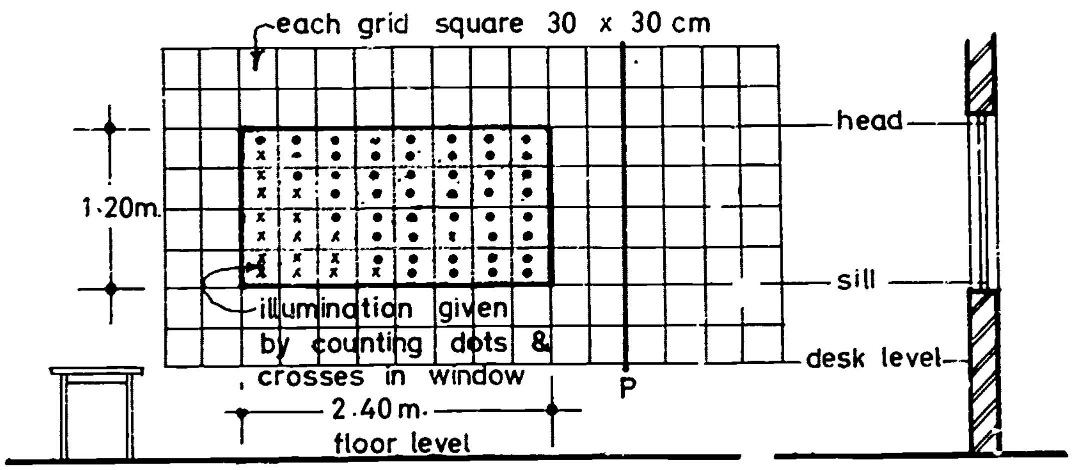


FIGURE 4

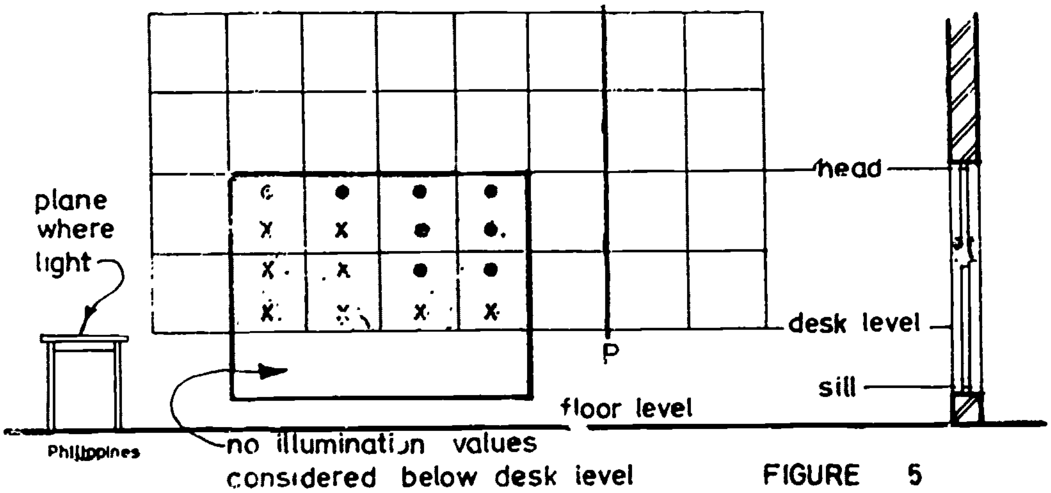


FIGURE 5

Levels of Illumination

In the absence of any local regulations or requirements concerning illumination levels in teaching spaces, the following can be used as desirable minima :-

Classrooms	108 lux
Laboratories	160 lux
Art Rooms	216 lux
Workshops:	
Course work	108 lux
Fine work	432 lux

In general, the finer the work, the greater the illumination needed to undertake it satisfactorily.

The preceeding ideas are now explained below in a series of practical examples.

Example 1 – **Illumination from a given set of windows**

Figure 6 shows a classroom having light-coloured, "A" type interior finish and in which it is desired to check the illumination levels on two desks. (Note :– it is not necessary to check the levels on *all* desks; only on those in what appear to be the less well illuminated positions in the room, i.e. desks furthest from the windows or desks behind piers).

Consider desk I first :-

Fix the scale of the grid from Table 1. The desk is 600cm from the wall and thus the size of one square on the grid is 60 x 60cm. Take a piece of tracing paper and lay it over the grid. Draw the elevation of *all* the windows on it with the point P_1 on the plan, coinciding with the heavy line at P on the grid. Make sure that the desk height, which is the base of the grid, is correctly related to the sill height. Figure 7 shows what should appear on the tracing paper.

Next, count the dots and crosses enclosed by the outlines of *all* the windows and add them together :-

	Dots	Crosses
Window A	8	0
Window B	10	6
Window C	0	8
TOTAL	18	14

∴ 1 dot = 2 lux and 1 cross = 1 lux therefore the total illumination is given by :-

2 x 18	36
1 x 14	= 14
TOTAL	50 lux

Correcting for finish; the correction factor for Finish A from Table 2 is 0. The illumination at desk I is thus 50 lux.

Now consider desk II.

The desk is 150cm from the window wall and thus the size of a square on the grid is 15 cm. Take a piece of tracing paper and lay it over the grid. Draw the elevation of all the windows on it with the point P_2 on the plan coinciding with the heavy line at P on the grid. Check that the base of the grid is at the level of the desk and correctly located in relation to the height. Figure 8 shows what should appear on the tracing paper.

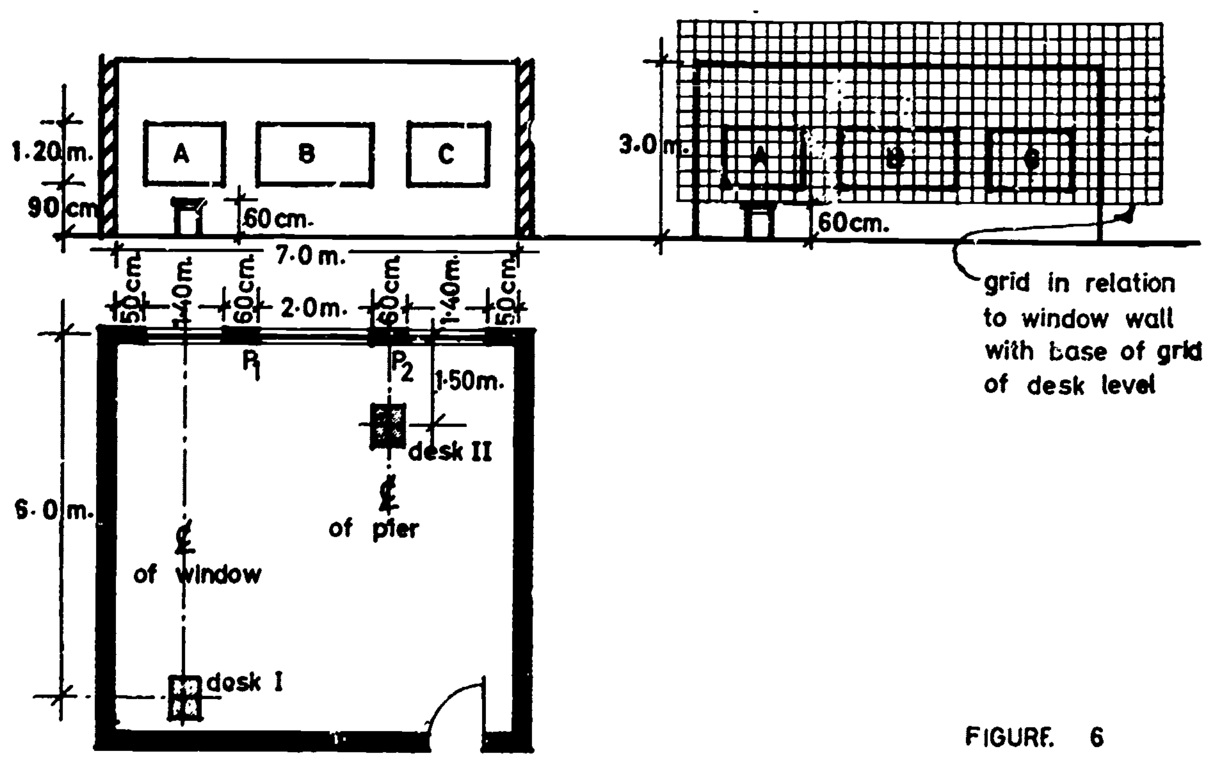


FIGURE 6

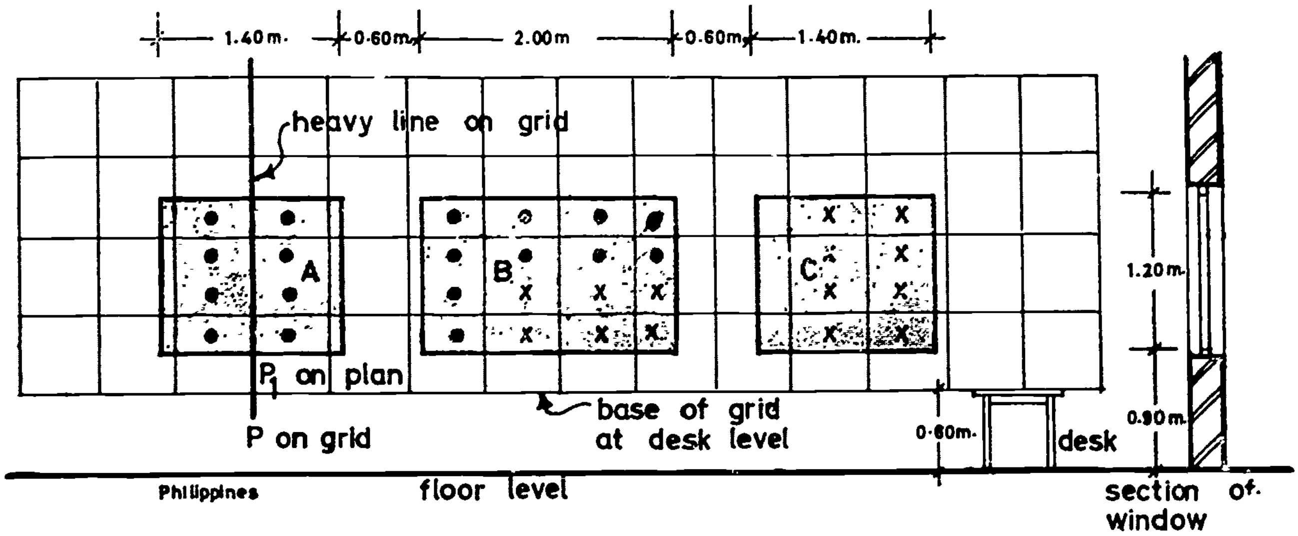


FIGURE 7

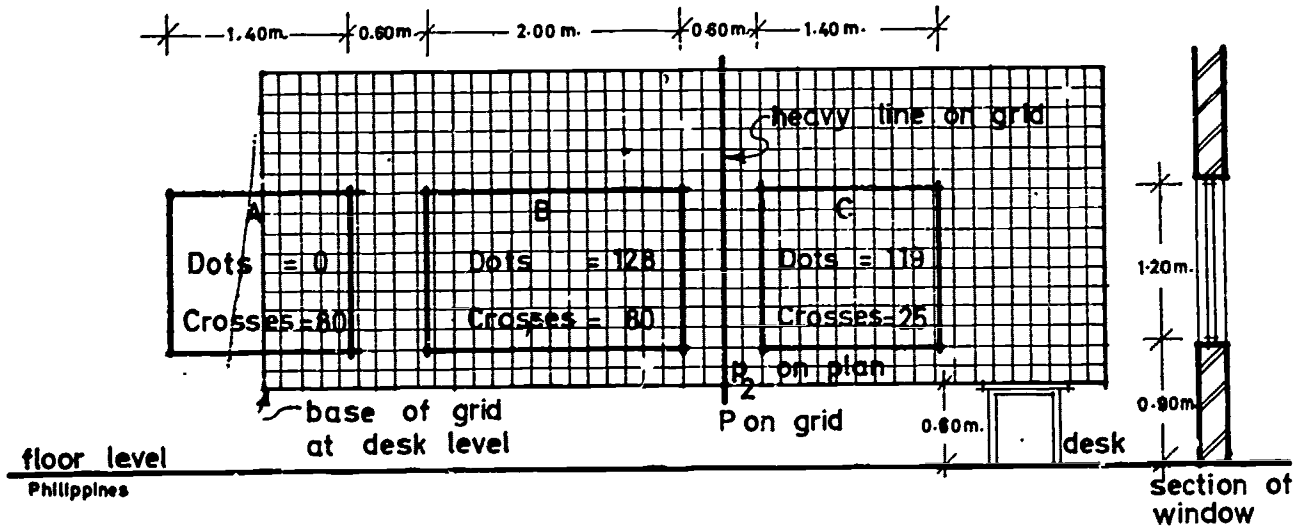


FIGURE 8

Next, count the dots and crosses enclosed by the outlines of all of the windows and add them together.

	Dots	Crosses
Window A	0	80
Window B	128	80
Window C	119	25
TOTAL	247	185

1 dot = 2 lux and 1 cross = 1 lux, therefore the total illumination is given by :–

2 x 247	=	494
1 x 185	=	185
TOTAL		679

Correcting for finish; the correction factor for Finish A, from Table 2, is -2.0.

The number of grid squares enclosed by *all* the three windows is:

Window A	=	40
Window B	=	106
Window C	=	74
		220 grid squares

Thus the total correction factor is (-2.0 x 220)
= -400 lux

The total illumination on desk II is thus
(679 - 440) = 239 lux

Windows in two walls

Quite often, teaching spaces may receive illumination from windows in opposite walls as shown in Figure 9.

In such cases the illumination on the selected desk is calculated by adding together the illumination obtained from windows in wall A to that obtained from windows in wall B. The method of calculation is that explained in the example above.

Example II – **Sizing of windows to achieve a required level of illumination on a desk**

Figure 10 shows the outline plan of an art room in which it is desired to obtain a minimum illumination level of 216 lux on the drawing tables. The problem is to fix the dimensions and positions of windows to achieve this illumination level. The windows are to be located in wall A on the plan.

By inspection, it seems likely that the desk that will receive least light is that marked D in Figure 10. A trial arrangement of windows is sketched onto a sheet of tracing paper overlaying the grid. This arrangement is shown in Figure 11.

Using the method of calculation already described, the number of dots and crosses is counted :–

	Dots	Crosses
Window A	44	4
Window B	2	46
TOTAL	46	50

If 1 dot = 2 lux and 1 cross = 1 lux then the total illumination given by the two windows is 142 lux.

Assuming it is decided to decorate the room in light colours, finish B, then the correction factor is 0.

The total illumination is thus 142 lux which is less than the required 216 lux. By extending the window the full width of the room, lowering the sill to desk level and raising the window head by 15cm an additional 83 lux illumination will be gained giving a total of 225 lux.

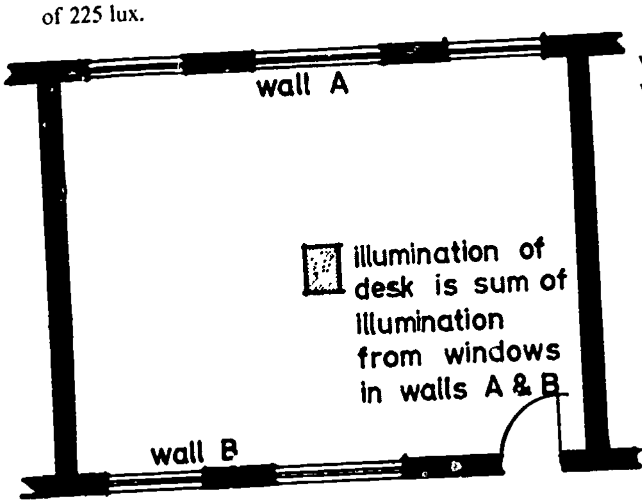


FIGURE 9

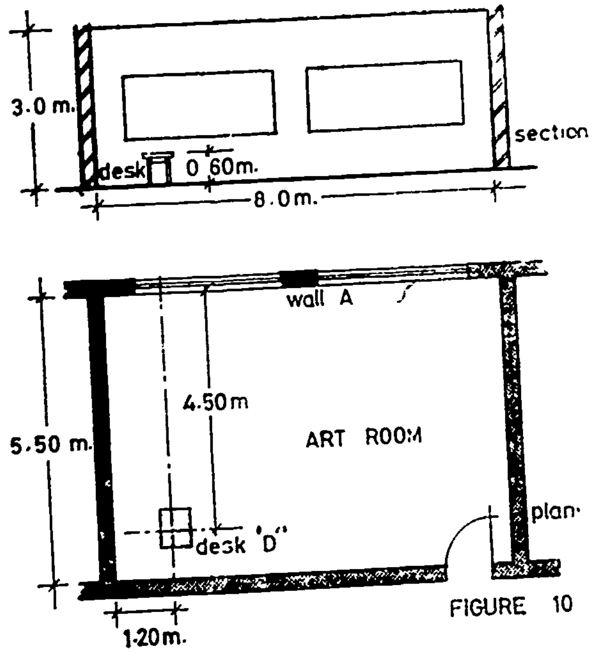


FIGURE 10

If the cost of windows per unit is greater than the cost of walling, then the size of the windows can be reduced by trial, in order to give a cheaper solution.

Limitations of the methods of the Digest

1. The measurements of sky luminance and availability of daylight on which the grid is based are applicable to Manila and an area of 50 miles around it. Data for the rest of the Philippines are not available. However, until more measurements can be made, the grid can be used for the whole country.

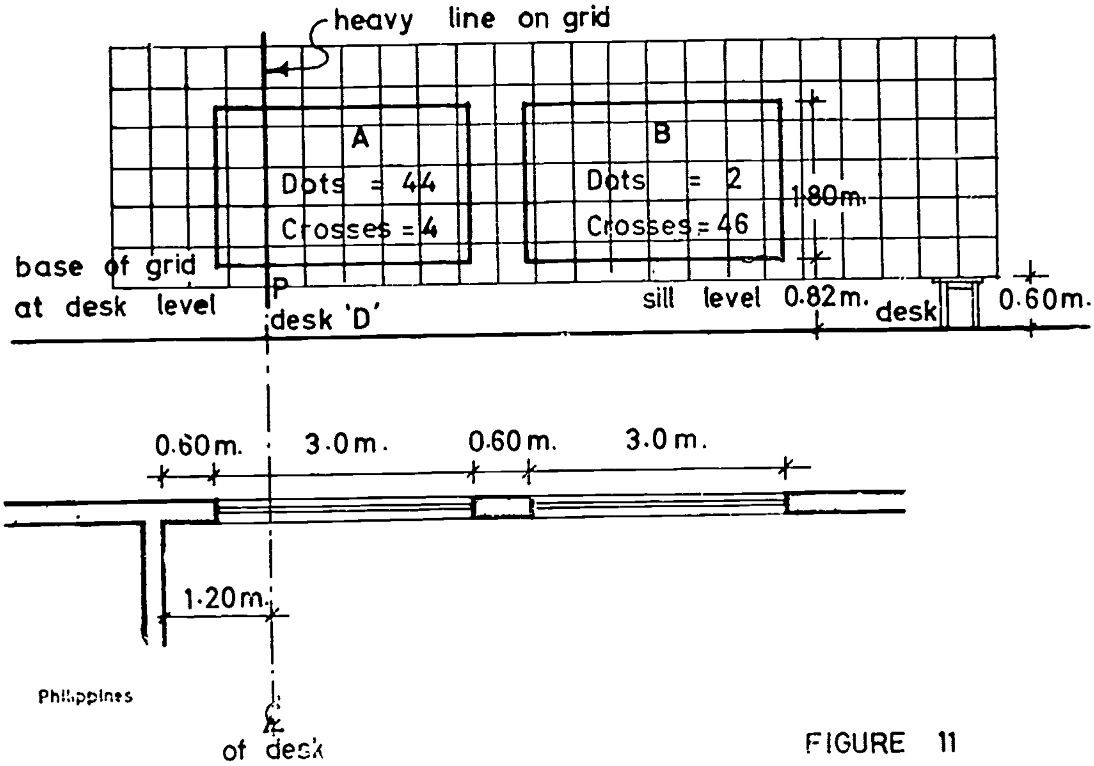
2. As far as the size of the teaching spaces for which the method can be used is concerned, the floor area should be between about 30 to 45 sq metres. The ceiling should be fr[illegible] 2.75 to 3 metres above floor level and pitched or [illegible]

3. The data assume that the ground outside the windows have a reflection factor of 0.20 – that is grass with some brick or concrete paving.

4. Obstructions outside the windows can be ignored if they are distant more than 3 times their own height from the window. Obstructions that are closer should be considered and deducted from the area of the window as is shown in Figure 12. The value of illumination so estimated will be lower than that actually obtained as external reflections have been ignored.

5. In designing the grid it was assumed that the window has a 60cm sunshade around it or that a 60cm horizontal louvre is incorporated in the window as is shown in Figure 13.

If there is a verandah or other large overhang outside the window then the size of the window, for the purpose of counting dots and crosses, should be reduced as is shown in Figure 14.



Philippines

FIGURE 11

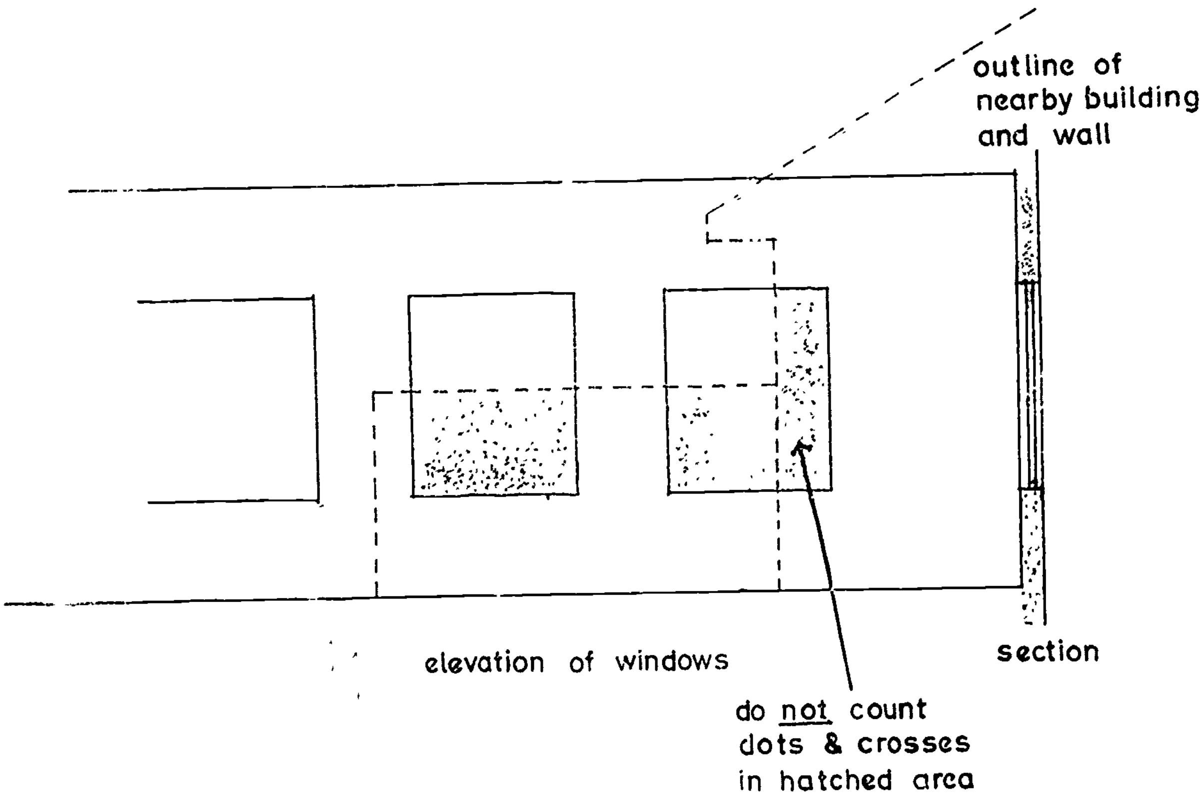


figure 12

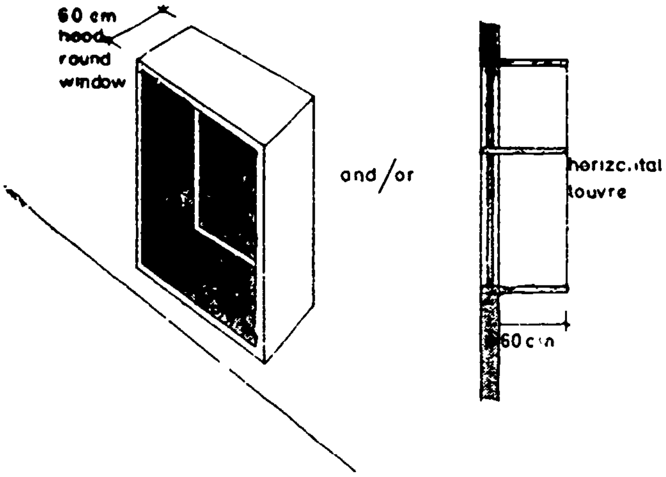


figure 3

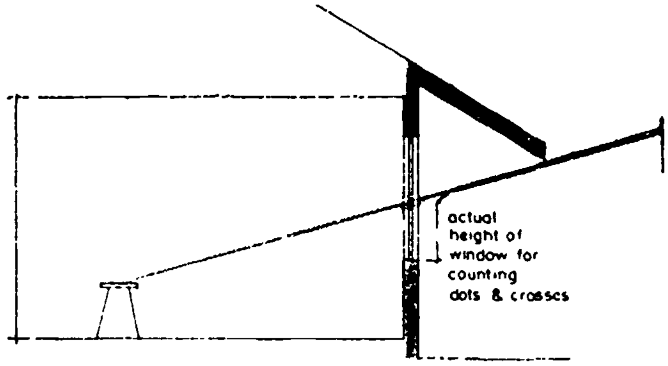


figure 14

The grid mentioned in this Appendix will be found in the back cover pocket.

APPENDIX VII

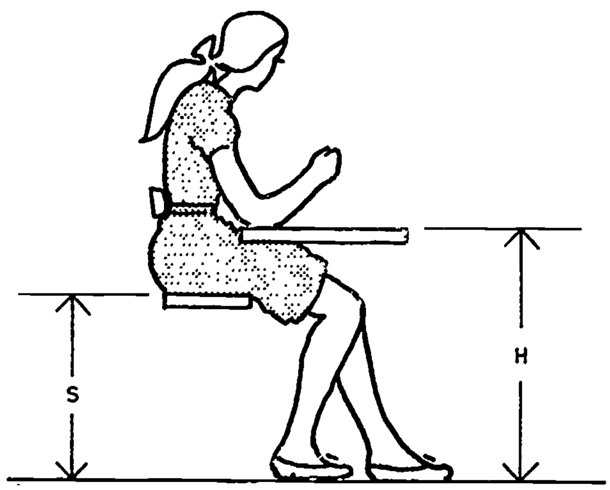
Non-Projected Materials and Aids Commonly Used in 15 Countries of the Asian Region (7.24)

Materials and Aids (Non-projected)	Percentage of Countries in which Commonly Used
Pictures	80
Photographs	33
Charts	60
Maps	87
Diagrams	47
Flash Cards	53
Bulletin Boards	40
Flannel Boards	27
Flat Boards	20
Models	13
Mock-ups	7
Objects	40
Specimens	53
Globes	60
Diorama	7
Planetarium	0
Weight Pieces	20
Dolls or Puppets	20
Picture Stories	40

In addition to the commonly used, non-projected aids listed above, the following other aids are commonly used as indicated below –

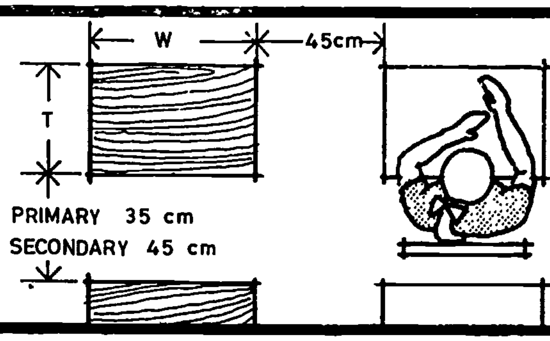
Records	in 33% of the countries
Recorded Tapes	,, 27% ,, ,, ,,
T. V.	,, 27% ,, ,, ,,
Radio	,, 27% ,, ,, ,,
Slides	,, 7% ,, ,, ,,

APPENDIX VIII

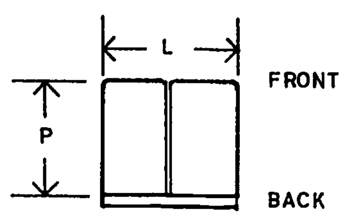


DESK TOP HEIGHT (H)	
TYPE	CENTIMETRES
A	41
B	46
C	51
D	56
E	61
F	[illegible]

CHAIR SEAT HEIGHT (S)	
TYPE	CENTIMETRES
A	27
B	30
C	33
D	36
E	39
F	42



DESK TOP SIZE (W) & (T)		
TYPE	W cm	T cm
A	55	36
B	55	36
C	55	36
D	70	45
E	70	45
F	70	45



CHAIR SEAT SIZE (P) & (L)		
TYPE	P cm	L cm
A	18.5	26
B	21	26
C	23.5	26
D	26	36
E	28.5	36
F	31	36

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Revue de l'armée du savoir, Ministry of Education, Iran	.. Plate 2
P. U. Pathirana	.. Plates 8, 11, 13b, 14, 15a, 15b, 19, 26, 27, 28, 29, 30, 31, 35, 36, 37, 38.
ARISBR Staff Members	.. all other plates.

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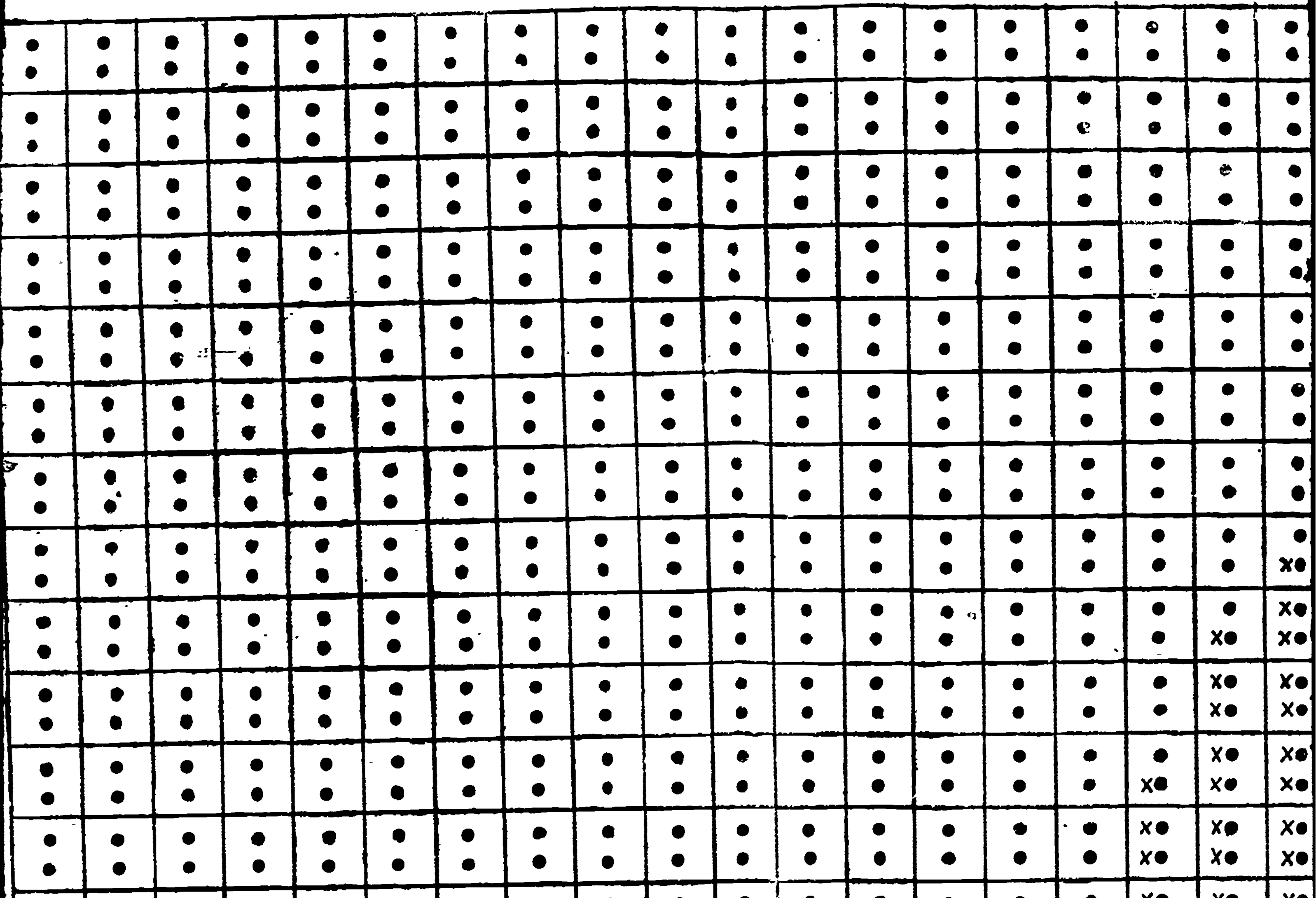

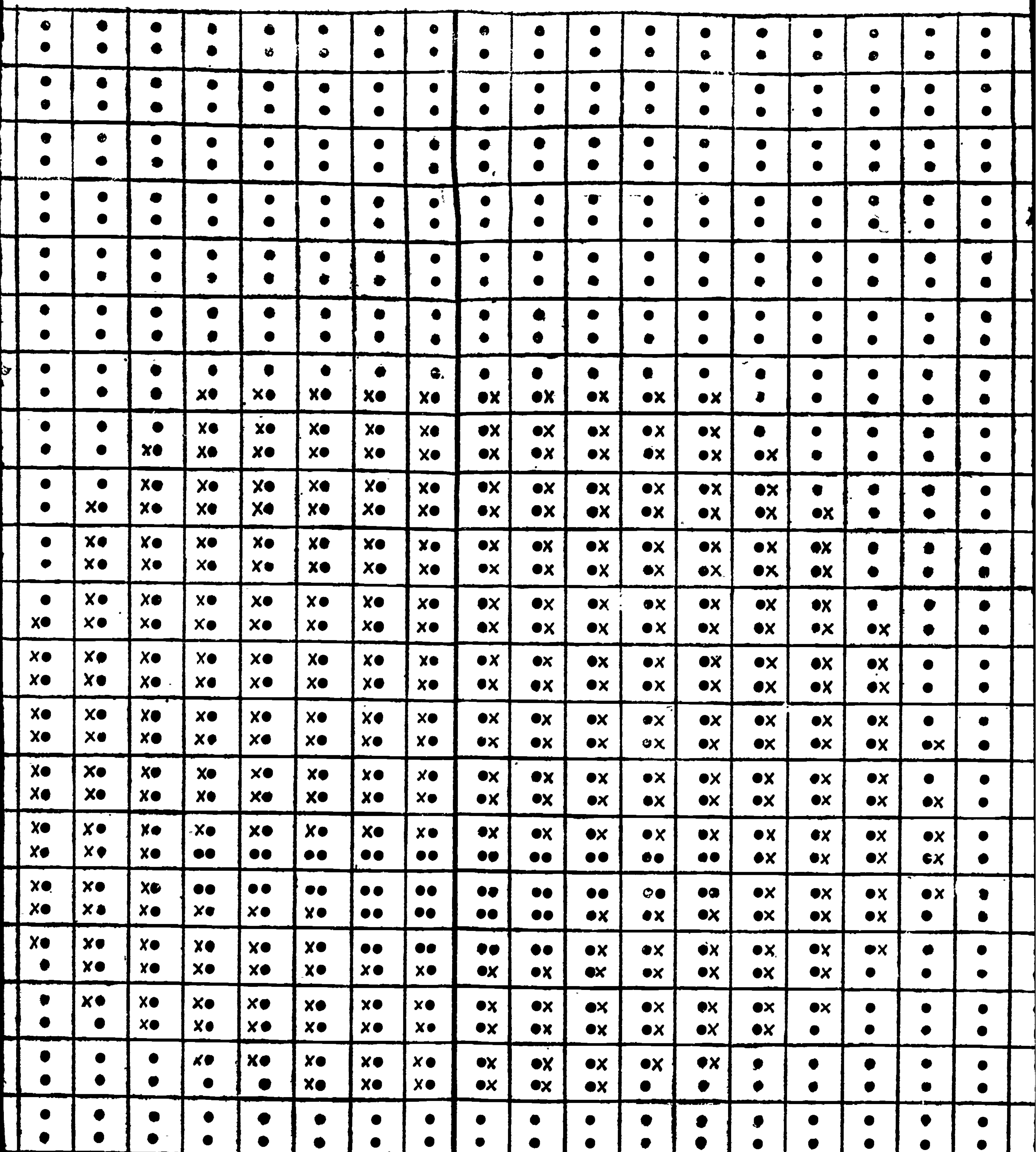

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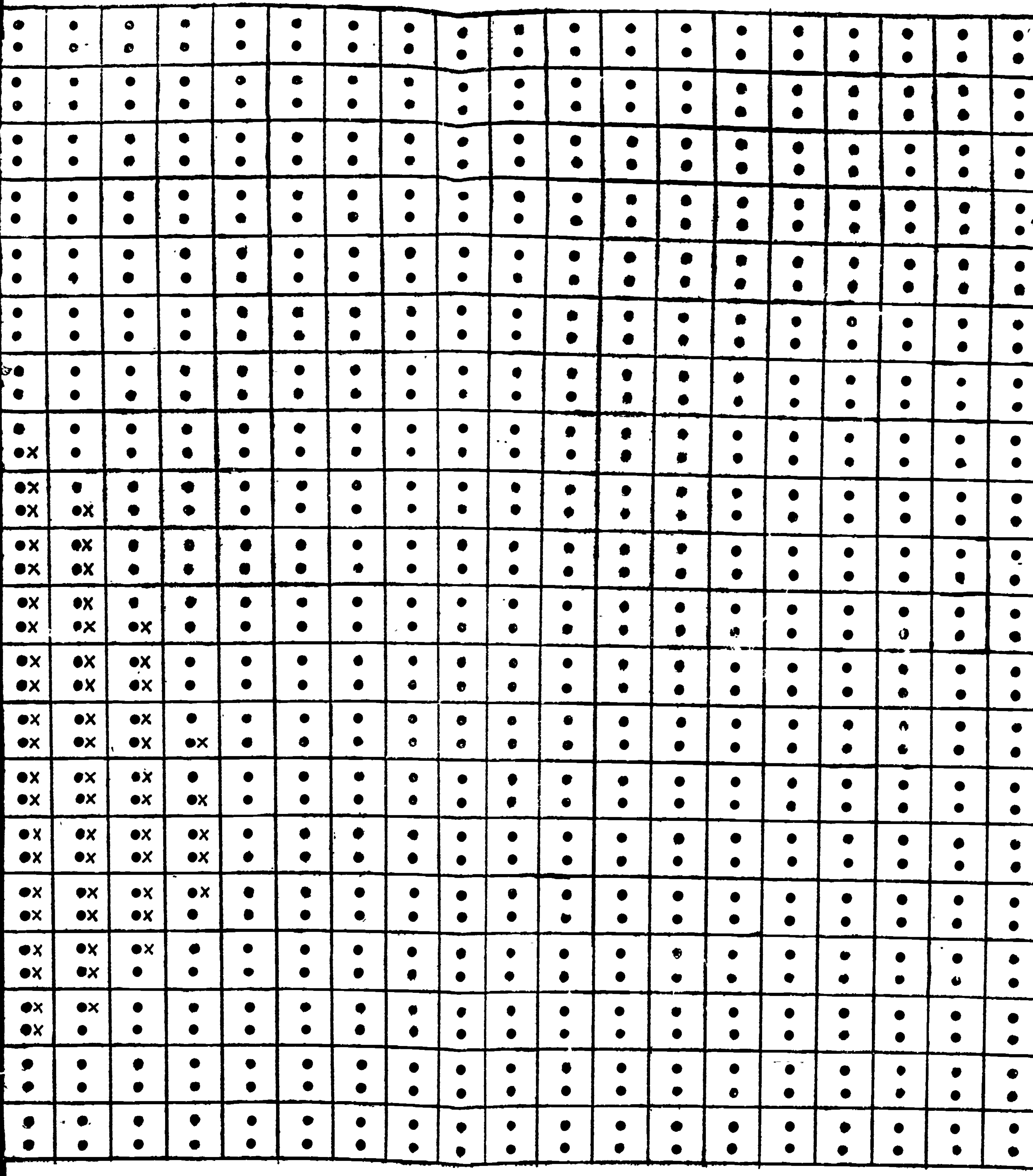

COLOMBO

x x	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x
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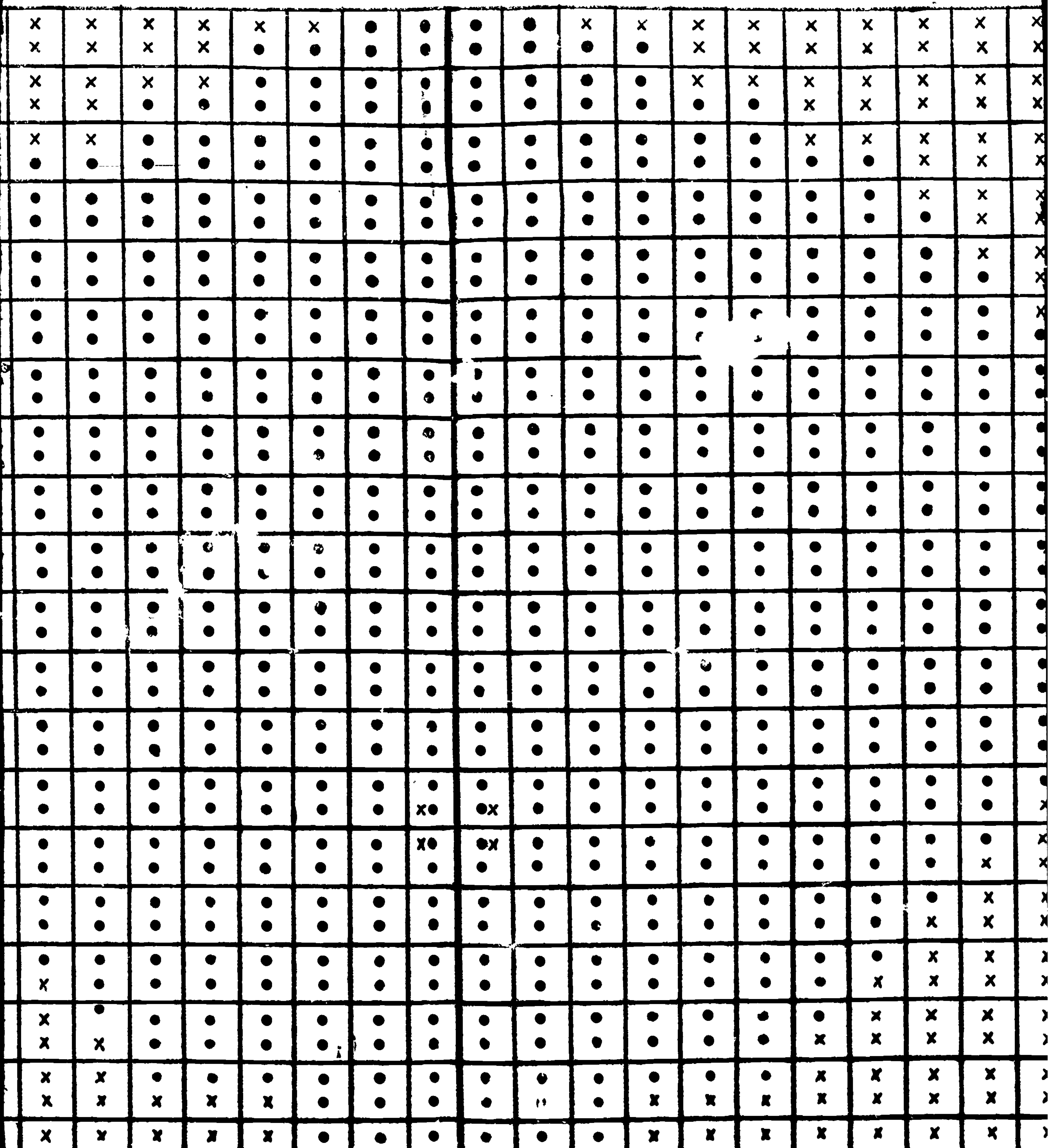

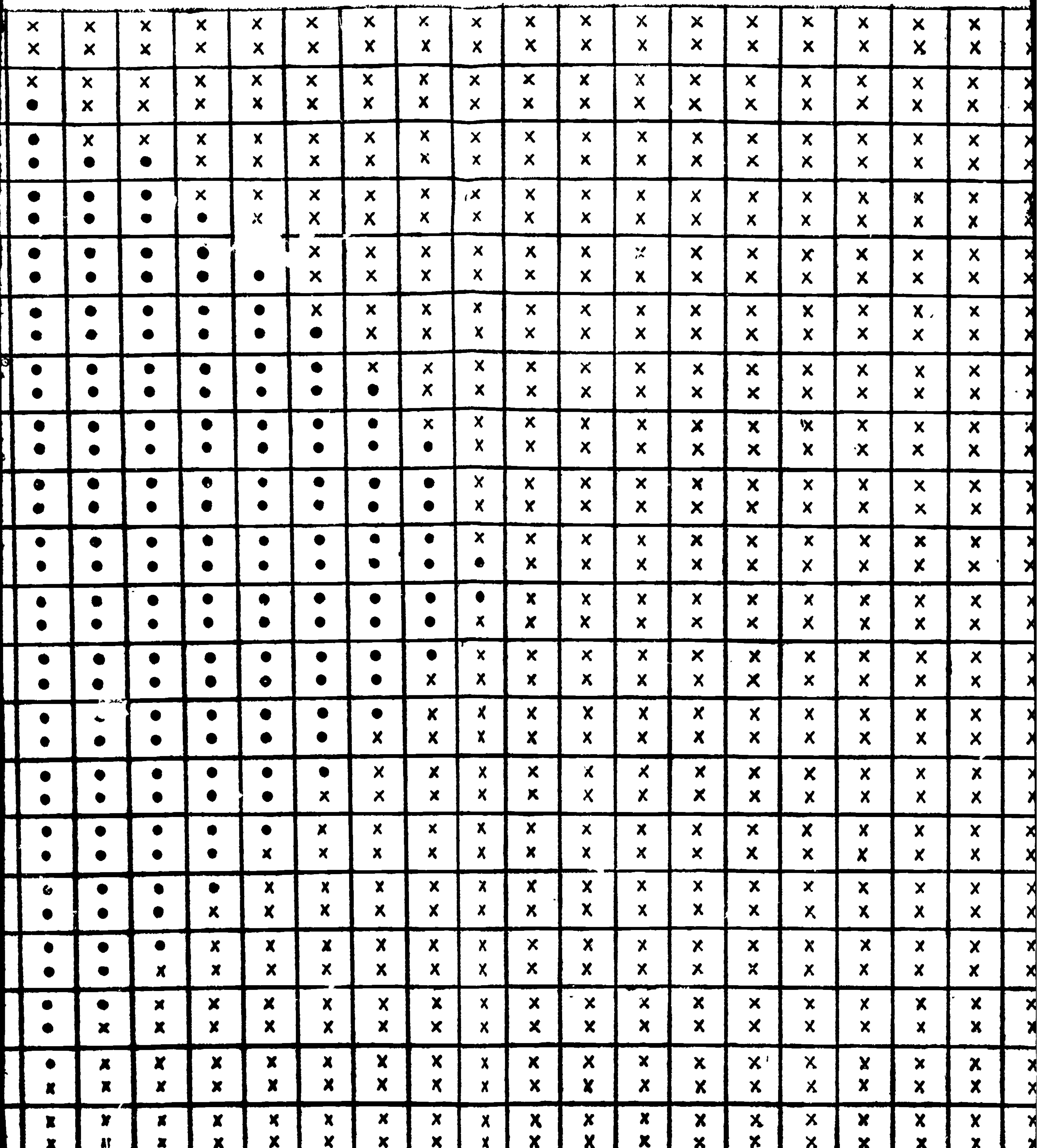

MANILA

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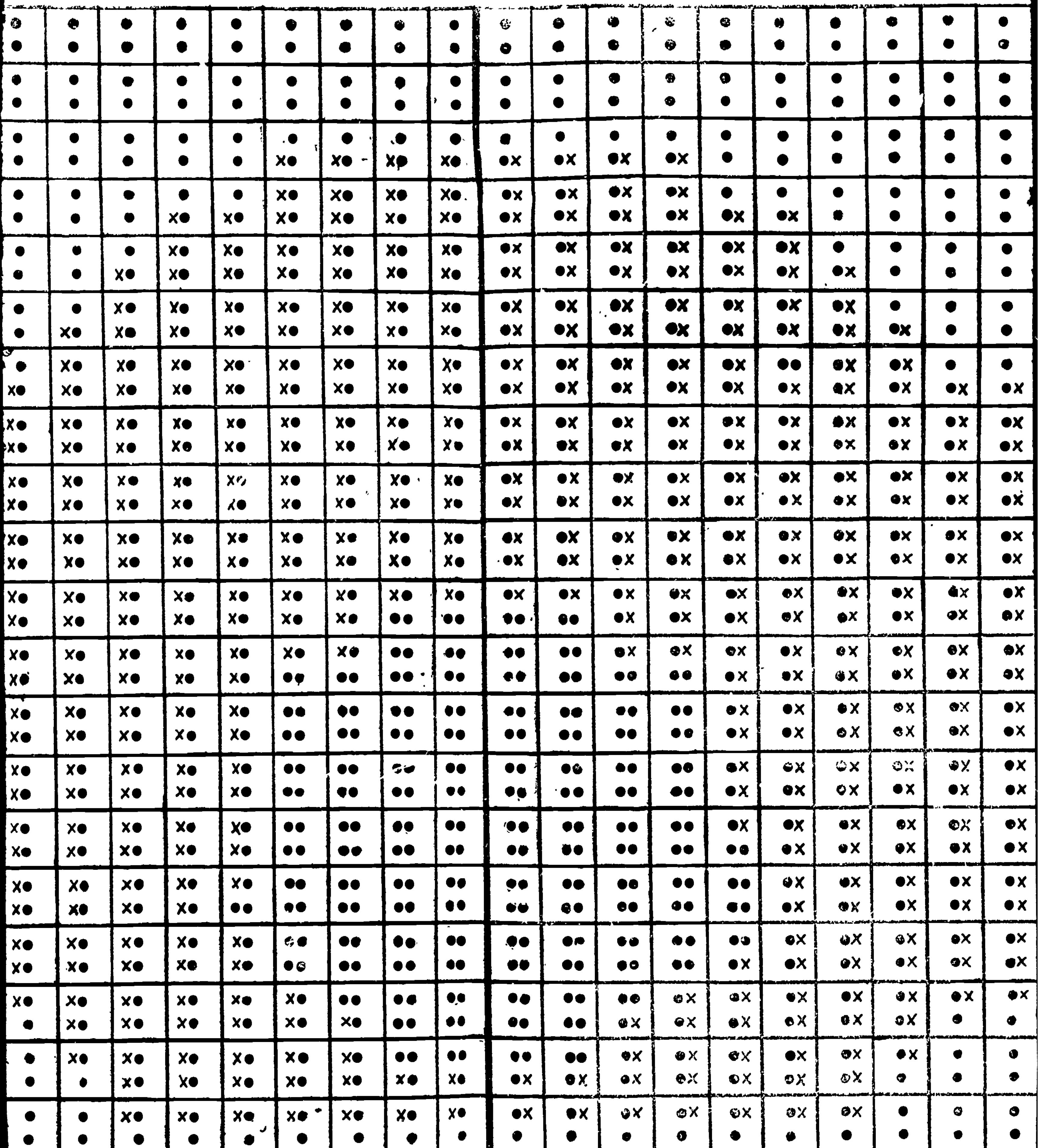

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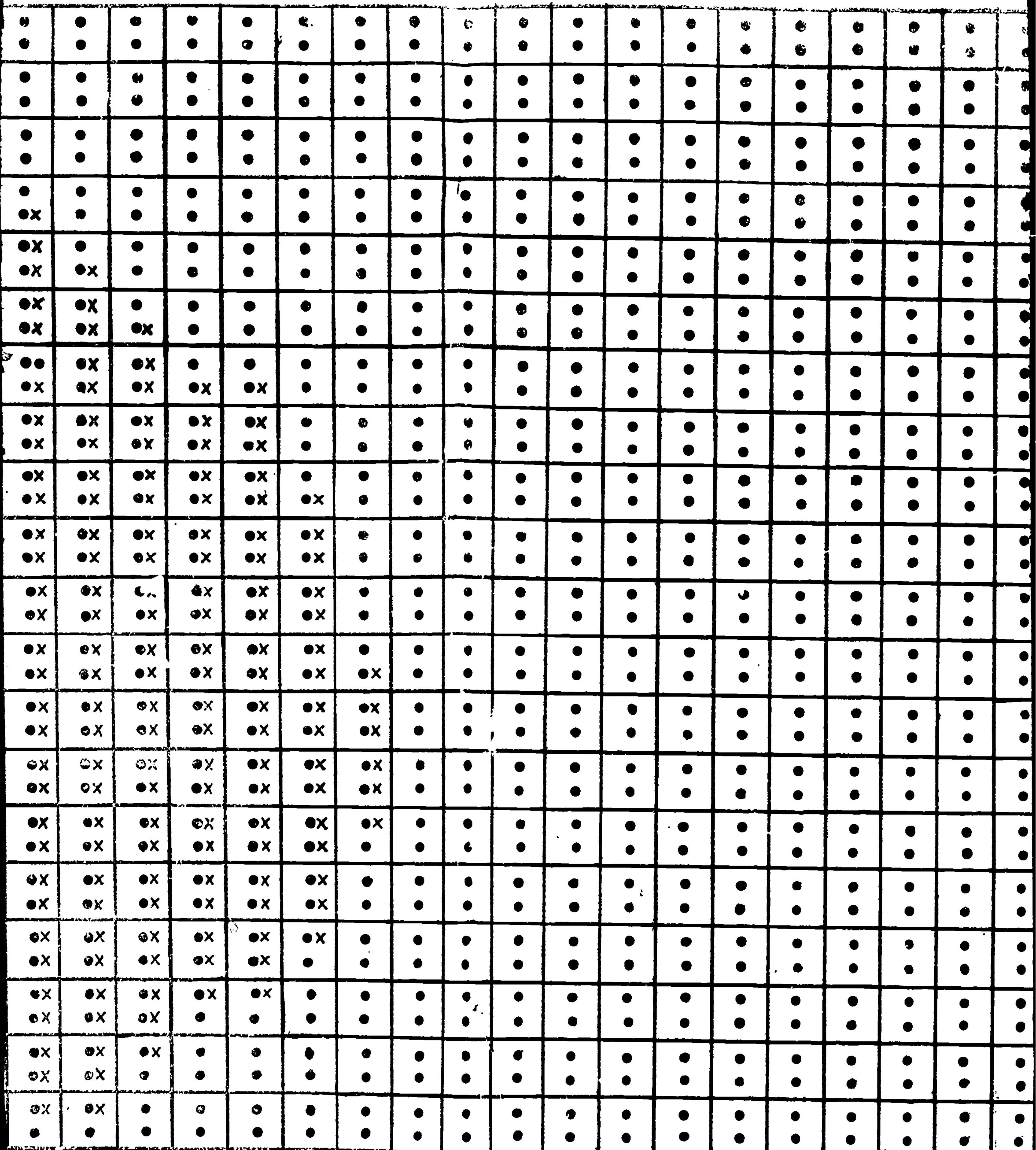

BANDUNG

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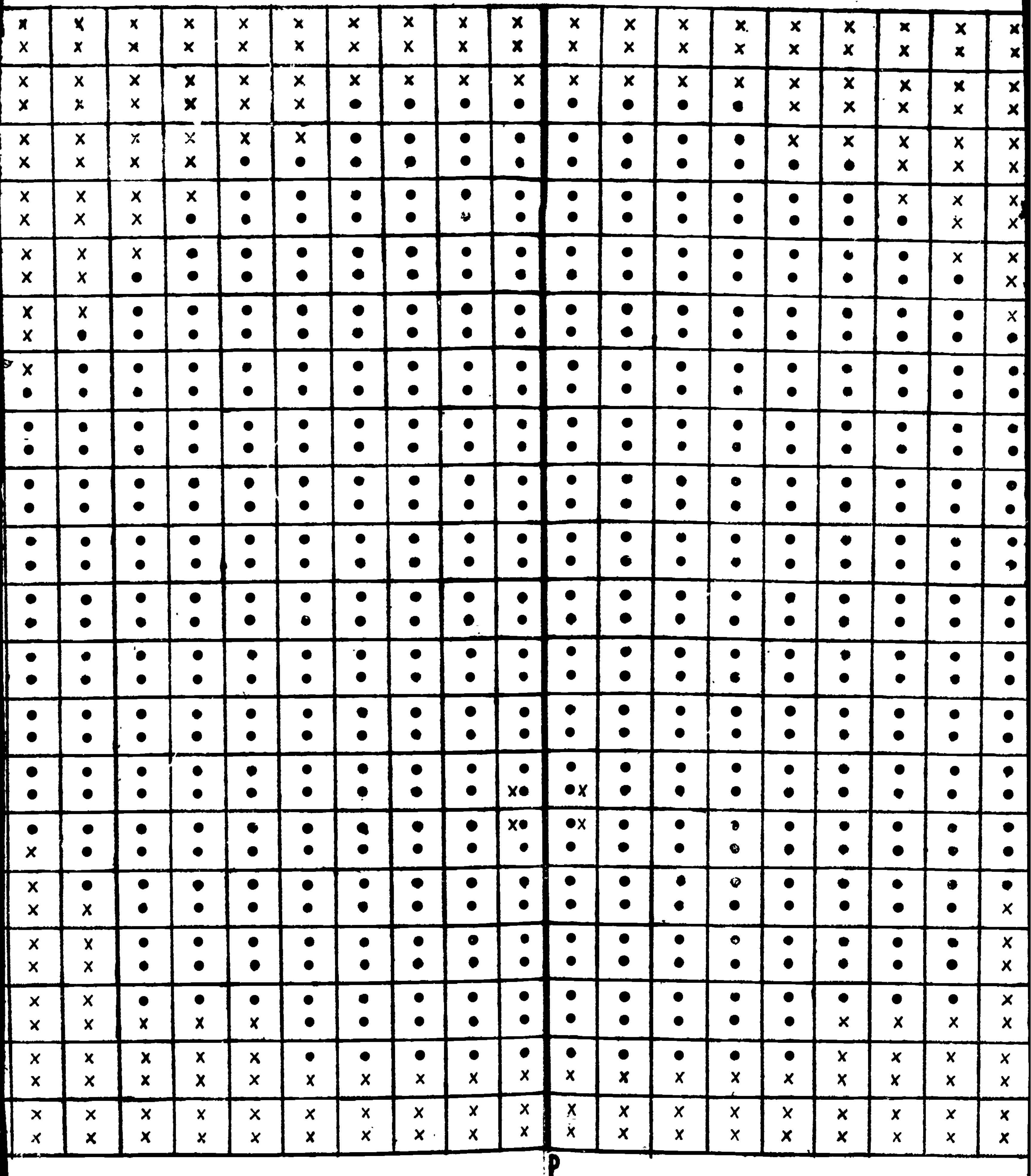
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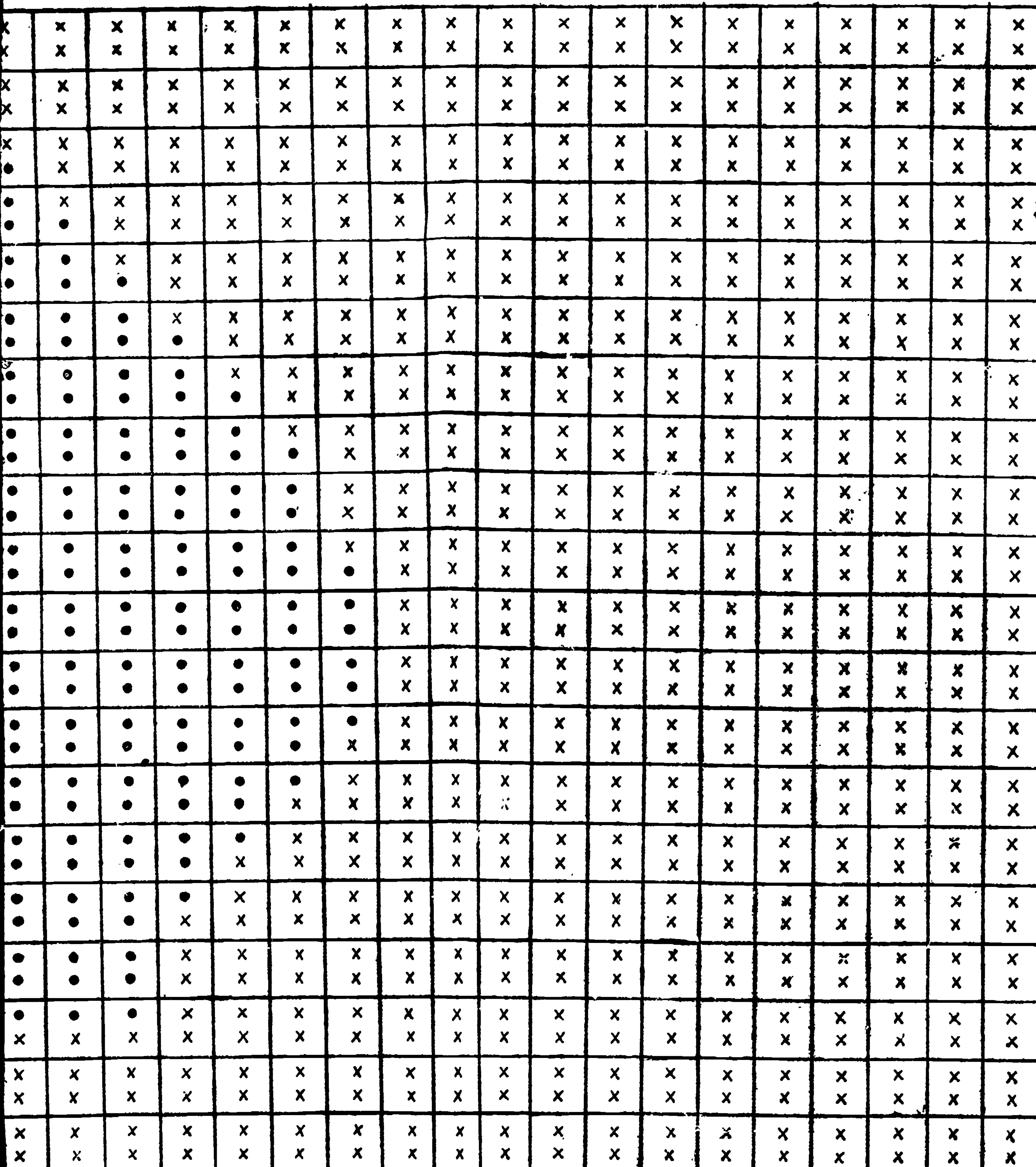
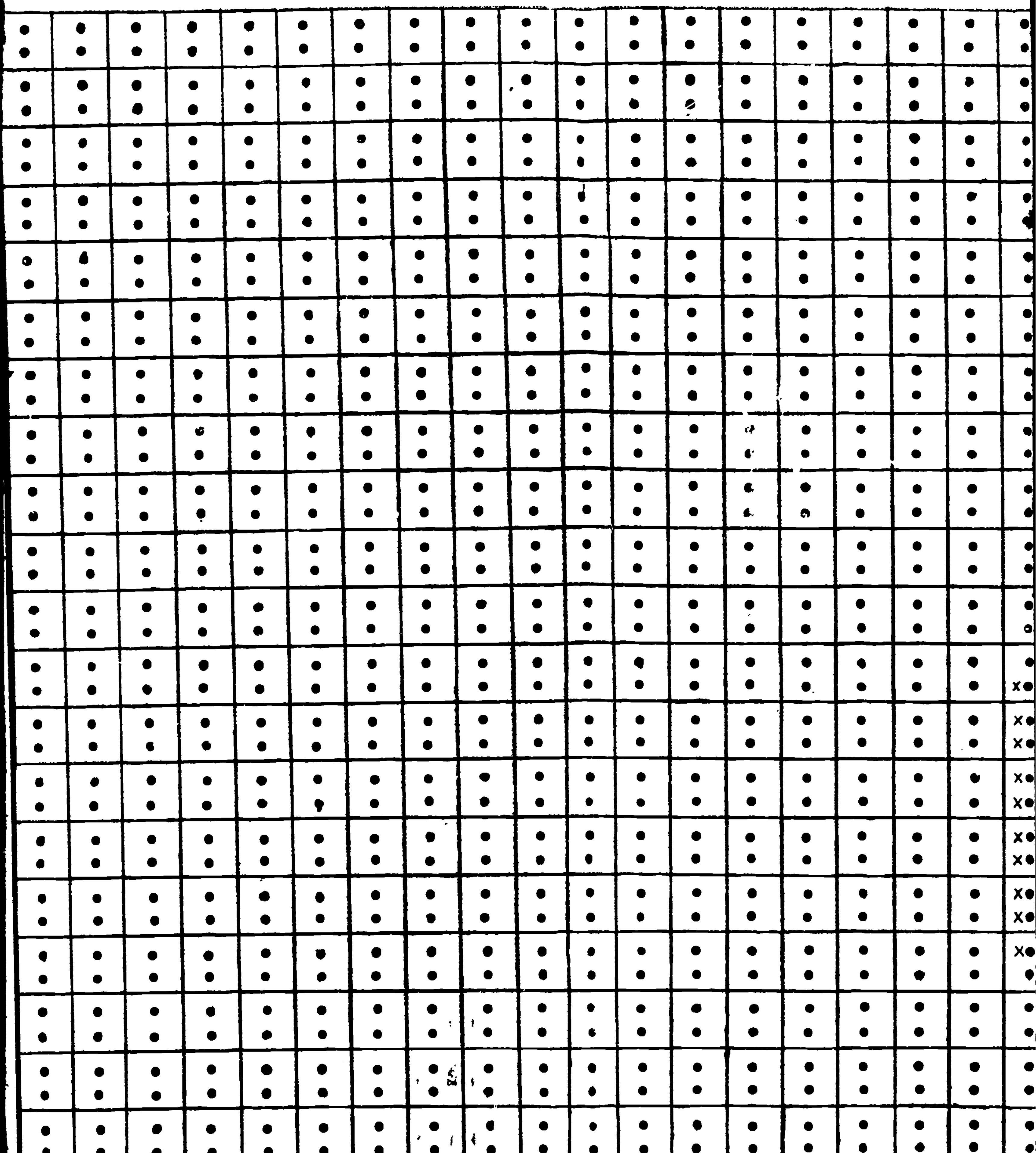
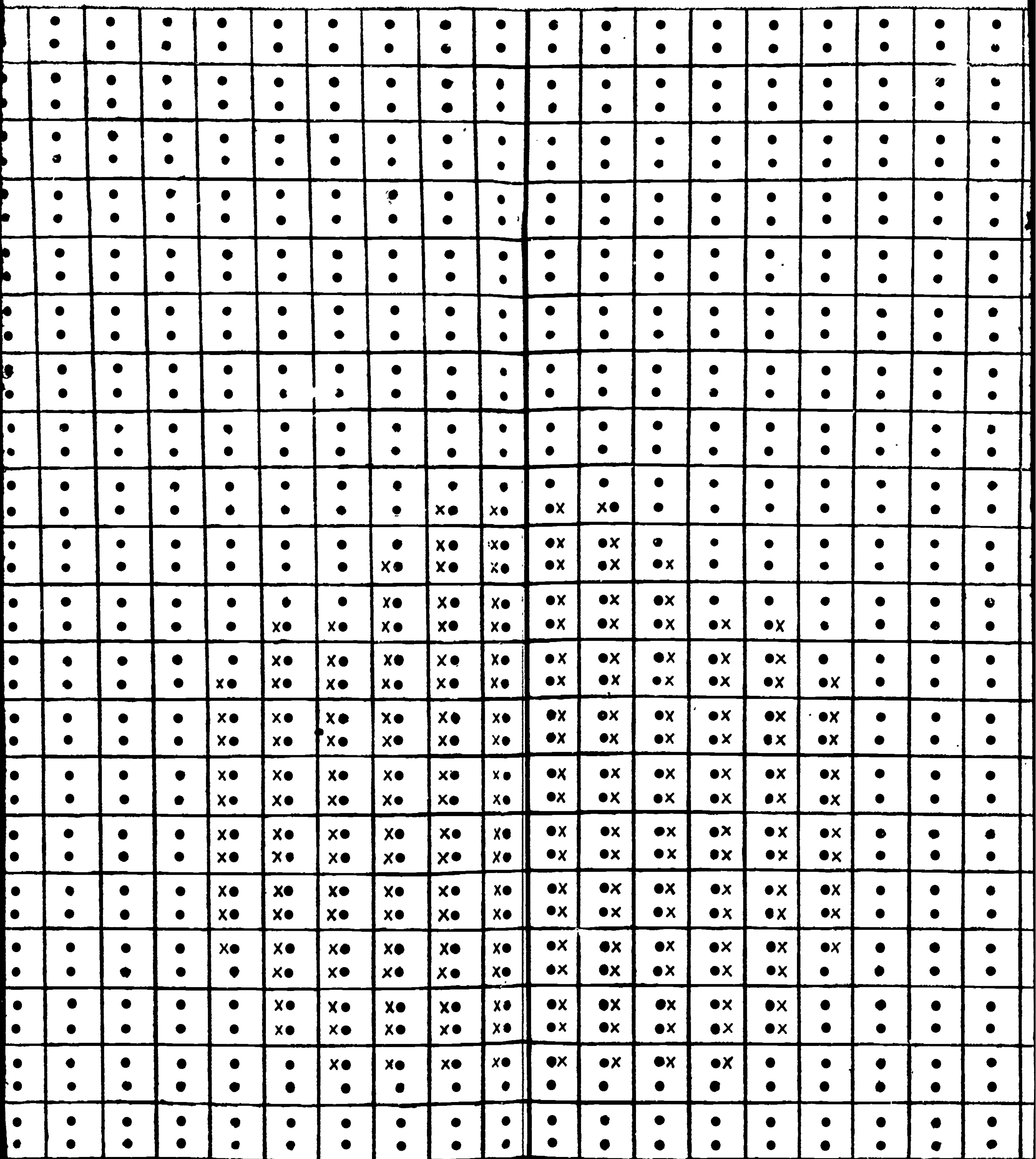


HONGKONG





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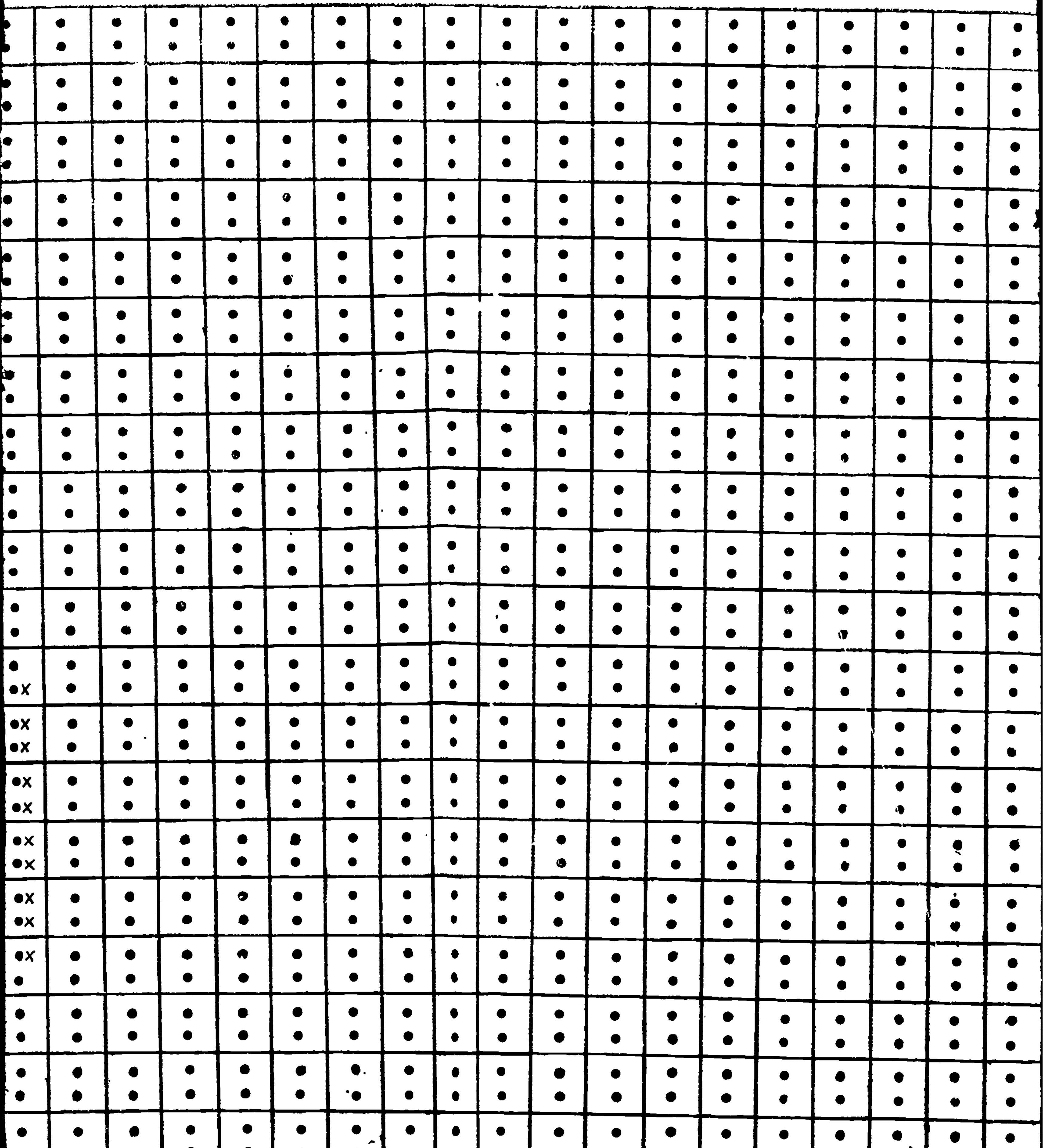

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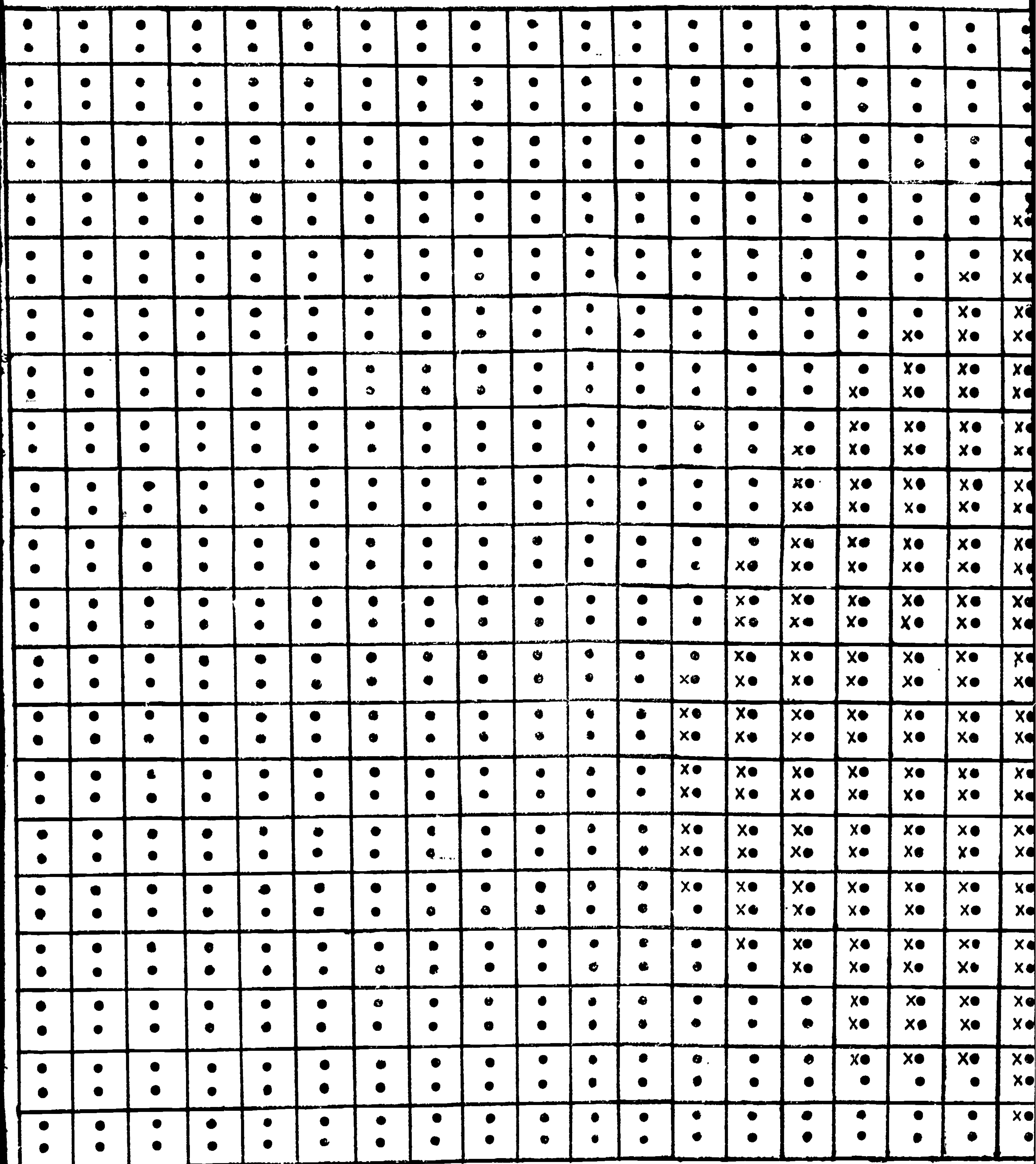

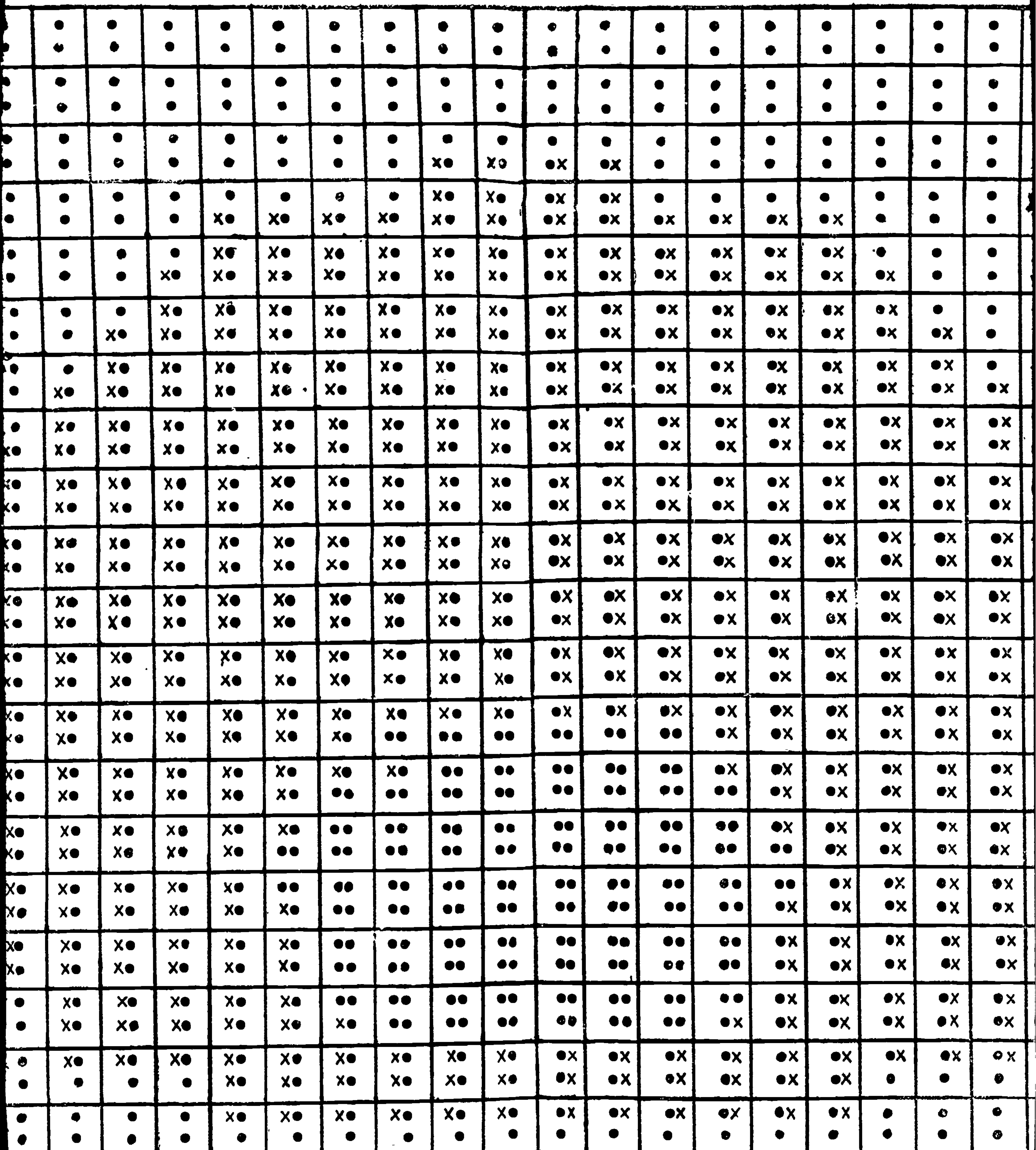

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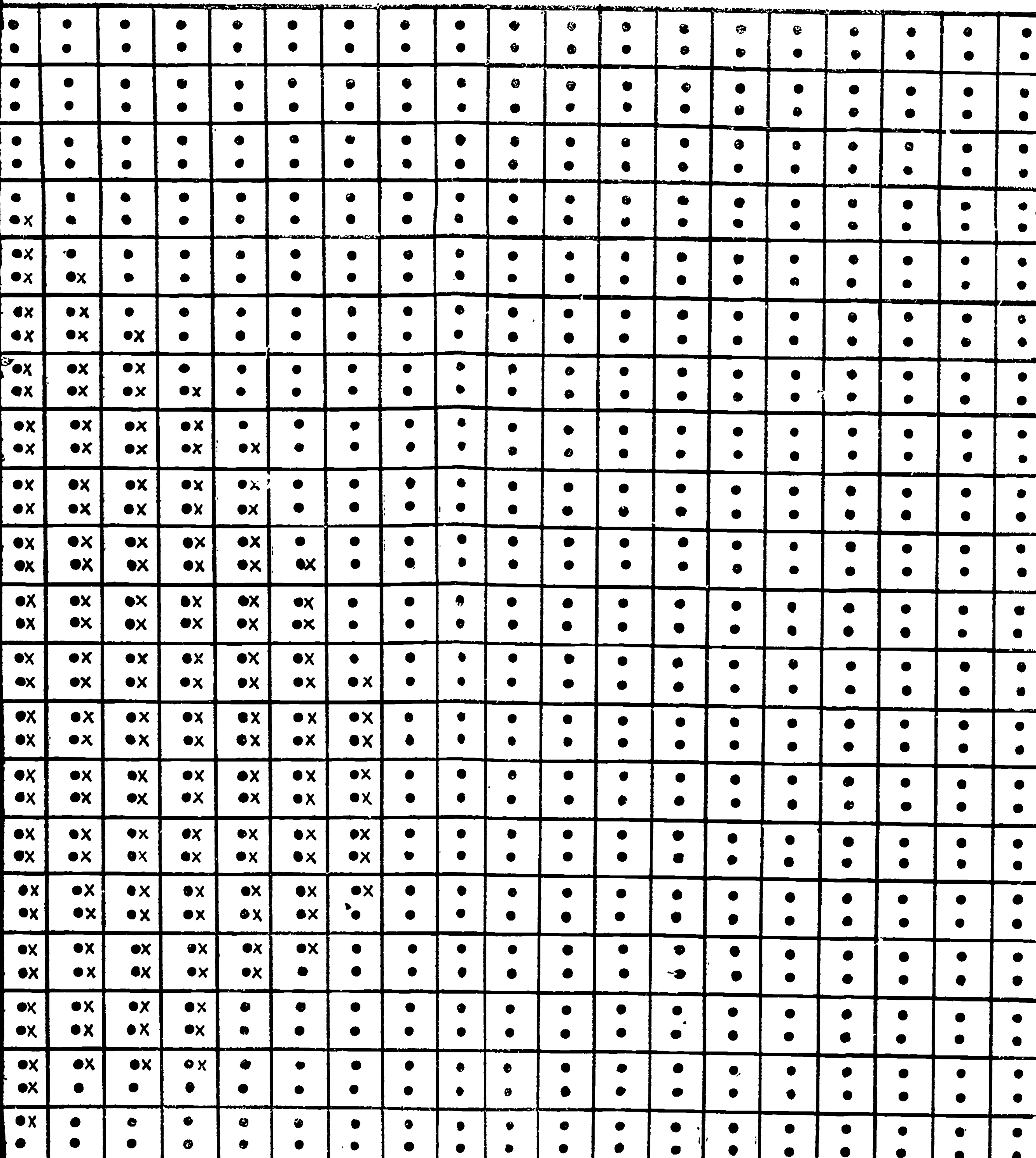

SINGAPORE