Published in the series:
Fundamentals of Educational Planning - 57

Physical facilities for education: what planners need to know

John Beynon

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The Swedish International Development Co-operation Agency (Sida) has provided financial assistance for the publication of this booklet.

Published by the
United Nations Educational, Scientific and Cultural Organization
7 place de Fontenoy, F 75352 Paris 07 SP
ISBN 92-803-1167-0

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Paris 1997
UNESCO: International Institute for Educational Planning

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Published in 1997 by the United Nations
Educational, Scientific and Cultural Organization
7 place de Fontenoy, 75700 Paris
Printed in France by Stedi, 75018 Paris

Cover design by Bruno Pfäffli
ISBN 92-803-1167-0

Fundamentals of educational planning

The booklets in this series are written primarily for two types of clientele: those engaged in educational planning and administration, in developing as well as developed countries; and others, less specialized, such as senior government officials and policy-makers who seek a more general understanding of educational planning and of how it is related to overall national development. They are intended to be of use either for private study or in formal training programmes.

Since this series was launched in 1967 practices and concepts of educational planning have undergone substantial change. Many of the assumptions which underlay earlier attempts to rationalise the process of educational development have been criticised or aban-doned. Even if rigid mandatory centralized planning has now clearly proven to be inappropriate, this does not mean that all forms of planning have been dispensed with. On the contrary, the need for collecting data, evaluating the efficiency of existing programmes, undertaking a wide range of studies, exploring the future and fostering broad debate on these bases to guide educational policy and decision-making has become even more acute than before.

The scope of educational planning has been broadened. In addition to the formal system of education, it is now applied to all other important educational efforts in non-formal settings. Attention to the growth and expansion of educational systems is being comple-mented and sometimes even replaced by a growing concern for the quality of the entire educational process and for the control of its results. Finally, planners and administrators have become more and more aware of the importance of implementation strategies and of the role of different regulatory mechanisms in this respect: the choice of financing methods, the examination and certification procedures or various other regulation and incentive structures. The concern of planners is twofold: to reach a better understanding of the validity of education in its own empirically observed specific dimensions and to help in defining appropriate strategies for change.

The purpose of these booklets includes monitoring the evolution and change in educational policies and their effect upon educational planning requirements; highlighting current issues of educational planning and analysing them in the context of their historical and societal setting; and disseminating methodologies of planning which can be applied in the context of both the developed and the developing countries.

In order to help the Institute identify the real up-to-date issues in educational planning and policy-making in different parts of the world, an Editorial Board has been appointed, composed of two general editors and associate editors from different regions, all professionals of high repute in their own field. At the first meeting of this new Editorial Board in January 1990, its members identified key topics to be covered in the coming issues under the following headings:

1. Education and development.
2. Equity considerations.
3. Quality of education.
4. Structure, administration and management of education.
5. Curriculum.
6. Cost and financing of education.
7. Planning techniques and approaches.
8. Information systems, monitoring and evaluation.

Each heading is covered by one or two associate editors.

The series has been carefully planned but no attempt has been made to avoid differences or even contradictions in the views expressed by the authors. The Institute itself does not wish to impose any official doctrine. Thus, while the views are the responsibility of the authors and may not always be shared by UNESCO or the IIEP, they warrant attention in the international forum of ideas. Indeed, one of the purposes of this series is to reflect a diversity of experience and opinions by giving different authors from a wide range of backgrounds and disciplines the opportunity of expressing their views on changing theories and practices in educational planning.

This booklet is concerned with planning physical facilities in education. Building and equipment represent the second largest element of the educational budget after teachers' salaries. They typically account for 20 to 25 per cent of the overall education budget. Hence, it is essential that they should be well planned, take due account of the objectives of the educational policy and contribute to reinforcing the quality of the teaching and learning process; they should also be sufficiently flexible so as not to impede possible changes in the future content of education and allow for multiple use by different groups and clienteles. Last but not least, they should be cost- effective and not unduly tax the present budget, nor future ones, through high foreseeable costs of maintenance.

In an increasing number of countries, primary school buildings are built and/or maintained by local authorities with or without voluntary community participation: certain norms of quality, security and light have nevertheless to be taken into consideration. How is this going to be ascertained? Secondary schools, technical schools and universities, on the other hand, continue to be built by Ministries of Education often with the help of donor agencies. Many of these buildings are very costly and are meant to last for a long time. How can the cost be reduced without endangering the quality? How can the fact be taken into account that in the next ten to twenty years the number of pupils attending, the content and the organization of education may have to change significantly? These are some of the very important issues that this booklet is trying to address.

The objective of this booklet is to present in a concise fashion what educational planners working with physical facilities planners need to know, as well as map out how current trends may affect the future of educational facilities planning. It was prepared by John Beynon, who, working as an architect in the UNESCO Bangkok Office, Thailand, and later on leading the UNESCO programme activities in educational facilities and furniture, has accumulated a wealth of experience. The IIEP is very grateful for his most valuable contribution to our series.

Jacques Hallak
Assistant Director-General, UNESCO
Director, IIEP

Preface

Physical plant (also known as physical facilities) for education comprises land, buildings, and furniture. It includes physical facilities for teaching spaces and for ancillary rooms. Although a considerable amount of experience has been accumulated since 1970 by architects, engineers, furniture designers, educators and those dealing with the cost aspects of different types of educational plant in terms of per student costs, much of the experience has not been summarised for educational planners. This monograph in the *Fundamentals of Educational Planning series* is an attempt to remedy this gap. It is only a partial remedy because it is not possible to cover all aspects of educational facilities within the length constraints of one monograph. However, an extensive bibliography has been provided for further reading.

Typically, within an educational system, the costs for physical facilities are second to those for teacher salaries. To justify the large expense of new construction and furniture and their maintenance, repair, re-modelling and replacement obliges educational planners to ensure that the physical facilities are cost-effective. There is a growing body of research that links physical facilities to increased educational opportunity and achievement. In the IIEP's research — conducted in 1995/1996 — in connection with the Southern African Consortium for Monitoring Educational Quality (SACMEQ), strong links were shown to exist even after controlling for other variables between the extent to which School Heads perceived their school buildings to be in need of major repair or total rebuilding and reading achievement in Grade 6 in all of the countries in the study.

When planners take account of the needs of the consumers in the conception and design of buildings, the physical facilities can positively support education. Catering for the needs of individual learners involves drawing from the body of research in the area of ergonomics and taking into account the educational objectives being pursued and to be pursued in the future as set down by the educational authorities. It is essential that the educational planners in a Ministry of Education be permanently in touch with the units in the ministry responsible for setting the general goals of education at each level in the system.

Planners can control costs by using indicators of cost per student place; architects can translate this indicator into area per place and cost per unit area. This approach can provide designers with the incentive to hold down construction costs and to reduce the non-educational area in schools in order to increase the space needed by students for learning.

It is a truism that educational systems change. There are demographic changes either in the size of the population or in the distribution of the population in the different parts of the country. Educational objectives also change sometimes requiring changes in the lay-out of schools. For example, some systems have introduced the wide use of computers in schools and this can have new demands on how the lay-out of the school should change. Educational reforms often result in larger percentages of an age group proceeding to higher levels in the school system. As the lifelong educational movement swells, it is often the case that such education should take place in the existing school facilities and this may well have implications for changing the size of thefurniture in the schools.

Since most educational buildings are permanent in nature they can hinder educational modernisation. However, it is possible for architects to design buildings that are relatively easy to remodel for new uses but they must be informed by the planners of the new uses that are likely to occur. It is also incumbent on planners to keep a detailed inventory (computerised or otherwise) of all school buildings in the country and from this predict for the years ahead the maintenance and charges required together with the projected costs.

Apart from the planners and professionals, such as architects and engineers, communities as well as local and central governments each can contribute to the process of needs analysis, setting standards, and planning future programmes and executing them. In some countries where many school buildings are in a poor state and where there are severe constraints on the ministry of education budget, it is possible for the local communities to help add classrooms to a school and maintain the existing buildings. However, such work should be known to the educational planners at the central level in a country and the work can be co-ordinated such that standards are adhered to and the design can be such as to anticipate foreseeable changes.

Future trends that will also need to be taken into account when modifying current approaches to educational building will be the introduction of communications technology, home learning, decentralization of government and the growing capacity of the private sector in some countries.

The above encapsulates many of the issues taken up in this monograph. The IIEP was fortunate in having John Beynon write the monograph. John Beynon has worked for UNESCO at its headquarters and in the field for many years. He has established a network of professionals working in the area of educational physical plant in many countries in all continents of the world. It was following his retirement from UNESCO that he wrote this booklet and, in a sense, it provides a summary of the distillation of knowledge and experience of this network. The members of the Editorial Board of the *Fundamentals of Educational Planning series* are grateful to John Beynon for undertaking this task and hopes that the educational planners who read the monograph will be able to improve the conduct of their work as a result of having read it.

T. Neville Postlethwaite
Co-general editor

Acknowledgements

The major contributors to this work are the small cadre of educational facilities planners who have developed this body of knowledge through their work for UNESCO and other international organizations, in particular the World Bank and the OECD. Those who have generated significant parts of this body of knowledge and submitted comments on this text are Kamal El Jack and Rodolfo Almeida (who, in sequence, succeeded the author as head of the UNESCO school buildings programme), Roger Aujame, Jan De Bosch Kemper, Hiroko Kishigami, David Lewis, David Vickery, and George Ziogas. Other major contributors to the body of knowledge are Pierre Bussat, Guy Oddie, Roland Sheath, Jacques Soulat and Richard Yelland. Our partners in this work have been the small army of national officers in those countries around the world where we have worked.

Special thanks have to go to my son, Robaire Ream, a graphic designer, experienced in educational materials, who prepared the graphics for this booklet.

Contents

I. Introduction

Capital investments in education account for the second largest share of the education budget. Expenditures for land purchase, building construction, furnishings and maintenance of all the above, typically account for 10 to 25 per cent of education expenditure. Financial planners need to be attuned to the cost-effectiveness of these expenditures and to find ways in which to raise funds.

The location of schools is a reflection of population location and is an expression of the political will of governments to provide basic services to a community. Physical planners need to foresee land requirements.

School grounds, buildings and furniture provide the physical environment for learning. Do they improve the motivation for pupils and students to learn and facilitate the work of teachers? These questions need to be addressed by educators when they participate in planning new educational facilities. Is a school getting the highest possible effectiveness out of its physical facilities? This is an issue addressed daily by school administrators in planning school activities.

In short, there is a lot that planners need to know about physical facilities for education. The other message that is clearly conveyed by the above is that architects and physical space managers need to be members of interdisciplinary teams to be effective.

The post World War II baby boom in industrially advanced countries and the recognition in the United Nations Declaration of Human Rights that education is a basic right even in the poorest of the emerging countries (United Nations, 1968) led to massive programmes of school construction around the world. This in turn triggered the creation of a new specialization for architects and educators, that of the educational facility planner. These new specialists carried out research in this field and during the four decades from 1955 to the present and churned out a substantial body of literature oriented at providing guidelines that could be applied across a large number of countries. As regards research and publications for the developing world, UNESCO was the major player basing these publications on the results of technical assistance programmes carried out around the world.

So what is the value, the reader may ask, of adding one more straw to the haystack of available literature?

In the current era of budget compression and diminished faith in research as the basis for drawing up strategic plans, this specialized profession is contracting and the amount of new globally or regionally oriented literature has substantially declined. Furthermore the 'haystack' of general knowledge is compressing as many of the earlier publications are out of print and available only in CD-ROM (UNESCO, 1996a).

Though the volume of nationally oriented documentation which addresses the more immediate problems of project implementation has grown, there is still a need for guidance on the development of well conceived, effective and economical physical facilities. For example, with each successful implementation project the educational building stock grows further. It has now grown to massive proportions prompting a priority concern for maintenance. On the other hand, for some countries the future will bring the challenge of planning for a decline of space needs; population programmes are reducing school-age numbers and distance education is shifting the place for learning from conventional classrooms to spaces for individual learning which are often linked with technology found at home.

The objective of this book is two-fold: to distil the experiences of the last decades in a concise form that will be useful to the variety of planners dealing with education, and to map out how current trends may affect the future of educational facilities planning. While the educational facilities planner communities will be the critics of this work, its audience is the other planners with whom they interface. This will, hopefully, become a handbook on which they will draw when planning or evaluating investments in educational infrastructure.

As much as possible, the book has been written with the ultimate consumers of education, learners of all ages in mind. In line with the IIEP policies for this series the text is particularly targeted at developing countries. Yet the contents are not exclusive; in this field all countries have something to teach and something to learn from others. Thus, the reader will find examples and information from countries across the economic spectrum.

II. Are physical facilities really necessary?

The essence of education is learning. Teachers, textbooks, educational technology, physical facilities and administration are all means to expand and accelerate learning. The physical facilities component of this interdisciplinary support system is viewed as both friend and foe by planners. Some argue that handsome and well-equipped buildings send a message of political support for education. Others express consternation over the high cost of the physical facilities component which siphon resources away from teacher salaries and learning materials. Often they try to diminish the importance of the physical environment by citing the Ghandi position that learning can take place under the trees.

Shelter

Just as we need shelter to protect domestic activities from the elements and to provide security, so must we provide shelter to education. Ghandi had the good fortune to lead to independence a country with vast regions of warm climates where much of domestic life takes place out-of-doors and where, for part of the year, learning could be attempted out-of-doors also. However, while outdoor learning may have been a viable emergency expedient in India when it was a newly emerging country, recent research in that country and elsewhere indicates that the 'no building' solution is unsatisfactory for an emerging industrial and political power, particularly where more and more schools are located in noisy urban neighbourhoods. It is now known that many Indian schools without their own building (and which hold classes under the trees or in space borrowed from other schools or from other users) tend to have poor attendance and those who do attend are inclined to have a poor academic performance (Govinda; Varghese, 1993).

Not all tropical countries have the accommodating climate of India's hill country which would enable them to consider having schools without buildings. Many suffer heavy rains, blistering sun and intense winds during the school year, all of which make effective learning without shelter is almost impossible. Neither are all developing countries in the tropics. Whole countries (as well as parts of certain tropical countries) are in mountainous or high desert areas where learning without shelter and supplementary heat is unimaginable.

Machines for learning

The renowned Swiss architect, Le Corbusier, said dwelling units should be a 'machine for living' (1923). Educational buildings as well as the sites that surround them and the furniture inside, are 'machines for learning' specially designed to accommodate their specific functions including receiving lectures, discussions, discovery and individual learning.

The challenge is to create physical facilities that respond to a variety of criteria; they need to be functional, economic, structurally sound and attractive. Achieving this requires architects and educational planners to see themselves as members of a multi-disciplinary team that also includes furniture designers, engineers, building cost specialists, educational economists and town and country planners. It is through collective work that they can achieve the objective so succinctly posed by Guy Oddie for the OECD in 1966: "It is axiomatic that an effective school building investments policy will succeed in building the right kind of schools in the right places at the right time and at the right cost."

Quantitative demand

On a global scale, the amount of educational space needed is growing due to five factors: populations continue to grow in all but a few countries; it is increasingly accepted that basic education must be provided to all children as well as young and middle-aged adults who seek it; the number of years considered to comprise basic education is rising. As educational quality standards rise there is a tendency to increase the number of specialized spaces and to increase the size of educational spaces to accomodate the trend toward active groups which is replacing traditional class lecturing and, finally, the realization of lifelong education is bringing adults back to school for a variety of learning experiences.

On the other side of the ledger there are two factors which tend to reduce the overall demand for educational space. Those countries which have succeeded in providing space for all pupils and students but have shrinking birth rates will find that the decline in the school-age population leaves them with empty learning spaces, particularly in rural areas. In addition, those countries which are able to launch large-scale programmes for learning at home (be it through distance education or home schooling) are able to reduce substantially the space needed for schools with full-time attendance.

Non-formal education has been much touted as a means for getting education to those who have missed out on formal schooling. Typically these programmes take place in 'found' space which has other primary uses, be it living rooms as in the case of Bangladesh (Ahmed et al., 1993) or Rajasthan, India (Lok Jumbish, 1997). An innovative solution adapted to the African situation is the Literacy Caravan of Senegal, Cameroon and other countries where teachers and learning materials are brought to rural areas and an educational fair is held which involves motivating the community to become literate. The initial physical facilities are demountable tents that can be transported overland which are ultimately replaced by more permanent learning resource centres. These are supported by UNESCO clubs and the UNESCO office in Dakar.

III. Managing qualitative dimensions

What are the quality issues that need to be addressed in an effort to providing the most appropriate physical environment for education? Of course, buildings need to be structurally sound so that they provide a secure learning environment but a soundly constructed building that hinders education may be more a liability than an asset. Thus educational buildings need to be conceived around concepts of quality learning. By starting the planning process from the level of individual learners the issues of quality are best addressed. The question of how to achieve these quality objectives within resource constraints is addressed in *Chapter IV*.

Links between the environment and learning

In *Chapter II* the argument has been made that physical facilities are functionally necessary, but just how much impact do they have on learning by those who use them? The search for this 'holy grail' of educational facilities planners has gone on for decades (University of Michigan in the 1960s; King and Marans, 1979; Fuller, 1990; Varghese, 1993, Cash, 1993 and 1994, and Lackney 1994). The recent accumulation of solid research data is revealing that physical facilities are a fundamentally important factor in both school attendance and achievement.

Education is a complex process that may be influenced by factors both inside and outside the walls of the classroom (Murimba, et al., 1995). A major concern of educational planners is to identify those factors that have a stronger relationship with school achievement than others. An analysis applying multivariate statistical procedures conducted by IIEP with the cooperation of the Ministry of Education and Culture in Zimbabwe revealed that — all things being equal — pupils could not be expected to learn effectively if the classroom did not have fundamental items such as a blackboard, sitting and writing places for all pupils and basic storage facilities for books and teaching aids.

Other researchers have conducted investigations and have provided empirical evidence to support the theory that in developing countries, low levels of learning among children can be partly attributed to poor and inadequate facilities in school (Heyneman, 1980). An investigation conducted in Nigeria (Urwick and Janaidu, 1983) formed the conclusion that facilities like buildings, separate classrooms, students' desks, etc., determine the very organization of teaching/learning activities and these factors do influence learner achievement. Research in India indicates that the existence of school desks, and to a lesser degree school buildings, are important if a school is going to be a success (Varghese, 1995).

Fuller, in a review of the international research on environment and learning (1990), concluded that physical facilities are important, though the evidence is less convincing for the UK and USA than it is for developing countries. Nonetheless Cash (1993) has shown that there are cases in the USA where, in comparable environments, students who attend well-maintained schools which have a good appearance have higher achievement rates than do those who attend poorly maintained buildings.

The overall conclusion, and which is being reinforced as new research results come in, is that while school buildings and furniture do not teach (parents, teachers, textbooks and supplementary learning materials do) soundly built, well-maintained and adequately furnished and equipped buildings have a profoundly positive effect on both participation and achievement rates.

The current situation of physical facilities in least developed countries gives cause for alarm. In 1994-95, UNESCO and UNICEF jointly undertook a pilot survey of schooling conditions in the Least Developed Countries (LCDs) (see *Box 3.1*) using a methodology developed by the IEA (Schleicher et al., 1995).

Box 3.1. The conditions of primary schools in fourteen LDCs

Learning involves some very basic inputs that are not enjoyed by large numbers of children in LDCs. Half the pupils in the pilot survey schools had no textbooks. In no country did every classroom have a useable chalkboard. Only half the first graders in Nepal, for example, had something to write with ... While enrolment has risen since 1990 for both boys and girls in the countries surveyed, the study found that in most, school conditions such as teacher housing, toilets, classroom supplies, electricity or building conditions had actually deteriorated. In three-quarters of the countries, 35 to 90 per cent of schools were seen as requiring either major repairs or rebuilding ...

Asked to explain why children were not enrolled in school, Heads most often invoked physical and socio-economic reasons. Schools may not have enough places for everyone or be located too far away from home. As many other studies have shown, parents feared for their daughters' safety ...

The average in most countries was one square metre of classroom space per student. To cope with limited space, schools run shifts or multi-grade classrooms. Although 80 per cent of children were in schools of only one shift, some schools, such as those in Nepal and Zambia, had four to five shifts, with schools in urban areas generally running more than those in rural ones ...

Although half of the participating countries had an average of 40 pupils per teacher, instructors commonly had to handle huge classes - 67 pupils per teacher on average in Bangladesh and nearly 90 per teacher in Equatorial Guinea ... In half the participating countries, grade 1 classes comprised more than 55 pupils, with Equatorial Guinea reporting classes of 110 ... Only seven out of thirteen countries had sitting places for up to two-fifths of the children in grade 1 classrooms. The situation was similar for writing places. In other words, even if children had a place to sit on the floor, there was possibly no room for them to write ...

For grade 1, actual hours of instruction per year ranged from 397 hours in Bangladesh to 993 in Togo. In the final grade of primary school, the actual hours ranged from 704 in the Maldives to 1,064 in Bhutan ...

Some parents refused to let their children attend schools where sanitation facilities were poor. Often, the toilets were unusable because they had not been cleaned. This appears to be an acute problem in both urban and rural areas in nearly one-third of the countries. Even the most modern well-equipped schools were lacking in piped water, electricity, a school garden, a first-aid kit, or a canteen. Well over one-third of classrooms in several countries have either inadequate ventilation or lighting ...

In many countries, 40 per cent or more of pupils attended schools needing major repairs or complete rebuilding, according to the school heads. Between 60 to 90 per cent of children in one-third of the countries were in schools without any regular maintenance. In some cases, parents took care of maintenance, in others, work was financed with the school's funds ...

In some African countries, one-third of the pupils attended temporary schools, especially in rural areas ...

School Heads felt that teacher housing, toilets, classroom furniture and supplies had deteriorated in the last five years ...

Source: Schleicher, A., et al., 1995.

The survey of 857 schools in 13 of the poorest countries (Bangladesh, Benin, Bhutan, Burkina Faso, Cape Verde, Ethiopia, Madagascar, Maldives, Nepal, Tanzania, Togo, Uganda and Zambia) covers enrolment and dropout, class size and overcrowding, teachers and teaching and school buildings and facilities. Extracts from the report summary are given in *Box 3.1*.

Functional aspects

Before designers can pick up a pencil or computer mouse and give shape to a building they need to understand the desires and the constraints of their clients. Design guidelines (sometimes referred to as architectural briefs or architectural programmes) include data on educational aspects, environmental norms, cost limits, building materials and construction techniques to be used.

The part on educational aspects, known in some countries as *educational specifications*, includes instructions on the numbers of spaces required, their sizes, the uses that will be made of them and the equipment required. For educational planners working at the institutional level or who are laying down the terms of reference for large-scale programmes which multiply the same designs, the introduction of educational technology needs to be analyzed for each space as the equipment takes up space and demands electricity and special wiring for networking (OECD, 1992b). *Box 3.2*. gives extracts of educational specifications used for a large construction project in Canada. To the data provided here should be added computer connections, including power supplies, internal networking and external telephone connections. Frequently, such documents include diagrams on internal functional relationships and lists of furniture (with dimensions) that will be used in the space. Readers are cautioned that the space requirements quoted here are for an economically advanced context.

Classrooms alone do not make a school. Educational specifications need to include the full list of facilities to be included in a school. The resulting list of rooms to be provided is known to designers as the *schedule of accommodation*.

Box 3.2. Educational specifications for a History-Social Sciences Department in a secondary school

A. Context

A short description of why the study of history is included in the curriculum

B. General user requirements

1. Size. An indication that a 2,000 student school would have 1,300 students taking classes in this department with a maximum of 220 present at a given time. The corresponding room requirements in square feet would be:

Large-group area 2200
Medium-group area 1400
Seminar rooms (4 @ 150 square feet) 600
Teacher preparation area 360
Storage 300
Total 4,900 square feet

2. Layout. In this case, the major requirement was that the seminar rooms be acoustically isolated and that the partitioning allow for room rearrangement in due course. Typically an educational specification would indicate which rooms should be directly accessible to others.

3. Special resource collection. Considering that the [central] information resource centre cannot be completely stocked for the department's needs, shelving for both print and non-print materials must be supplied in the storage area of the history-social science complex.

C. Specific user requirements

1. Large group area. An area of 2,200 square feet is proposed to permit three groups to join together for presentations in an 'open space' arrangement which could be subdivided by moveable partitions (panels hanging from rails) that could be easily moved to subdivide a large space.

2. Medium group area. This would be a standard classroom, preferably adjacent to the large group area and separated from it by moveable partitions.

3. Seminar rooms. These rooms would have two functions: discussions by groups of 10 to 15 students (extensive use of audio-visual materials to be foreseen), and parent-teacher conferences.

4. Teacher preparation area. This room would be used by teachers to prepare lectures and to arrange field visits. Furniture and equipment would include tables, chairs, telephone and access to the school-intercommunication system.

5. Storage and display. Closed storage for rare materials and audio-visual equipment; open storage for reference materials that would be freely used by students. All instructionalareas to have adjustable shelving to store materials currently in use. Storage to provide for display on tackboards as well as maps, globes, old documents, artifacts and special collections.

Table 3.2. Environmental criteria

Level	Square Feet	Area
Secondary	1440	Medium-group Area — History

Environmental Criteria

Atmospheric Criteria			**Desirable**	**Tolerance**	**Remarks**
Temperature	outside	>90 F°	75°-78°	± 2°	
	temperature	< 0 F°	72°-75°	± 2°	
Relative	outside	>90 F°	45%-55%	± 5%	
Humidity	temperature	< 0 F°	25%-30%	± 5%	
Outside Air	CFM per sq ft		0.3 to 0.8	>0.15	
	CFM per person		15-30	>8	
Air Changes	per hour		6-8	>5	
Air Movement	velocity: FPM		25-40	±10	
Room Pressure	In.WG		+0.10	>+0.05	
Air Filter Efficiency	>5µ		80%	—	
	<4µ		45%-80%	—	
Odours	Body, chemicals				
Population	max 50 min				
Heat Gain	source		watts	BTUH	
	lighting		2-4/sq ft		
	AV equipment		Varies		

Visual Criteria

Visual Performance Index (VPI) 63		Ft Candles N/A	
View Out Op'l View In Op'l	Blackout Yes	Privacy No	
Daylight Op'l Level Control Yes			

Acoustic Criteria

Ambient Noise Level: NC 35 max

								Remarks
Reverberation Time*	Frequency: cps	125	250	500	1000	2000		see notes
(in seconds)	max				N/A			
	min				N/A			
Generated Noise Level	Frequency: cps	31.5	125	500	2000	8000		
(in db re .0002 dynes/cm^2)	design level	58	77	89	75	60		

Services

Mechanical Services

CW No	HW No	Steam No	Gas No
Air No	Drain No	Exhaust No	
Other			

Electrical Services

PA Yes	Intercom Yes	Handset Yes	Ball Tel No
Programme System Yes		Clock System Yes	TV Terminal Yes
Computor Terminal No		Underfloor Duct System No	
Power 120V - 1 Ø for AV and cleaning equipment			
Other			

Notes

Consider induction loop system

* Acoustic treatment of floor and ceiling is recommended. Reverberation time calculation is not meaningful.

Source: Study of Educational Facilities, Metropolitan Toronto School Board, 1970.

A UNESCO study (Hutton and Rostron, 1971) of 100 secondary schools in 14 countries around the world identified the spaces found in the different schools. Over the ensuing years the spaces typically included in a school have evolved to include computer rooms, more specialized laboratories or workshops and decentralized resource centres or group project work areas. In addition, special spaces for adult education are needed. A check list of almost all spaces that may be considered for inclusion in a schedule of accommodation in an *advanced* general and technical secondary schools of a certain size is given in *Table 3.3*.

The essential point is that each educational activity foreseen requires an appropriate space for it to take place. Educational planners have a major responsibility to define these activities and to request the needed spaces (Vickery, 1980). When the budgetary shoe pinches it is up to the educators to decide which functions can share the same space (see *Chapter IV* below). For example, large expensive laboratories are not absolutely necessary in lower secondary schools and cheaper arrangements than mentioned above can be perfectly adequate (Caillods et al., 1997). Ancillary spaces such as teachers' workrooms need particularly careful analysis. In moments of austerity these are dropped entirely with the argument that teachers can do their planning work in the classroom outside school hours. In moments of generosity to the staff, teachers rooms are planned with spaces for working, casual chatting and making tea, and school principals may be given offices fit for an industrial executive. A 1997 UNESCO mission has noted that Sri Lanka teachers have virtually no space, while in Maldives the teachers' room is larger than a regular classroom.

Physical comfort

The most obvious and generally agreed link between environment and learning is the need for a basic level of physical comfort so as to permit learners to concentrate on their studies. The field of ergonomics (synonym: human engineering), which covers this issue, is the study of the human body and how it carries out specific tasks and responds to external physical conditions such as sound, light and temperature.

Table 3.3. Checklist of spaces in educational buildings for large, general and technical schools

A. *Academic*	B. *Administration*
General teaching regular classroom (24 to 40 places) seminar rooms (10 to 23 places) lecture rooms (41 to 120 places) computer classroom drafting room	offices medical maintenance
Science teaching multipurpose laboratory physics-biology laboratory physics laboratory biology laboratory chemistry laboratory preparation room lecture-demonstration room	C. *Ancillary* sports halls sports equipment store multi-purpose hall (assembly/dining) kitchen toilets
Skills teaching workshops machine basic mechanical fitting-turning forge-welding sheet metal-plumbing auto mechanics electrical motors electronics electricity installation carpentry-joinery masonry-concrete plastering-finishing	D. *Boarding facilities* dormitory showers, washbasins and toilets supervisors storage E. *Other* corridors vertical ducting wall area
Library and individual study main library resource centre audio-visual room independent study space for document study computer room for independent work	

Sources: UNESCO and World Bank internal working documents.

Technical norms on acoustics, thermal comfort and illumination for the task of learning have been developed for global use and, where necessary, adapted to specific geographic regions. The most integrated approach to these factors as they relate to education has been carried out by UNESCO with developing countries of Asia in mind (Asian Regional Institute for Building Research, 1972) and by Vickery who relates these to secondary schools around the world (1984). Though this information is now several decades old, the laws of physics, on which it is based, do not change. The conclusions, therefore, remain valid. These issues are of primary concern to designers and are therefore not elaborated here.

One field of ergonomics that does concern planners is anthropometrics, the study of the size of the human body and the proportions of its components. The research which addresses the application of anthropometrics to education is particularly concerned with the comfort of using furniture for specific educational activities. Anthropometric research in the United States in the late 1950s and in the United Kingdom (United Kingdom, 1970, 1971, 1974 and 1976) and UNESCO (Vickery, 1964; UNESCO, 1979 and Asian Regional Institute for Building Research, 1972) have led to an accepted set of norms which define the proportions of the human body and the positions in which the body is the most comfortable for learning.

Applying anthropometric data to education is particularly challenging since learners may be small children of four years or fully grown adults. Furthermore, different nutrition levels has resulted in a range of average heights of people of the same age (in 1981 an average 14 year-old Laotian male was 143 cm tall while his Singaporian counterpart was 162 cm). A third complicating factor found by UNESCO is that over several generations eating habits may change resulting in a consequent change of average standing heights of a specific age group. For example, an average 14 year-old Japanese male was about 148 cm tall in 1950 but 163 cm in 1980 (Guat-Lin, 1984). Recent data indicates that 14 year-old Maldivian males averaged 134 cm in 1974 and 157 cm in 1997 (Kishigami, 1997).

Box 3.4. Furniture sizing

Selecting a sample of children for measurement.

Two sampling techniques exist. Method 'A' below gives accurate results which are specific to a country. However, arriving at the average standing height requires considerable time and resources. Method 'B' will give approximate results but is much easier to implement.

Method A. The designer may measure the standing height of a sample of children of each of the 5 to 17 years age-groups. Those who are processing the data should ensure that the population from which the random sample is taken includes all socio-economic age-groups in the country. A sample giving a reasonable degree of reliability must be chosen. Random samples of sizes 300 to 500 children for each year of age have been used. [From the analysis of this data] a curve showing the [average] standing height versus age relationship is obtained from the population of that country.

Method B. The standing heights of a random sample of 100 children in one of the age groups are measured. Then the average height is compared with data from [other countries]. The growth curve of a country which has a similar height at the same age as country 'X' is identified from *Figure 3.5.* We can use the curve which gives the standing height versus age relationship of this population in a number of [other] countries to represent that of country 'X'.

Measurement of standing height of persons in the sample.

A measuring scale is drawn on or attached to a wall of the classroom. Each child is measured standing barefoot with his back against the wall (*Figure 3.6*). He has to stand erect and look straight ahead, making four points of contact with the wall; the back of his head, his shoulders, his buttocks and his heels. Using a right angle square, the teacher places the straight edge on top of the child's head and the other straight edge against the measuring scale on the wall. The height of the student is taken as the reading on the underside of the horizontal edge. Measurements should be made by the teacher to the nearest centimetre.

Source: Guat-Lin, 1984.

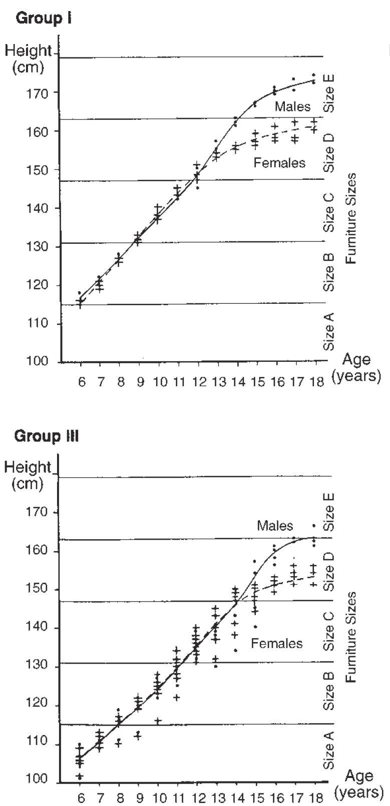
Designing anthropometricly comfortable school furniture is a six step process: (1) selecting a sample of children for measurement; (2) measurement of standing height of persons in the sample; (3) applying body proportions to determine critical furniture dimensions; (4) sizing furniture; (5) allocating furniture types according to age and sex of users, and (6) matching seat heights to table top sizes. While furniture designers need to be intimately familiar with all these steps, numbers 1, 2 and 5 are of particular relevance to planners. Steps 1 and 2 are described in *Box 3.4*.

Going from that point to making cost-effective furniture involves studying available materials, local production capacity, storage, shipping, assembly and maintenance. (See *Chapter VI*).

Sizing furniture, rooms and school sites

While the use of this data in the design of furniture is not the planners' responsibility, it is important that planners define which age groups will use the same sized furniture. Since one size can comfortably serve learners over a three-year age span, it is typical for four sizes of furniture to be produced to serve ages six to eighteen. It is the planners' decision as to how these different furniture sizes will be matched to the educational structure. For example, in a 4-4-4 system will each level have two different furniture sizes to ensure comfort for almost all learners (including recognition of the shorter stature of females after puberty) or will each be supplied only one size in order to simplify the logistics of providing furniture? To facilitate these decisions UNESCO Bangkok has defined three groups of countries (designated I, II, III) which have children of similar standing height. See *Figure 3.7*.

Figure 3.5. Growth curves for Asia and Pacific children



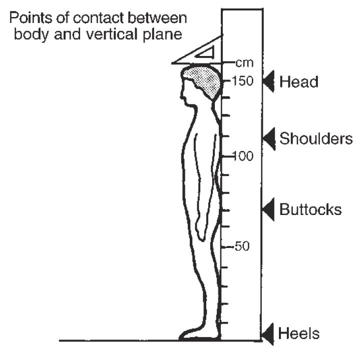


Figure 3.6. Measurement of standing height

Source: Guat-Lin, 1984.

Figure 3.7. Furniture sizes suitable for standing height and age ranges by group of country

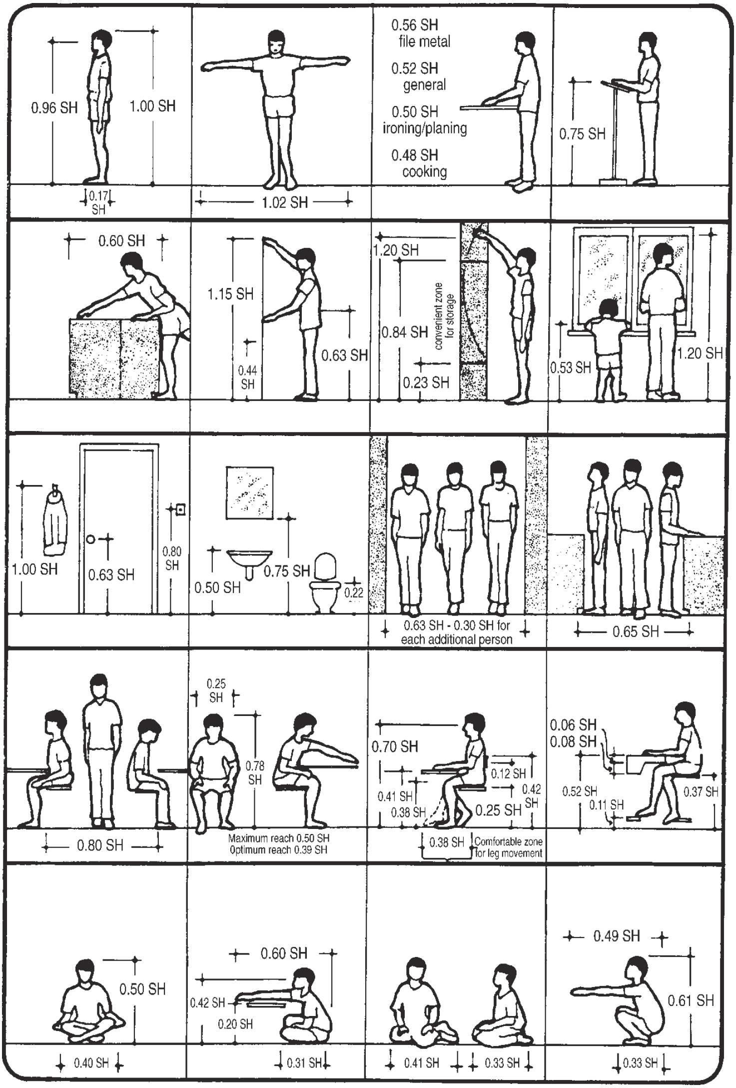
	Standing height (cm)		Corresponding age range in each group (M: Male F: Female)		
Furniture size	Range	Midpoint	Group I	Group II	Group III
A	115	108	-	-	6-8 M+F
B	115-130	123	6-9 M+F	6-10 M+F	8-12 M+F
C	131-146	139	9-12 M+F	10-13 M+F	12-14 M+F
D	147-162	155	12-14 M	13-16 M	14-17 M+F
			12+ F	13+ F	
E	163-179	171	14+ M	16+ M	-

Source: Guat-Lin, 1984.

Research has generated some generally accepted ratios between standing height and a number of critical furniture dimensions. While the ratios shown in *Figure 3.8* are those used by designers, they will be useful to administrators when placing orders for manufactured items. While vertical dimensions that yield comfortable furniture vary enough to justify adopting four or five sets of dimensions, horizontal dimensions are a function of the use of learning materials and the size of plywood sheets or other materials. Consequently, normally only two sizes of desk tops, one for primary and intermediate education and one for secondary level, will be chosen.

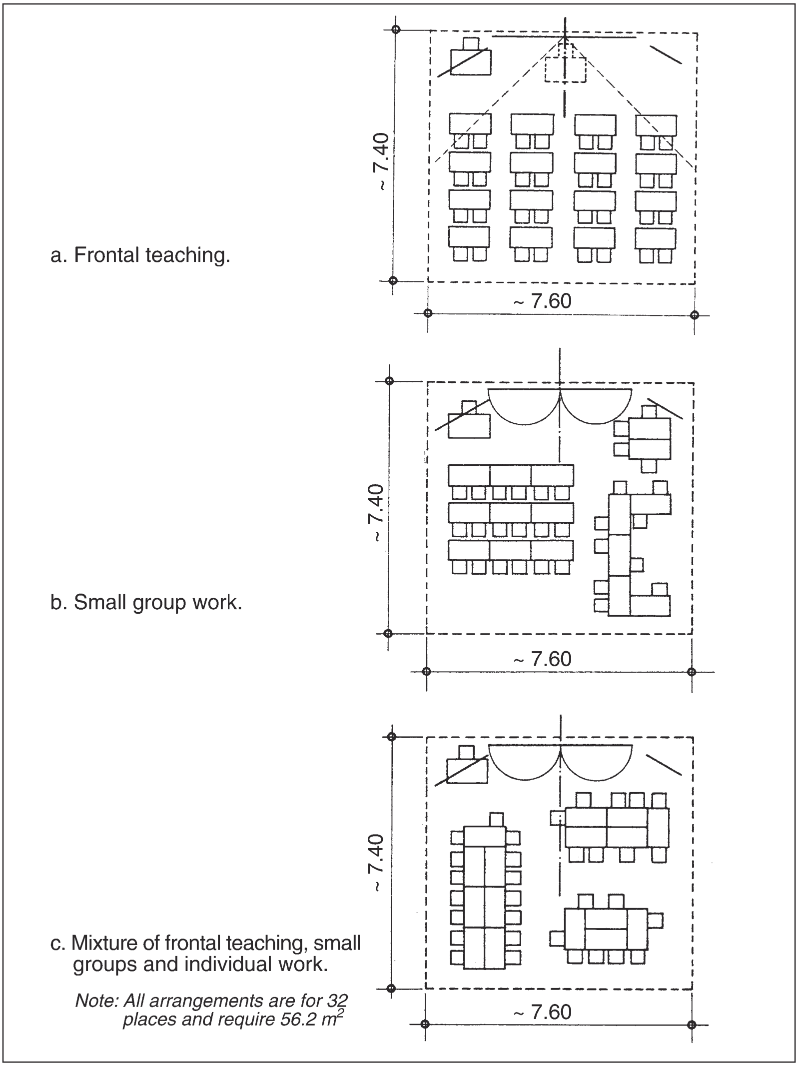
Room sizes are a function of furniture size (horizontal dimensions), teaching methods used, subject matter taught, the number of learners and their possibilities to see and hear the materials presented by the teacher. This multiplicity of parameters means that there is no norm that suits all situations. On the other hand, it is possible for educational planners and designers to generate some excellent norms tailored to their specific needs. Work done in Switzerland by Bussat is the cornerstone of this kind of analysis (*Figure 3.9*).

Figure 3.8. Dimensions used for design of educational furniture and buildings: Ratio to standing height



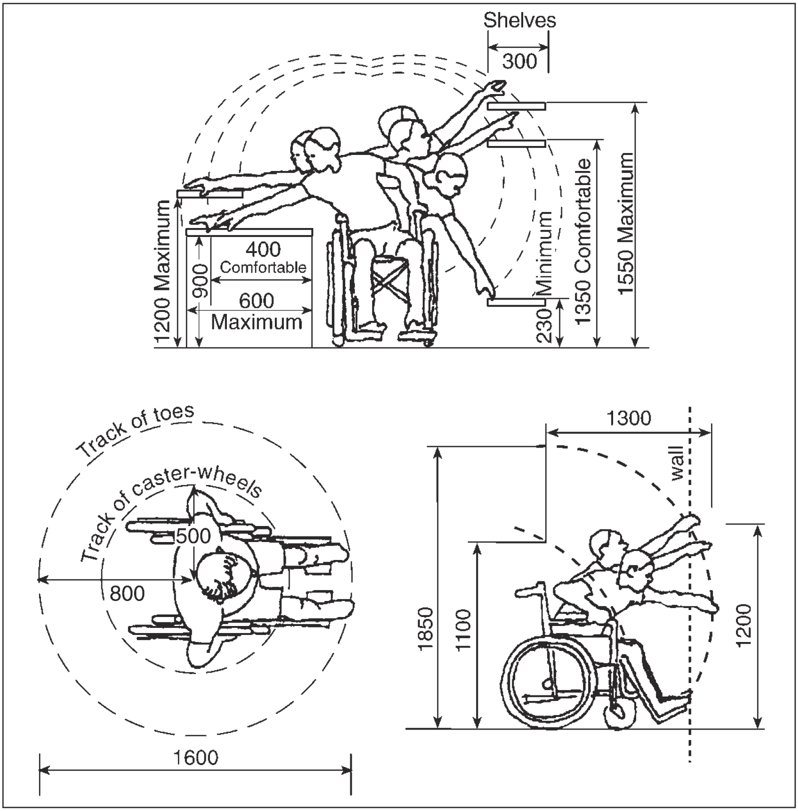
Source: Guat-Lin, 1984

Figure 3.9. Room sizes



Source: Pierre Bussat for the: Centre pour la rationalisation et l'organisation des constructions scolaires (CROCS), Lausanne, Switzerland, 1966, 1967.

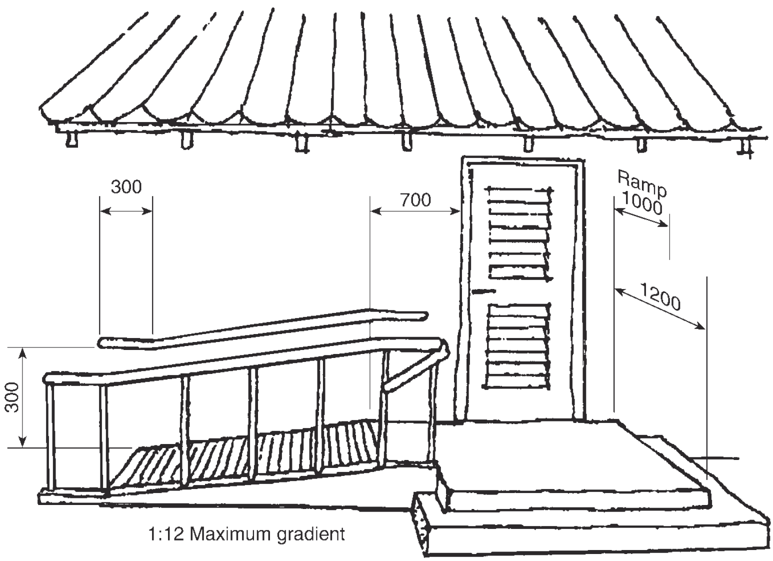
Figure 3.10. Wheelchair dimensions



Source: Reuterswärd, 1990

As the trend grows to ensure the mainstreaming of most learners suffering from disabilities it has been incumbent on planners to ensure that the physical facilities for education are accessible to all. This material developed by Hiroko Kishigami (UNESCO, 1984) and Lars Reuterswärd (1990) is available from UNESCO, two examples of which are presented in *Figures 3.10* and *3.11*.

Figure 3.11. Accessible entrance ramp

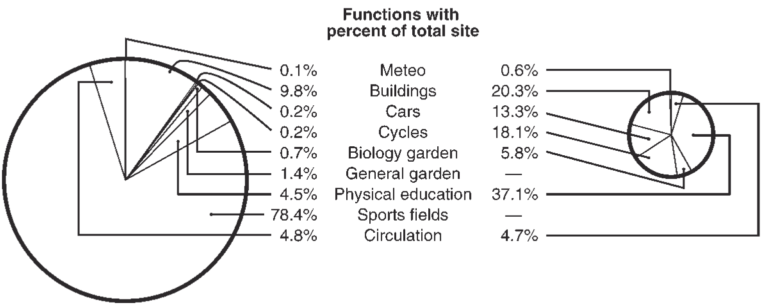


Source: Reuterswärd, 1990

For each institution, educators and architects will come to an agreement concerning the functions that will be served by the site and the consequent land area required. The architect will check the suitability of the land for construction and will call in engineers to check soil quality and access to utilities. *Figure 3.12* illustrates how a site area might be determined for a secondary school.

Figure 3.12. Site area

Rural school with 640 student places: site area (m^2)		**Functions with unit areas**	**Urban school with 640 student places: site area (m^2)**	
16		Meteo station ($16m^2$)	16	
2 248	(single storey)	Buildings ($3.5m^2$/place)	560	(four storeys)
46	(2 cars)	Car park ($23m^2$/car)	368	(16 cars)
50	(50 cycles)	Cycle store ($1.0m^2$/cycle)	500	(500 cycles)
160	(320 places)	Biology garden ($0.5m^2$/place)	160	(320 places)
320	(320 places)	General garden ($1.0m^2$/place)		(not taught)
1 024		Physical education ($1.6m^2$/place)	1 024	
17 920		Sportfields (football, basketball, volleyball)	0	(use community facilities)
1 089		Circulation (5% of total)	131	
22,865	**m^2**	**Total site area**	**2, 759**	**m^2**
35.73	**m^2/place**	**Site area per place**	**4.31**	**m^2/place**



Source: Asian Regional Institute for School Building Research (ARISBR), 1972

Quality construction

Large-scale educational buildings construction programmes are carried out by governments in response to demand for education, be they to accommodate growing populations, or to introduce national scale educational reforms such as was launched in Chile in 1996. These programmes have been attractive to international funding agencies which often like to be associated with broad ranged educational reforms. The result is now clear; increasing the available space through the construction and continued maintenance of sound buildings of which the community is proud increases the demand for and access to education (Cash, 1993 and 1994).

In the 1970s and 1980s, before the convening of the World Conference on Education for All, there was already concern that the burgeoning school-age population needed an enlarged pool of educational space. Countries such as Indonesia and Thailand which had available resources financed their own construction. Others such as Malaysia, Maldives, Bangladesh and Burma (now Myanmar) obtained financial support from international funding sources, notably the World Bank, UNICEF and more recently the Asian Development Bank.

There is no doubt that all programmes were successful in adding new classrooms and other facilities to the school-building stock with a consequent increase in the number of school places available. A close look at these schemes in the course of evaluations or project preparation, summarized in *Box 3.13*, revealed that there were important qualifications to these successes. They reflect some of the errors to be avoided.

Insisting on, and providing resources for, *safe buildings* is the responsibility of planners and administrators. As these are important issues, it would be prudent for planners to draw up a comprehensive maintenance programme that would bring a certain number of buildings, say 20 per cent of the total stock, up to safety standards each year. Guidelines for designing schools to reduce accidents have been drawn up by UNESCO (Saini, 1988).

More difficult is making buildings secure against disaster including fire, earthquakes, strong winds and floods. Following the 1994 Northridge, California, earthquake a local official was quoted as saying “earthquakes don’t kill, buildings do”. There is great wisdom in this remark as most bodily injury experienced during earthquakes and strong winds are the consequence of falling or flying debris, much of which comes from poorly constructed or maintained buildings. Happily, twentieth-century building technology is sufficiently advanced for us to expect any newly constructed educational building to survive all but the most extreme natural disasters such as tsunamis (tidal waves) or tornadoes. National agencies prepare maps giving seismic risk, maximum wind speeds and flood frequency. Physical planners need to consult these maps before approving school sites.

UNESCO has researched the matter as regards the specific needs of educational buildings and published globally applicable design guidelines for resisting earthquakes, strong winds and fire (Van't Loo, 1976; Arya, 1987; Ziogas, 1976 and 1989; Macks, 1996). Planners can require that these guidelines as well as the local building codes be followed for all new construction. To build a safe new building will normally raise construction costs to the order of 2 to 10 per cent.

More problematic is the existing school stock. While natural disasters generate a high level of trauma when they occur, they are quickly set aside as a once-in-a-lifetime event when reconstruction begins. It is possible to evaluate all existing buildings for their resistance to earthquake and wind forces as well as fire and to protect them accordingly. The costs of such 'retrofits' is normally a small fraction of the cost of replacing a building that is worth keeping. When they exceed 25 per cent of replacement cost, planners should give priority to replacement except for buildings that are historically important or have other intangible, non-monetary values.

The best defense against having a building damaged by a flood is to build on high ground. This is a planning decision. The other rules are in the domain of designers: construct with non-erodable materials placed on deep foundations; use hard finishes such as tile and painted cement plaster that can be easily washed up when flood waters recede and avoid the use of wood which becomes an energy source for stranded refugees. Planners can designate specific schools in flood-prone areas as emergency refuges and provide them with a secure reserve energy source for emergency use.

Box 3.13. Flaws in outstanding primary school construction projects

In one country the programme was based on building, furnishing and equipping one complete five classroom school with a teacher's office and a storage room (capacity 150 in single shift) in every village. Subsequent visits revealed that the programme was rigorously executed, even in communities where there were far fewer than 150 children of school age. The consequence was that in many villages capacity grew more than did enrolment.

In another country the Minister of Education insisted that each of 19 new primary schools be identical to avoid any political controversy between administrative regions which could argue that they were not being treated equally. The result was that only a few regions had a school complex that corresponded to the student population. In others, the buildings were either too large or too small. Once the available funds were transformed into coral stone, lime mortar and teakwood roof trusses, there was no way to redistribute resources.

One country had proudly maintained a modest but steady capital budget for the construction of new schools for 20 years after independence. When a burgeoning population growth outstripped the government capacity to support all needed construction it turned to international finance agencies to supplement government funds. As the need for more space increased government abandoned all pretenses of paying the construction from its own funds and thus ended up relying exclusively on externally supported, and externally supervised, projects for all primary school construction.

In a fourth country a visit to a reconstructed existing school indicated a trebling of enrolment to a point where class sizes had exceeded all reasonable limits (in many schools there were upwards of 100 pupils in grade 1). Questioning of the pupils revealed that a large portion of the new students had moved from a nearby neighbouring school with derelict and unsafe buildings.

IV. Managing capital investments

The cost debate is the same the world around:

"What will it cost for a new school that meets all our quality criteria?";
"'X' millions."
"What! we can't afford that. Why do contractors charge so much?";
"Since we can't increase our budget we must eliminate rooms or lower the quality of construction";
"Isn't there some way to achieve our dreams by cutting non-essentials?";
"Cancel the library or build with temporary materials."
"No way. We don't want to change our quality criteria, think of the children."
"But we can't afford these costs."
"Then how do we build a library for nothing?"

While this struggle will no doubt be with us as long as we have physical facilities for education, planners now have tools to test the interaction of these questions to reach optimum answers. The art of good physical facilities planning is to maximize the quality of the facilities while keeping resource expenditures to a minimum. As this issue is so often addressed many researchers have studied the topic and written extensively about it. This chapter distils vast international experience and focuses on points which will be of particular interest to financial planners. It also discusses experiences by designers and builders which are useful to planners.

Initial capital cost

The elements of capital cost are:
Site purchase
Site development
Building construction
Furniture (five to 10 per cent of building construction cost)
Equipment and electronic installations (five to 30 per cent of construction cost)
Design fees (three to six per cent of building construction cost), and
Contingencies (about five per cent of construction cost). For projects in the planning stages an additional element must be added;
Inflation at the current annual rate multiplied by the number of years before construction

The bottom line is that total capital costs can be as much as double the estimated cost of the building.

Cost per place

Planners are often tempted to use gross planning indicators such as cost per school or cost per classroom. For their post World War II school construction programme the Architects and Buildings Branch of the United Kingdom's Ministry of Education looked extensively into this issue (United Kingdom, 1957) and concluded that a cost per place target, worked out for each individual school was the best way to approach cost control (see *Box 4.1*). Later publications by the OECD and UNESCO supported this conclusion. (Oddie, 1966, Hutton and Rostron 1971).

The United Kingdom took advantage of this planning figure to set a maximum cost for each individual school and then allowed local authorities to develop designs where they could trade off savings in construction costs for increased space or, alternatively, absorb unexpectedly high construction costs by reducing space. This put the central government in the position of fixing cost limits while devolving to local authorities responsibility for design and execution. Though this experience is a half-century old it is highly relevant for today's centrally financed educational systems which are moving towards decentralization.

Area per place

As pointed out in *Chapter III*, schools are made up of many kinds of spaces. Now we will explore how to get the most effective possible use out of those spaces.

Offices in a normal business or a government are used 40 hours each week and about 50 weeks a year giving a use of 2,000 hours. The maximum reasonable use of an educational space would be used from 7 a.m. to 9 p.m. six days a week, 50 weeks a year adding up to 4,200 hours. Typically, in developing countries, primary school classrooms are used about 6 hours a day over 180 days or 1,080 hours while specialized secondary teaching spaces such as laboratories may be used only 4 hours a day or 720 hours annually.

Each educational authority must set its own standards for maximum space use after having wrestled with the question of cost-effectiveness resulting from the options indicated above. A commonly used standard is 40 or 44 hours per week over a 36 to 40 week school year giving a maximum standard for use of 1,440 to 1,760 hours per year. They must then set a standard for minimum utilization rates which is defined as the ratio between the number or hours a space is actually occupied and the chosen maximum standard. A ratio of 0.90 or above is often used for general classrooms while 0.75 is typically used for specialized teaching spaces. If a given teaching room has a ratio of 0.5 or less it should be suppressed and its uses assigned to other spaces with a less that 1.0 ratio. When specialized rooms such as laboratories or workshops have low ratios, multi-purpose spaces need to be designed to accommodate two or more subjects, e.g. biology and physics.

Box 4.1. Unit cost elements

The cost of building a school is a consequence of how much space is built and of the relative cost of that space. To obtain optimum value for capital expenditures, planners need to consider both factors. The components of these costs are defined as shown below.

area/place = total building area/total number of student places
cost/area = total cost/total area
cost/place = (cost/area) * (area/place)

The major advantage of this planning figure is that it encompasses educational quality considerations as expressed through area per pupil (square metres or feet per student as defined by the design capacity of a school functioning on a single shift) and construction quality considerations as expressed through cost per unit area (amount in local currency per square metre or foot of enclosed space). At the same time, it allows for fine tuning that reflects the space needs for differing enrolments of institutions, the amount of ancillary spaces required at each level of education and the efficiency with which all spaces are utilized. For drawing up a programme to expand an educational system, planners should develop a table of planning standards similar to *Table 4.2*.

Table 4.2. Area per place variations for level and enrolment of school

Level of education	Maximum Enrolment in Single Shift						
	30	90	120	240	480	960	1440
Early childhood	3.10	2.50	-	-	-	-	
Primary school	-	-	3.30	2.80	2.85	-	
Intermediate	-	-	-	4.80	4.20	3.50	-
Secondary	-	-	-	-	8.00	6.50	6.00

Note: While the figures given are typical of developing countries, each country needs to generate its own norms.

Though each ministry and international financing agency has its own specific procedures for calculating teaching space needs based on educational programmes offered and enrolments in each class, they all stem from the considerations above. An example for calculating space needs for a general secondary school is given as developed by Soulat and reproduced in *Table 4.3*. (calculations for large secondary schools and technical schools are much more complex but follow this general approach).

The above discussion illustrates that teaching spaces, even if used at a ratio of 0.9 of a 1,760 hour year, would be empty for 2,616 hours when they could be used during evening hours, weekends and school holidays. Planners and administrators will have to judge if having classrooms occupied for 90 per cent of an easy target is a measure of success or if having classrooms vacant 62 per cent of a challenging target is an indication of failure.

Whether a teaching space used 1,584 hours a year is viewed as a cup 90 per cent full or 62 per cent empty, these unoccupied hours are a capital resource available for other uses. There are three ways the creative administrator can make use of this underutilized capital resource. The classrooms are available to serve a second (or even a third) shift of formal schooling or they may be put to use in a year-round schedule. Multiple shifts are seldom welcomed by teachers or parents but they can be successfully operated (Bray, 1989). Year-round scheduling is less practiced internationally but has been successfully implemented in some countries. (OECD, 1995). A third option is the all-day use of educational sites and buildings by all members of the community where children, youth and adults share the same facility as has been demonstrated in the Pilot Centres for Education for All in Venezuela (Almeida, 1996).

But back to the first question of this chapter, how can one obtain the library without increasing the capital budget? Obviously, a library costs money but so do corridors, lobbies stairwells and administration offices which sometimes account for as much as 30 per cent of the total built area in a school.

Table 4.3. Converting educational programmes to educational spaces

A NAME AND LOCATION	B	MODEL – SCHEDULE OF TEACHING ACCOMMODATION: SECONDARY SCHOOL							TERMINAL SCHOOL									C	D	
Secondary and Terminal School North Africa Type: Day, Boarding	Grade	1	2			3			4			5			6			Total Subjects Loading (Periodes)	Lenght of Period	1
	Stream		Acod.	Ec.	Tech.	Acod.	Ec.	Tech.	Gen.	Com.	Ind.	Gen.	Com.	Ind.	Gen.	Com.	Ind.		Potential room use	37
																			Flexibility Factor	10
Enrolment 1,200	No. Classes	6	4	1	1	4	1	1	1	1	3	1	1	3	1	1	3		Room use	34
Subjects taught in ordinary rooms	Mother tongue	48	24	6	6	24	6	6	5	5	12	5	5	9	5	5	9	180		
	Second language	36	20	5	5	20	5	5	5	5	12	5	4	9	5	4	9	154		
	Foreign language		16	4	3	16	4	3	3	3		3	3		3	3		64		
	Mathematics	18	15	4½	5	15	4½	5	4	4	12	4	3	13½	4	3	13½	128	Number of needed teaching spaces	
	Civics, Religious instruction	9	6	1	1	6	1	1	2	2	3	2	1	3	2	1	3	44		
	Music		4		4												8			
	History, Geography	12	8	2	2	8	2	2	2	2	4½	2	2	4½	2	1	4½	60½		
																	Total	632	19	
Subjects taught in special rooms	Drawing	12	4	1		4	1		2	2		2			2			30	1	
	Biology	18	8	2	1	8	2	1	1	1	1½	1	1½	1				47½		
	Physics, Chemistry				2			2	2	1	3	2	1½	6	2		7½	29		
																		25*		
																		101	3	
	Typing						2			4			4			3		13		
	Shorthand												3			3		6		
	Accountancy			1			2						3			5		11		
	Commerce			1			1						1	5				8		
																		38	1	
	Technical drawing				4			5			12			12			12	45		
	Technology										4½			4½			4½	13½		
																		58½	2	
	Physical education	18	12	3	2	12	3	2	2	2	3	2	2	3	2	2		70	2	
	Woodwork, Metalwork	18	8			8			2			2			2			40		
	Technical training										54			57			63	174		
																		214	7	
																		Total	35	

* 1/3 of the Science teaching is devoted to practical work for which the class is split in two groups. Consequently 1/3 more periods have been added.

Source: Jacques Soulat for UNESCO, circa 1963.

One important development in school-building design in the United Kingdom and in certain developing countries has been the minimizing of circulation and administrative spaces and the diversion of these savings into educational spaces. While there is no such thing as a free library, there is the possibility of trading non-educational space for spaces (such as libraries) that do contribute directly to learning.

The important concluding point is that educational planners are responsible for most of the decisions that lie behind area per place which may vary by as much as 10 times (see *Table 4.4*).

Cost per unit area

It is equally important to be frugal in approaches to cost per unit area (the domain of engineers and architects). However, contrary to common wisdom, there is less to be saved in this side of the cost per place formula than in area per place. A big difference between the minimum and maximum cost per square metre (or foot) of formally constructed buildings is a factor of two.

Construction costs are made up of building materials, labour, contractor overheads and contractor profits. As the breakdown between these categories varies greatly from one country to the next, and from one geographic region to the next within a given country, setting standards for the relative cost of each component and the resulting cost per unit area needs to be derived at district or provincial level. This is done by building cost specialists who have professional training as engineers, or, in countries influenced by United Kingdom practice, quantity surveyors.

There are, however, several factors that influence cost per unit area on which educational planners and administrators may have an impact either through their own policy decisions or in decisions taken jointly with architects and engineers.

The type of construction recommended may be of a single storey building using low-cost local materials such as mud walls and pole rafters, or a multiple storey structure which in most cases would necessarily be constructed of steel and concrete. By obtaining large plots of land and by specifying single storey construction of local materials substantially lower capital costs can be expected. This approach is more suitable to small rural schools than to large or urban institutions. In Africa more than one half of the new classrooms constructed each year are spontaneous community efforts which rely on informal approaches and make use of indigenous materials.

Construction quality is associated with durability and low maintenance costs. The basic rule of thumb is that one gets what one pays for (better quality buildings cost more) though poor construction supervision and poor workmanship can reduce the quality of a building without a concomitant reduction in costs.

Table 4.4. Educational decisions leading to variations in area per student place

	Number of shifts:		
	One	Two	Three
Primary			
minimum CR. only	1.20	0.60	0.40
generous CR. and ancillary	3.50	1.75	1.16
General secondary			
minimum CR. and ancillary	4.00	2.00	1.33
generous CR. and ancillary	8.00	4.00	2.66
generous CR. and ancillary with boarding	15.50	11.50	10.16
Technical secondary			
minimum CR. and ancillary	6.00	3.00	2.00
generous CR. and ancillary	12.00	6.00	4.00
generous CR. and ancillary with boarding	19.51	13.50	11.50

Note: While the figures given are typical of developing countries, each country needs to generate its own norms.

Most educational building architects would argue that with a bit of drawing board creativity good looking buildings need not be more expensive than ugly ones. This has been shown true in cases where a sensitive and creative architect is prepared to work within set cost limits.

Most existing literature in this field avoids the question of contractors' internal costs. In the new era of increasing accountability for governments, both at national and local level, it is time to discus the problems openly. Typically, a contractor is allowed 0.5 to 1.0 percent of a contract to get set up on the site and another 8 to 10 per cent profit. Who is financing the building of a school also makes a difference. Often enough, constructions financed by an aid agency are more expensive than those financed by the national Ministry of Education. In Kenya in 1990, for example, a science laboratory financed through external aid cost US$73,500, while a laboratory financed by the Ministry cost US$41,500 (Caillods et al., 1997). In 1980, in an Asian country, school buildings financed by a bilateral donor and designed, tendered and constructed by an architect and contractor from the donor country cost eight times what an international organization had paid for virtually identical schools built by the recipient government's Ministry of Education.

Finally, political obligations should be zero. Reality is often different in countries where architects, engineers and contractors often have to meet certain political obligations if they are to get government jobs. The consequences can be staggering. In one Asian country for example, one contractor admitted to the author that his internal costs were 50 per cent of any contract; 30 per cent for his own profits and 20 per cent for political obligations.

Economies of scale

Many countries, both developing and developed, have found themselves faced with the need to undertake large-scale construction programmes in short periods of time. While this represents a massive undertaking both organizationally and financially, it also presents an opportunity to achieve economies through the rationalization of building spaces and the mass production of building components. Some early examples of this are the CAPFCE programme in Mexico which won a design award for its architect Ramirez-Vasquez at the Milan biennial in the early 1960s and the Bangladesh primary school construction scheme headed by Ziogas for Doxiadias associates. In developed countries the outstanding projects were in the United Kingdom (CLASP in Hertfordshire), the USA (SCSD in California), Canada (SEF in Toronto) and Switzerland (CROCS in Lausanne) all of which were active in the 1960s (Almeida and Osorno, 1972).

One of the key concepts in such projects is the use of 'open' building systems which allow standardized building components to be assembled in a variety of ways generating a variety of educational spaces along with technical specifications based on performance rather than on preconceived designs. This has effectively mobilized industry as a creative participant in the design process. The benefits have been better quality buildings, better cost control (and sometimes but not always, lower costs) and shortened construction time.

Lifetime costs

Initial cost is a short-range view; the long-range consequences of constructing a building can only be seen if one studies total costs over the expected lifetime of the building (Hutton and Rostron, 1971). These include:

Initial capital cost;
Building maintenance cost;
Building major repair and remodeling cost;
Furniture and equipment maintenance cost;
Furniture and equipment replacement cost;
Utilities;
Staff costs.

Many countries have accepted foreign assistance for capital costs without accurately calculating the total recurrent costs of running an educational institution over the life of the building and determining from where these funds would come. *Planners need to address these issues before giving the green light to capital spending*.

Building maintenance and repair

Maintenance management includes the difficult task of getting government (at any appropriate level) to provide a reasonable budget for maintenance and to spend the allotted funds. When they fail to do so buildings run down ever more quickly, community support for education wanes, attendance decreases, vandalism increases and, finally, governments must decide between major remodelling and replacement. Training materials developed by UNESCO are useful in guiding governments on setting up policies for maintenance and management of maintenance operations (Vickery, 1984) This challenge is not unique to developing countries. It was estimated in 1994 that in the United States "schools need $112 thousand million to complete all repairs, renovations and modernizations required to restore facilities to good overall condition and to comply to government mandates" (United States of America, GAO, 1995a).

In the past, a figure of 1 per cent of the cost of a new building was often promoted as the reasonable basis for budgeting maintenance. The United Kingdom approach is a more refined one where one estimates the cost of maintaining, and where necessary replacing, each building element over its normal lifetime and adding up the total for each year in the future. While this takes some effort by a qualified professional, it has the advantage of giving a maintenance and replacement budget for each institution that has been reached by rigorous analysis (United Kingdom, 1957).

If maintenance is to be done on a regular basis, the community must be brought into play. Their participation may take the form of raising local funds to cover maintenance and repair, or volunteer labour and donation of materials by local enterprises, as in the Philippines and Venezuela (Beynon and Caldarone 1989; Philippines, 1990).

The problem with community participation in maintenance is that one is often using poorly qualified, if not downright totally unqualified, personnel to deal with technical problems. To address this problem UNESCO initiated studies on school building maintenance and developed viable procedures in different contexts. This work has resulted in several well-illustrated technical manuals with text and captions written in the local language. These manuals, which reflect the level of literacy and visual perception of the persons carrying out the maintenance work in each country, have been developed in the field and have been tested in real situations before being corrected and printed and disseminated to communities. While Venezuela and other Latin-American countries can be cited as the early leaders in this area, examples can now be found in Asia, Africa and the Arab States as well (Venezuela and UNESCO, 1990; Nepal HMG/UNESCO/NORAD 1992, Bhutan HMG/UNESCO/NORAD circa 1993). *Figures 4.5 and 4.6* are taken from the Nepal manual.

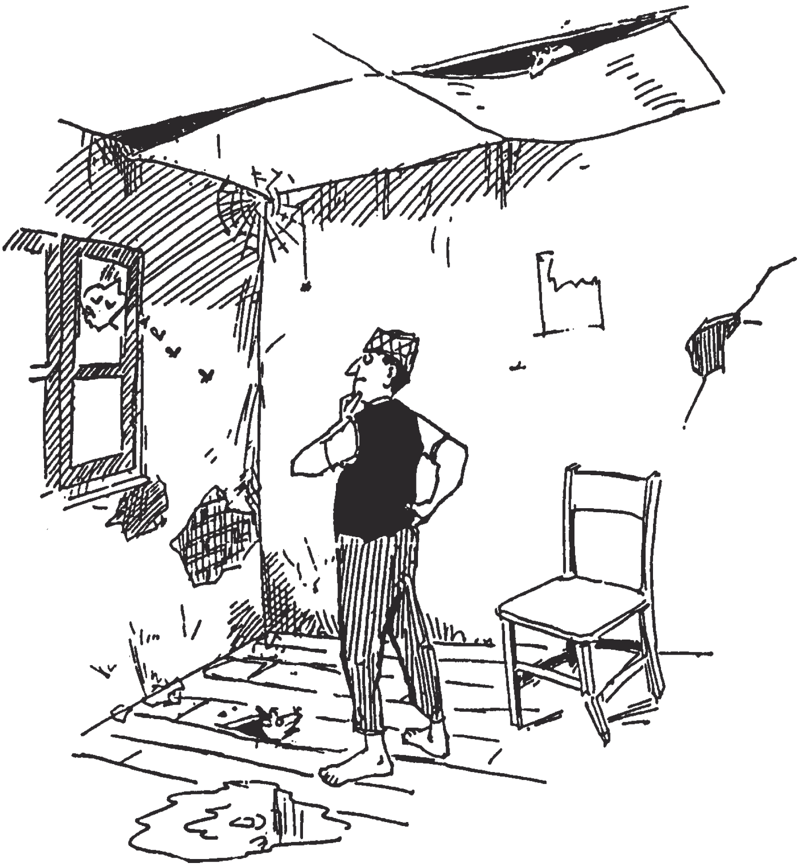
But maintenance should not be an afterthought or a consequence of poor design decisions. The best time to deal with reducing maintenance needs and costs is to consider needs from the design stage.

Building remodelling and replacement

In a time when educational reform is the platform of almost every new minister of education (and ministers change often), there is a strong demand for educational buildings to be modified in response to new curricula and structures (see *Chapter V*, Managing change). This involves the conversion of primary schools into middle schools through the addition of specialized teaching spaces and the remodelling of existing classrooms into offices or student activity rooms. Such actions generally require a new capital investment which, when accurately budgeted, may provide a motivation for avoiding reckless reforms.

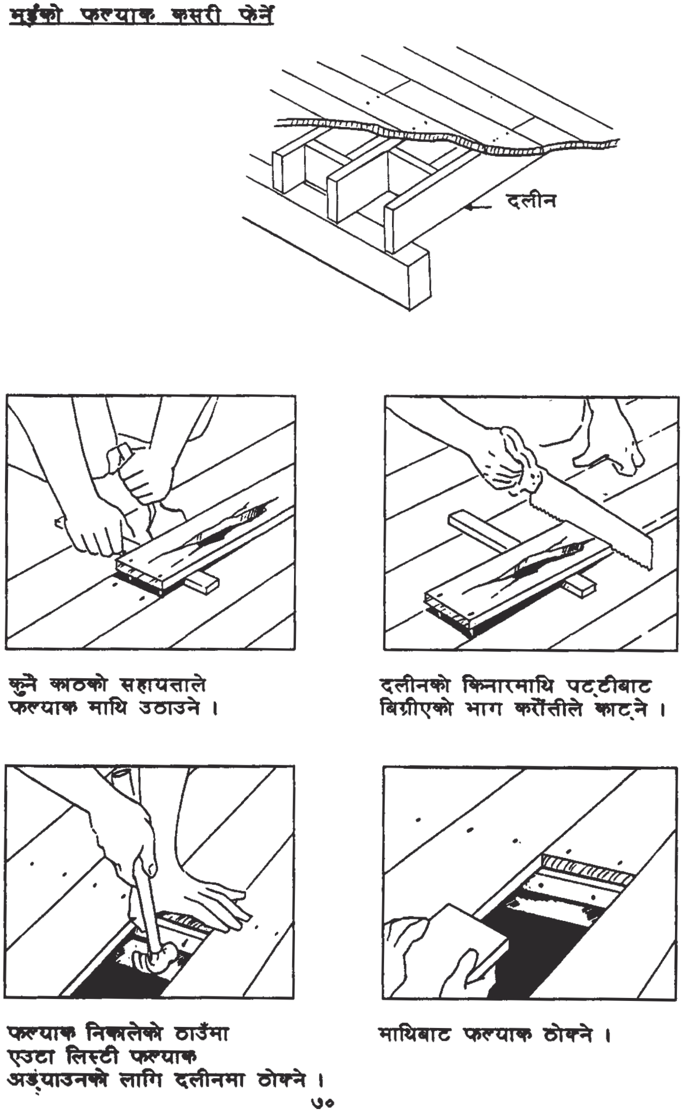
The building replacement cycle is a function of the durability of the initial construction, the degree to which it has been maintained and the degree to which it is no longer possible to remodel it to suit current uses. A well-built, well-maintained and regularly remodelled educational building in an industrialized country may be used for 90 years or more. In Africa, it is not uncommon to see unusable 20 year-old concrete and steel buildings, that have fallen victim to poor maintenance and vandalism, or that have been destroyed during their occupation by military or militias.

Figure 4.5. Maintenance needs



Source: Nepal HMG/UNESCO/NORAD 1992

Figure 4.6. Illustration of one maintenance procedure



Source: Nepal HMG/UNESCO/NORAD 1992

Furniture and equipment maintenance and replacement

The useable life span of good furniture is in the range of five to ten years. Shorter periods of use are usually due to minor damage which goes unattended. Furniture maintenance involves the reattachment or replacement of broken parts and refinishing. Many developing countries fail to foresee mechanisms for carrying out these tasks. Since school administrators lack authority to dispose of broken furniture it is piled in a storeroom, a classroom, outdoors behind the classroom block or, if the building has a flat one, on the roof. As furniture has a direct impact on the comfort of learners there is a compelling justification for planners to foresee budgets for contracting local carpenters, metal-workers and painters to maintain the furniture, or if such enterprises are unavailable or unreliable, engaging and training adequate maintenance staff.

Being the third most important variable related to learning (after the educational level of parents and the knowledge of teachers), educational equipment maintenance and replacement needs to be addressed by the appropriate educational technology specialists. This is beyond the purview of this booklet.

Cost sharing

While many central governments, particularly in developing countries, would like to fully fund both construction and maintenance this has often proven unrealistic in practice. Consequently, local governments are asked to share the financial burden. But if local and regional governments have no way of generating income how can they meet these responsibilities? One way to do it is to mobilize local support for construction, landscaping and maintenance.

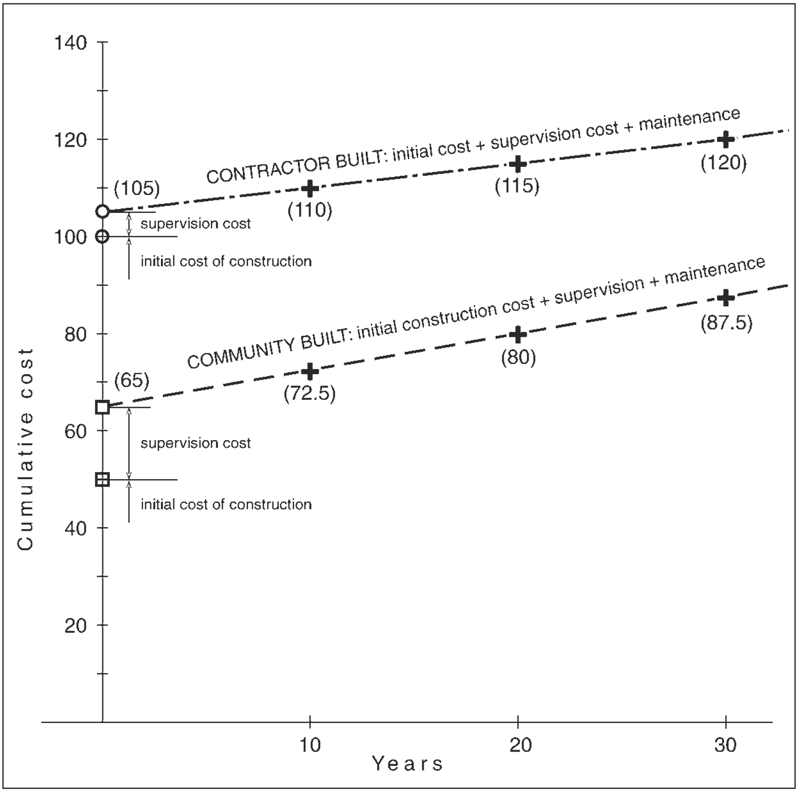
The Seti Zone in Western Nepal is one of the poorest regions of one of the world's poorest countries. A UNDP-Government of Nepal/ UNESCO project integrated into acoherent programme many innovative ideas for rural education involving primary school-age children and adults alike (Crowley, 1990). Amongst the ideas implemented was that of mobilizing the community to provide and maintain the physical facilities. Communities constructed some 345 schools (complete with buildings, water supplies, pit latrines and boundary walls) following plans based on the technology used in the construction of farmers' houses. Final construction costs were well less than half of what local contractors would have charged (Tamang and Dharam, 1995). In addition, those schools which had satisfactory classroom blocks were improved through a maintenance programme that covered the same components.

Community participation in construction of schools and places of worship is an old tradition in much of the world (Abdulac, 1985). There are many examples of governments, non-governmental organizations and international agencies working to reshape this is into 'aided self-help' such as the Nepal example above. In the 1960s UNESCO cooperated with the World Food Programme in Afghanistan in the construction of 324 schools. In this project, communities were compensated through receiving food for work. The same principle was followed in Senegal (de Bosch Kemper, 1987) under an OPEC-funded project which built prototype schools in Mauritania, Somalia, Sudan and Yemen (UNESCO, 1996b).

While management costs for aided self-help construction may be treble that of supervising established contractors, the capital investment costs may be cut by 20 to 50 per cent. *Graph 4.7* indicates the overall initial cost savings and considers that the annual maintenance cost of a contractor-built structure may be 0.5 per cent of initial cost while that of a community-built structure could be 1.5 per cent. This graph does not give any cost value to the longer construction time which is often associated with such local initiatives nor to any difference in the lifespan of the buildings.

The possibility of involving the community in *maintenance activities* has been mentioned above and examples provided from Nepal, Philippines and Venezuela, but such experiences are not unique to the third world.

Graph 4.7. Cost over time for contractor-built and community-built buildings



Comparison between initial cost at 100 and 50 with supervision at 5 per cent and 15 per cent of initial construction cost and maintenance at 0.5 and 1.5 per cent of initial construction cost.

A third area where communities can contribute to capital expenditures by volunteering time is in *site development*. Finding competent volunteers is relatively easy as much of this work requires the same expertise as is needed for maintaining one's own fields or garden. The results are highly visible and can contribute to raising community pride in their local schools.

It is sometimes suggested that communities can contribute effectively to constructing school furniture. This is seldom the case. Furniture uses large quantities of precious materials, timber in particular, that undergo great stress in use. Poorly built furniture is quickly destroyed and the materials used are lost. Furniture manufacture is highly specialized and should be entrusted only to proven manufacturers. Even repairs can be entrusted only to well-qualified workmen (see also *Chapter VI*).

Mobilizing community participation is a complex matter since it can easily become a form of taxation of the poor. Villagers may come to feel that they are being asked to help the facilitating agency rather than feeling that the agency is there to help them. As the main community contribution is time and they are usually involved in the time-consuming livelihood of small plot farming, the contribution expected from them is more valuable at local level than a purely monetary analysis indicates to central planners.

V. Managing change

Physical facilities need to be seen as a capital asset. There is a time to build, a time to rent, a time to redeploy and a time to divest. It is a twentieth century truism that the only thing certain about education is change. This poses major problems for planners dealing with the physical infrastructure of education which more often than not is made of masonry, concrete and steel. There are certain options open to planners which help them to see physical facilities as a malleable material which can accommodate new and varying forms of education. Old assumptions need to be challenged to ensure that physical facilities are developed to serve tomorrow's educational needs. To be avoided are situations where yesterday's physical facilities shape tomorrow's education.

Internal flexibility

Educational buildings can be reshaped during each day to accommodate a variety of class sizes. This approach to short-term flexibility, very much promoted in the United States during the 1960s, and in Europe during the 1970s, can be achieved by constructing new buildings (and remodelling existing ones) with mechanically moveable partitions. During the school day, these partitions can be opened to combine several standard classrooms thereby creating a lecture hall or closed to sub-divide standard classrooms into spaces suited for small group discussions (Aujame and Aujame, 1986). While these devices increase utilization rates their high initial cost and complex maintenance may render it more economical to build special purpose spaces for large and small groups and tolerate their low utilization.

Long-term flexibility, on the other hand, offers substantial returns. Industrialized countries have learned that replacing load-bearing internal walls with structural frames and internal partitions of inexpensive materials, permits them to make affordable internal rearrangements when curriculum and teaching methods reforms require a new arrangement of spaces. As technology advances in developing countries and structural frames become more economical, this approach is increasingly cost-effective for them (International Union of Architects, 1974).

In developing countries the justifications for flexibility stem from different considerations. First is the matter of class size. Often first grade classes have double, triple or quadruple the number of pupils enrolled as do fifth grades. The implication is that classrooms need to be sized to accommodate real enrolments, not the theoretical enrolments projected by planners. Second is the matter of flexible use of the classroom space. In Africa it has been found that all mobile furniture has a much shorter life than fixed furniture and that teachers rely almost exclusively on frontal teaching which requires a minimal movement of furniture. A proposal made to Guinea by UNESCO's Dakar office was to fix the desks but have moveable seats. This provided modest flexibility at an affordable cost.

Physical facilities as a real estate asset

During the 1980s the OECD Programme for Educational Buildings (PEB) began to view physical facilities for education as an investment in real estate. In countries where demographics are static or declining (as in the majority of OECD member countries at the time) or where dramatic population shifts are underway, planning parameters change drastically from the constant growth model. Critical decisions need to be taken regarding neighbourhood schools which suddenly have a clientele that is less than its design capacity. Should several schools be combined? Can the empty school be effectively used for adult education classes or should it be leased or sold to generate income for the educational authorities?

The United States and other OECD member countries produced a number of excellent examples of how old educational buildings can be remodelled either for continuing education activities or for residential or commercial uses (Educational Facilities Laboratories, 1976; OECD, 1996a).

Micro planning and inventories

By looking at all the educational buildings in a cluster or district as a space resource, the number of options open to planners for dealing with change substantially increases. For example, if an 8-4 structure is changing to 6-3-3, educational planners can calculate the enrolment of the new middle schools, analyze travel distances (or times) and decide which of the original primary schools come closest to accommodating the expected enrolment and yet meet the travel standards. In this way, planners can propose additions of specialized rooms to existing primary schools rather than building new middle schools. When new schools are to be built, physical planners advise on which neighbourhoods are scheduled for growth and on where the new institution should be located (Hallak, 1977; Gould, 1978). Micro-planning techniques, which include considerations of staff as well as physical facilities, have been pioneered in the 1960s and 1970s by the IIEP (Caillods, 1983).

One way to upgrade existing secondary, technical and vocational schools in situations where several nearby schools all lack adequate laboratories or workshops is to provide a central block of these specialized facilities which serves the entire school cluster. Such centres can be cost-effective even though well-staffed and well-equipped because of high utilization made possible by the economies of scale.

Selecting those schools to be upgraded and estimating the cost is dependent on having good data available both as regards student numbers and a detailed inventory of the physical facilities. Many countries find themselves with statistical towers of Babel created by a number of specialized planning bodies, each of which has set out to collect statistics to suit its own needs. Modern data-processing enables school districts to establish for each school an integrated database that gives both basic information needed by any administration dealing with the school (e.g. name, address, grades served) and detailed information used by specialist planners and designers for finance, staffing assignments or construction and maintenance (e.g. the date when each classroom was last painted). Successful examples are that developed by the Kingdom of Jordan, Republic of South Africa and a host of Latin-American countries including Argentina, Chile, Costa Rica, and Mexico.

The Palestinian Authority has developed a database for educational buildings that has proven very satisfactory for identifying priority schools for improvements and extensions. As this database includes budgets for bringing each school up to standard it has proven to be a useful tool in attracting external finance. Another interesting experience has been that of South Africa which mobilized contemporary satellite technology to locate schools then followed this up with on-site surveys of actual accommodation. A checklist for developing a comprehensive inventory of educational facilities is given in the *Appendix*.

Macro planning

Large-scale school construction programmes may be geographically oriented (e.g. provinces which have fallen behind in provision of educational facilities) or at those schools across the country which fail to meet a newly approuved standard of accommodation (e.g. middle schools without libraries and science laboratories).

Thanks to computerized data bases large construction programmes funded through external assistance are increasingly made up of aggregated micro-planning data generated for the specific schools to be included in the programme. In cases where it is necessary to work from generalized standards, experience suggests that cost per place data should be based on total initial costs of institutions at various levels, then weighted to reflect the typical enrolments of different sizes of institutions as suggested in *Table 4.2* above. Approaches for generating national standards are given in *Chapter VI.*

VI. Managing the actors

The preceding chapters have covered what needs to be done to develop and implement a sound physical facilities policy; let us now take a look at how to get such a policy in motion and who should carry out its different aspects. The roles for the different actors are reviewed through the different phases of the project cycle which is typical of externally aided programmes for educational expansion or quality improvement and which, inevitably, involve a physical facilities component. The respective roles of central and local government and the private sector are reviewed. While these are largely national issues, they have also been addressed at regional level for Africa (UNESCO, Dakar, 1995) and the economically advanced countries (OECD, 1992a).

Standards setting

Since ministries of education are the ultimate owners of educational buildings (or represent the local authorities who may be the owners), it is they who need to take the lead in setting standards that are based on the national conditions: educational, economic and industrial. Nonetheless, external donors may offer their own space and construction quality guidelines in the interest of defending their investments against criteria understood by their governing bodies. For recipient governments to protect themselves against the imposition of irrelevant external standards, soundly drafted national norms need to be firmly in place before projects are discussed with external donors.

The approach taken by the United Kingdom is useful for countries setting up standards to study. Since ministries of education are the ultimate owners of educational buildings (or represent the local authorities who may be the owners), it is they who need to take the lead in setting standards that are based on the national conditions; educational school construction in the post World War II United Kingdom was based on a partnership between the Ministry of Education which dealt with broad education policy issues and educational finance while the local authorities were responsible for running the schools. At both central local authority level, interdisciplinary 'development groups' were created, made up of specialists in education, architecture and building costs. This formula gave selected local authorities responsibility for experimenting with new ideas and evaluating their effectiveness. Once it was determined that the ideas were valid the central ministry published and widely disseminated the results in the hope that other authorities would follow the example. Furthermore, financial support was provided on the ability of local authorities to meet these standards or to justify their deviation therefrom.

UNESCO's work in educational buildings was based on the United Kingdom experience and the recommendations of the International Conference on Educational Buildings, London, 1962 (UNESCO, 1962). Realizing that the objective was to develop the national capacity to generate affordable schools designs based on relevant national norms, UNESCO, in cooperation with host governments, created regional centres for educational buildings research in Latin America (CONESCAL, Regional School Building Centre for Latin America and the Caribbean), Asia (ARISBR, Asian Regional Institute for School Building Research), and Africa (REBIA, Regional Educational Buildings Institute for Africa) whose functions included research, training, technical advice and information dissemination. The OECD Programme on Educational Building, which also grew out of the London conference, launched the DEEB project which aimed to develop rational approaches to educational buildings for the Mediterranean countries which were facing large demands while experiencing financial constraints.

The conclusions of the UNESCO centres and the OECD project as regards the setting of school-building standards were the same; effective standard-setting for buildings and furniture requires an *interdisciplinary team* where educators, architects and cost specialists work together to promote solutions that ensure an adequate quality of education and yet are functional, affordable and attractive. Good standards are generated through careful research that defines needs and design development work where spaces and furniture are tested in use by learners. Poor standards are those which are rigid and thoughtlessly imposed in all situations.

Setting standards that are based on national educational, economic and industrial conditions can be entrusted to national teams selected for their creativity and ability to carry out applied research and for their familiarity with public works standards for construction. UNESCO training materials include a volume on the development of norms and standards (Vickery, 1985). See also the chapter on research in the UNESCO Handbook for Educational Buildings Planning (Almeida, 1988).

Where qualified national professionals are lacking within the concerned ministries it will be necessary to turn to national universities experienced in applied research or international consultants. Good examples of design guidelines for schools of all levels are Kenya, Somalia (Bussat and De Bosch Kemper, 1971), Senegal (Ministry of Education) and Morocco (UNESCO, forthcoming).

Sector analysis, project identification and preparation

Overall reviews of education systems are often undertaken as a prelude to major educational reforms. To be an effective comprehensive assessment such reports need to include an evaluation of the quantity and quality of educational facilities (see for Cyprus Drake, Pair, and Ziogas, 1997).

Another title in this series (Magnen, 1991) gives full information on project preparation. It is important to stress that drawing up plans for the expansion of educational facilities requires balanced contributions from educators, demographers, education finance specialists and the communities to be served. Many donors will send their own teams to prepare projects in cooperation with local professionals. Typically, the external consultants are an educational planner and an architect. Countries which have adequate expertise in project preparation are increasingly taking on this task themselves following guidance given during occasional visits from the funding agency.

This is a necessary dialogue since governments have (or should have) their own standards for what they feel they need and each funding agency has its own criteria for the kinds of projects it supports. Since these two sets of criteria usually do not fully match, a waltz of negotiations takes place that involves certain compromises but usually ends with a grand finale in the form of a signed project document. Left sitting on the sidelines, all too often, are the community groups which are to be served by the project. There are abundant examples of community schools which have developed outstanding physical facilities, either on their own or semi-independently of government (Kennedy, 1979). It is the planners' task to bring them on board.

What is good design?

If design quality is the responsibility of architects (which it is) how are planners toknow when the architect has done a good job? Existing literature is very limited on this point but it is possible to give a few guidelines which could lead to a better dialogue between architects and planners.

Architecture is an interdisciplinary field which involves functionality, building materials and construction techniques, esthetics and cost. Typically, critics judge buildings by the one or two of these factors that the critic understands. These narrow judgments are unfair as *good design is achieved only when all four factors have been satisfactorily addressed.*

To help planners understand the complexities of a good design, *Box 6.1* gives an idea of the various elements that are included in each factor.

Box 6.1. Elements of good design

A. Functionality

1. Provision of all spaces requested,
2. Respect of comfort norms set out in the architect's brief and international literature,
3. Close proximity between spaces that are used in conjunction with one another,
4. Adequate distances between noisy and quiet activities on the school site.

B. Construction

1. Use of local materials that are understood by local workmen,
2. Introduction of modern materials that will bring long life and low maintenance,
3. Respect of local building codes,
4. Choice of materials and construction methods that resist damage by natural disasters.

C. Esthetics

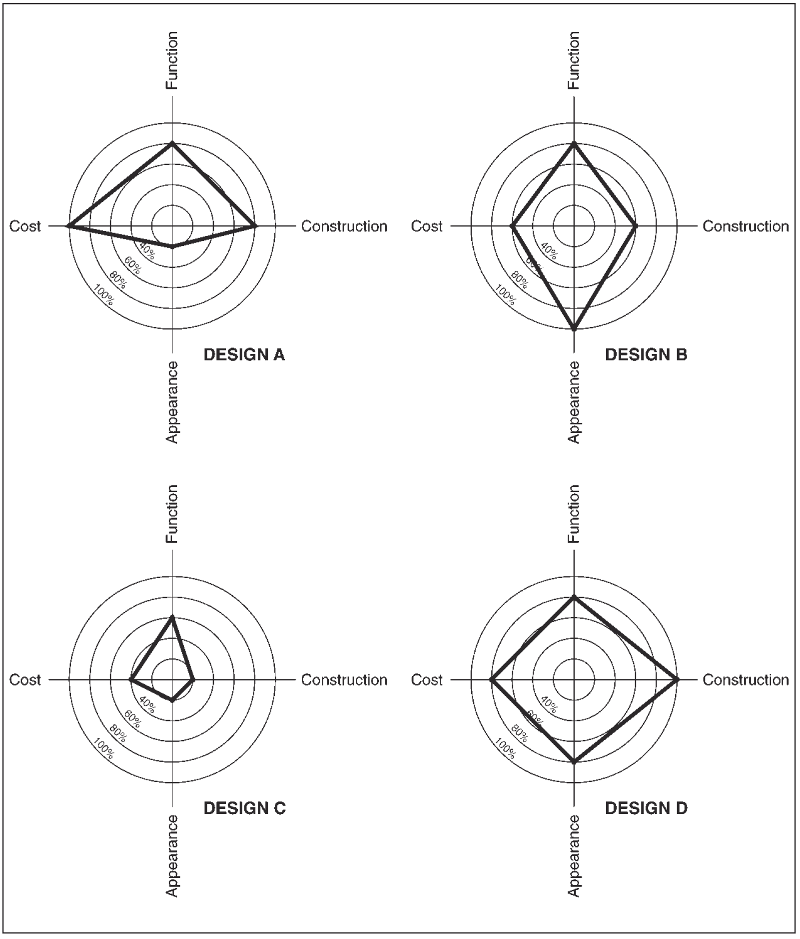
1. Appropriate human scale of spaces and volumes,
2. Visual integration into the community,
3. Attractiveness to invite learners and community members,
4. Respect of prevailing architectural standards.

D. Cost

1. Areas provided respect the architectural brief,
2. Cost per unit area respects standards set in the architectural brief,
3. The cost per student respects the limits set in the brief.

By ranking the four major factors on a comparative scale it is possible to generate a simple graphic shown in *Figure 6.2* that enables planners and laymen (and even architects) to make a comparative evaluation of preliminary designs of new and existing buildings, site layouts or furniture or of existing buildings.

Figure 6.2. Graphic presentation of design evaluation



Source: Caudill Rowlett and Scott, architects.

Project implementation of physical facilities

Normally construction components of education projects are implemented by the Ministry of Public Works or Education or a specially created project implementation unit. All governments have established procedures for tendering building construction to established contractors and furniture purchase to established suppliers. These procedures, normally established by the national or provincial public works department, are designed to ensure that the lowest possible prices are obtained and that a reasonable level of construction quality is achieved. When these market forces are allowed to work reasonable results can be expected. In special cases, the ministry may take on the job of the contractor through direct execution using its own skilled personnel.

External funding agencies often like to see international tenders for construction, partly because they may not be convinced that national contractors have the necessary expertise and capacity and partly because their own donor governments insist that contractors from their countries have the right to submit tenders. As the construction capacity of developing countries has grown they have increasingly taken over educational building construction. More recently, aid agencies have come to recognize that development of national capacity is their end objective and some give priority to national contractors provided their tenders do not exceed international tenders by a fixed limit (often 15 per cent).

Current trends towards administrative decentralization could encourage project managers to rely more on community participation, particularly in remote areas where contractors will not work at established rates. Experience has shown that communities will work for modest payments provided they know that fairness is scrupulously practiced by management. In the Nepal Seti Zone project mentioned in *Chapter IV*, workers recorded the number of hours worked, and records of what the village committee paid them were made public in such a way that even illiterates knew exactly how funds were disbursed.

Getting communities to respect deadlines is challenging. Work in the fields takes precedence for the local people and if the management is not absolutely transparent disputes may break out and halt project execution. Such inconveniences need to be weighed against the indirect benefits of providing villagers with added income, teaching villagers new skills and engaging villagers in their local education system.

Planners often get involved in project implementation by being appointed to the implementation team be it as a regular post within the existing ministry hierarchy or detachment to a specially created, semi-autonomous implementation unit. In such a capacity, planners are charged to ensure that educational components of a project (e.g. textbook development, teacher training) and the physical facilities components come together at the same time. In this role they will coordinate with supervising engineers who prepare the critical path diagrams that are used to manage the various construction components.

Enlisting the private sector in buildings

The last half of the twentieth century has seen a massive effort in nation building. In many cases these new nations which lacked national professionals and private enterprises have followed socialist approaches of government to protect themselves against exploitation in the competitive marketplace. Education being a state responsibility and public buildings involving the expenditure of public funds, educational buildings have been heavily influenced by government. With the maturity of these nations has come the growth of a private sector, the vigour of which can now be called upon at appropriate levels.

In many countries, private architects have brought new creativity to educational building design. The most effective work is done when the designer and client have a mutual and profound understanding of the architect's brief and evaluate together the various designs according to the criteria laid out (see *pages 67-69*).

Construction of relatively small buildings such as schools is increasingly handled by the private sector on the basis of competitive tenders. Ministries of Education or Public Works need to be highly competent in preparation of tender documents, prequalification of contractors, evaluation of tenders and supervision of construction.

For very large-scale projects the private sector can be enlisted in the design and manufacture of standardized construction components as described on *page 71*.

Who makes the furniture?

One area where the private sector can be particularly effective is school furniture. This is a specialized field which needs to be approached with a full understanding of the issues involved (see: Brian Scriven; Bo Fritzell; Hans Enulf in UNESCO, 1979).

Well-constructed, long-lasting furniture is most easily produced under factory conditions where special equipment is available for shaping materials, producing special connectors and applying finishes. The major problem with factory-produced furniture is that its design may have benefited from expertise on how to build robust furniture but fall short in terms of meeting the special needs of educators. Ministries of Education can overcome this lacuna by carrying out a thorough research and development activity which includes construction of prototypes and testing through classroom use. The results of such testing can be translated into performance specifications which allow furniture manufacturers to develop detailed designs that not only respond to the educators' specifications but are also robust and economical to manufacture.

Many countries import school furniture since they do not have their own factories. This may provide good furniture at low prices which reflect the mass production processes used. On the other hand, this moves capital out of the country and demotivates national industries from competing. During the 1950s and 1960s when wood was still in abundant supply, one way around this dilemma was to have furniture locally made by skilled joiners. As this approach is no longer feasible due to the lack of materials it is now wiser to contact national manufacturers of domestic and office furniture and to work with them on prototypes that can be produced locally at prices and quality competitive with the international market.

Evaluation

The key to building on real success and to avoid repeating old mistakes is sound evaluation. This is now insisted upon by most external donors who need this kind of data to justify their lending programmes to their governing bodies. Governments are also increasingly expected to undertake evaluations to justify the use of tax money.

While each donor, and most governments, now have general guidelines for undertaking evaluations (the UNESCO evaluation methodology was prepared by Almeida and Goodwin-Diaz in 1990, and World Bank procedures for completion reports have been inplace since the 1970s, both of which are contained in internal documents), there are no generally agreed procedures for evaluating physical facility components. There is, however, a vast inventory of project evaluation reports co-authored by educators and architects from UNESCO (e.g. Courtney and Hovik, 1987 for Swaziland or Almeida and Eide, and Pitanilabut and Smith, for Bhutan) which compare implementation and actual use to initial objectives, budgets and calendars. On its side, the World Bank undertook a comprehensive review of unit area and unit cost estimates of its projects over the period 1981 to 1983 (World Bank/IDA, 1983). This internal document served as a guideline to be used by staff in the preparation of subsequent projects.

The OECD (1996b) has published photographs and plans of 41 recent new or remodelled buildings in 19 countries which have been chosen as outstanding examples of the application of ideas promoted by the OECD Programme on Educational Building. The schools presented cover all levels of education and each is briefly described though without any attempt at comparative analysis. Some in-depth evaluation research in the USA and Australia attempts to measure the impact of the facilities on users including impact on learning, behaviour and the introduction by occupants of unforeseen uses. Angus et. al. (1979) have demonstrated that the widespread use of open-plan schools had a direct impact (negative in all subjects over the course of the school year) on cognitive outcomes in mathematics, reading, written expression as well as on attitudes toward school (positive initially but waning over the course of the year). In the United States, McKenzie (1995) has evaluated community use of school facilities which were conceived only to provide education to school-age children while Dancu and Garnon (1994) have undertaken an evaluation that lends itself to graphic presentation.

VII. Summary and conclusions

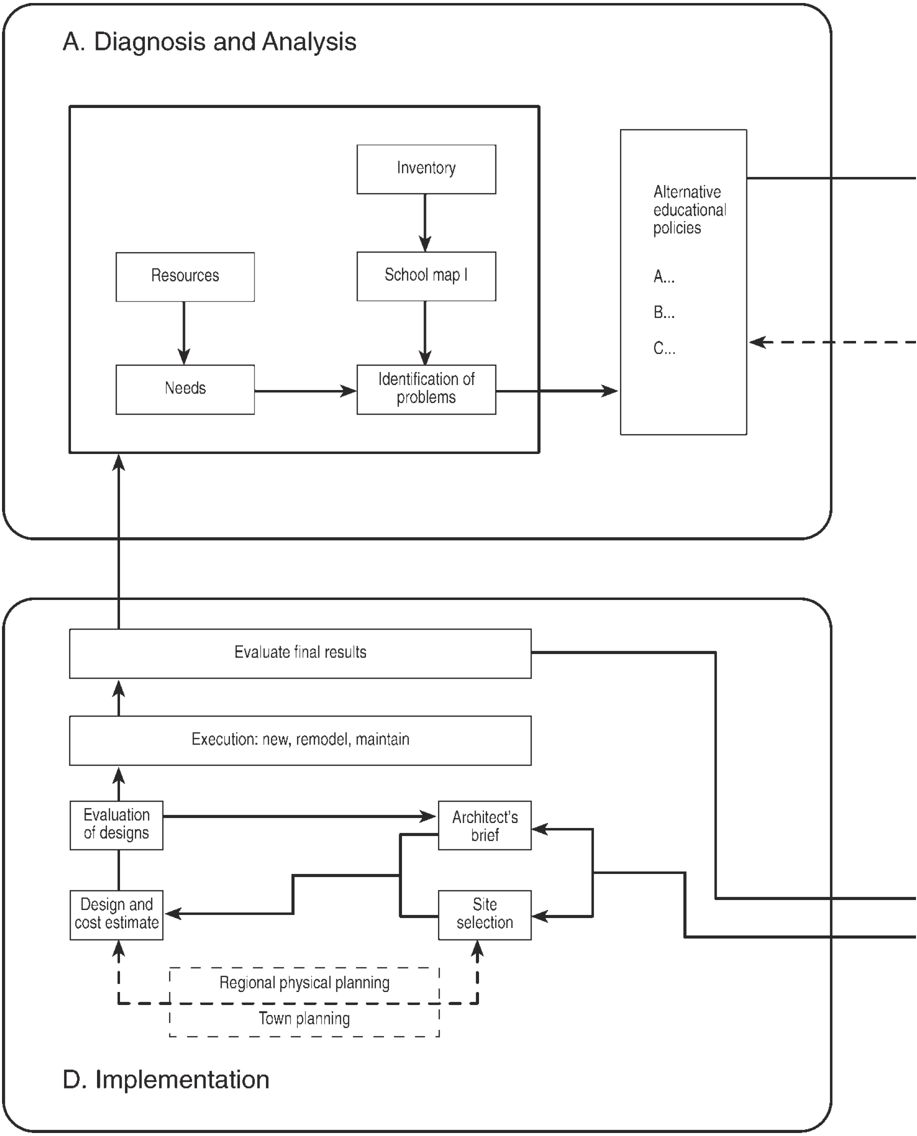
Over the last half century country after country has had to face major challenges of building massive numbers of new schools or adding teaching spaces to existing schools. Now that universal primary education is on the way to being achieved and population growth rates are showing signs of slowing, countries need to assess their stock of physical facilities and to draw up new strategies. Undoubtedly, the new thrust will be dominated by management and maintenance of previous investments with new construction having reduced importance.

Towards a systemic model

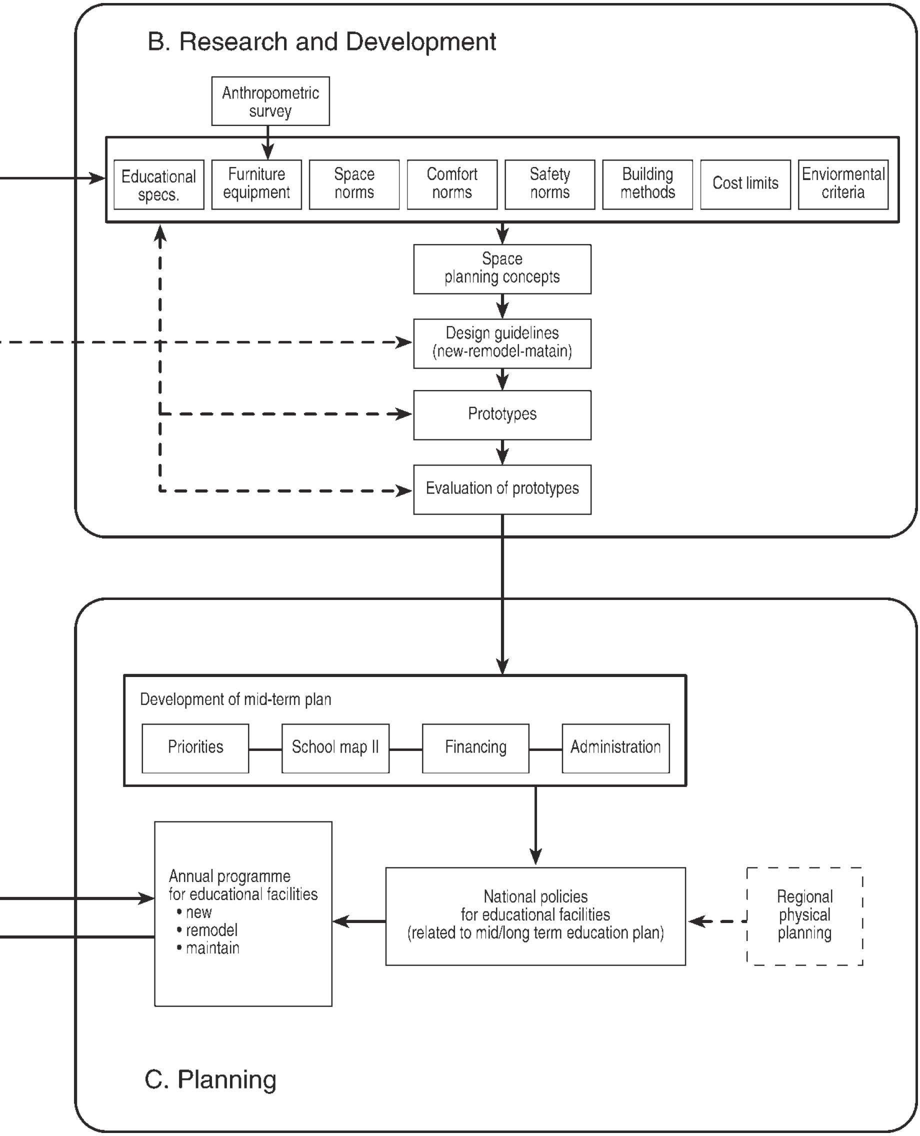
Two publications synthesizing UNESCO experience in this field (El Jack and Almeida, 1980, and Almeida, 1988) propose a model that shows the interface of four major activities: (i) analysis and diagnosis of the existing situation; (ii) research and development to establish standards; (iii) planning and drawing up future programmes and (iv) implementation of physical facilities maintenance, repair and construction programmes. The model has been generated by architects as the result of working together with planners, and it is very similar to the model for planning educational reforms presented by Haddad and Demsky in this series (1995).

The basic chart laying out the inter-relationships of the steps involved is given in *Figure 7.1*. This model may be used by planners as a tool for drawing up strategies for dealing with physical facilities. It provides a useful checklist for architects to ensure that all issues important in educational buildings are taken into account when preparing building designs and plans.

Figure 7.1. The educational buildings planning process



Source: El Jack, K.; Almeida, R., 1980.


B. Research and Development
Anthropometric survey
Educational specs.
Furniture equipment
Space norms
Comfort norms
Safety norms
Building methods
Cost limits
Enviormental criteria
Space planning concepts
Design guidelines (new-remodel-matain)
Prototypes
Evaluation of prototypes
Development of mid-term plan
Priorities
School map II
Financing
Administration
Annual programme for educational facilities
• new
• remodel
• maintain
National policies for educational facilities (related to mid/long term education plan)
Regional physical planning
C. Planning

Where to go from here?

Looking backward at physical facilities for education involves examination of both the history of architecture and the history of education. The notion of constructing permanent buildings to shelter human activities is a very old one. Educational history can be traced back 2,500 years to Socrates who taught in the shade of olive trees.

The last 150 years or so has brought some significant developments to education, particularly the idea of equal access to education and life-long learning. Technology has held out some tempting promises for the future; can teachers and books be replaced by teaching machines, audio-visual media, television and, most recently computers and the Internet? The United States with the so-called Trump Plan of the 1950s with its variable sized classes and Bangladesh with the Bangladesh Rural Advancement Committee (BRAC) scheme of the 1990s (Ahmed et al, 1993) have both experimented with innovations to redefine class sizes and change the educational calendar drawing on the conclusions of educational research. The insight used and the success of pilot schools notwithstanding, most school systems continue to function with classrooms organized more around teachers and textbooks than the processes of learning and more around the calendar of agricultural harvests than a calendar based on how children can best retain and expand knowledge through regular reinforcement.

Given the apparent massive inertia against any fundamental change in education there is reason to believe that educational buildings and furniture will be with society for some time. On the other hand, the steady trend toward increasing public access to education at all levels and to citizens of all ages make it clear that changes will take place.

To bring about rational planning of physical facilities a sound statistical base is necessary. As of this writing internationally agreed guidelines for keeping statistics on educational facilities are still lacking.

As indicated in the opening of this chapter, future thinking about physical facilities of education will be increasingly influenced by considerations of how to maintain, remodel, expand and off-load existing buildings rather than being dominated by the construction of new schools.

Computers are now a way of life and a way of learning. Every school, even those in the poorest and most remote areas, needs to have one or more computers. Solar energy which reaches beyond government electrification schemes can be called on to energize these machines. The challenges of meeting initial cost and ensuring that the machines are kept operable have yet to have been breached. This is true even in the most developed countries. The United States/GAO report (1995b) indicates, for example, that 'most' of the 80,000 schools in that country are 'unprepared for the 21st century' particularly due to the absence of information technology or the poor use of what is available.

The information age is already adding new dimensions to this field. The United Kingdom Open University pioneered some fresh ideas about learning at home (including using the kitchen sink as a chemistry laboratory). This trend will expand resulting in a growth of home-learning centres or the use of study carrels in neighbourood learning centres (Beynon, 1964, OECD, 1995). The use of e-mail to create virtual schools is beginning to happen, and will spread rapidly.

Life-long learning trends are making educational buildings into a community learning resource. This is requiring planners and designers to provide accommodations for all age groups within the same institutions.

Computers have also revolutionized the way architects and engineers work. The introduction of computer-aided design (CAD) for generating building layouts and cost estimates, means that educators and financial planners can now react to preliminary schemes by viewing three-dimensional presentations and expect the designers to generate other more optimal solutions. This technology is already found in developing countries and will soon become pervasive.

Construction techniques are evolving towards the increased use of industrialized materials and away from increasingly scarce locally produced materials. At a time when increased community use of schools helps to encourage increased community participation in school governance and also in construction and maintenance of community schools, the shift towards use of more industrialized construction materials and techniques makes it increasingly difficult for communities to contribute to physical facilities through donated labour.

Finally, the current trend of decentralization of public administration will have a major effect on the management of physical facilities for education. With the growth in the number of qualified educators, architects and engineers in developing countries there is a growing professional pool available to work on cost-effective educational buildings and furniture. The number of educational facilities specialists will need to increase so they can serve the regional and local authorities entrusted with growing responsibilities for implementing educational programmes.

With more professionals working in this field, information will increasingly be transmitted through professional associations such as the International Union of Architects Working Group on Educational and Cultural Spaces or the Council of Educational Facilities Planners International.

In addition, there will be more individual exchange of information. With the advent of the Internet massive amounts of technical information can now be freely and quickly exchanged around the world. This provides an opportunity for innovations to be exchanged and should lead to a greater variety of solutions for school-building designs. On the flip side of that coin is the absence of analysis and editing of much of this information. In this context the traditional normative and information exchange roles of international organizations may need to be reshaped to include on-line services that are immediately responsive to requests for information based on sound research.

Glossary

Anthropometrics: measure of human body sizes.

Architect's brief: instructions to architects commissioned to design a building. This includes the area of each space, the character of each space, environmental conditions and the type of construction recommended as well as cost limits not to be exceeded. Common terminology in the United Kingdom.

Architectural programme: see architects brief. Common terminology in France.

Area per place: total building area divided by the design capacity of the institution

Capital cost: total cost of site, buildings and long lasting (five years or more) furniture and equipment.

Capital investment: expenditures made to meet capital costs

Construction cost: cost of buildings alone.

Cost per place: total construction cost divided by design capacity.

Cost per unit area: total construction cost divided by total floor area.

Design capacity: the maximum number of students who could use the school under adequate working conditions on a single shift.

Educational specifications: similar to architect's brief but with more stress on requirements of educators. Common terminology in the United States.

Ergonomics (synonym: human engineering): Study of the human body and how it carries out specific tasks and responds to external physical conditions such as sound, light and temperature.

Lifetime costs: total initial cost plus maintenance, remodelling and operational costs.

Physical facilities for education: land, buildings, furniture and equipment used in educational institutions.

Student place: see design capacity.

Total area (synonym: gross area): the total constructed area of a school comprising educational, administrative, service, ancillary, and additional spaces and wall-section areas.

Total initial cost: cost of design, construction, supervision and furnishings.

Appendix

Educational buildings inventory: checklist of data to be collected

by Rodolfo Almeida

A. General construction data

Location: district, locality, urban or rural area, address.
Property ownership: national, private, community.
Original purpose: constructed as a school, adapted as a school or constructed for another purpose.
School operations: number of schools that use the building, morning, afternoon and night shifts.
Other operations: community centre, assemblies, recreation, religious activities, hurricane shelter.
Construction: party responsible (public works, Ministry of Education, private, community, religious institution).
Date: date of construction of each building (or indicate if under construction).
Physical condition of each building: good, average or bad.

B. Particular educational administration data

Number of school:
Name of school:
Code for school:
Tenure: owned, lent or rented
Monthly rent:
Administrative dependence: government or private.
Number of buildings:
Enrolment: by level, grade, shift, sex.

C. Data on site and construction system

(i) Site
Land: total area, constructed area, covered area.
Possibilities for expansion:
Basic Services: drinking water, water source (well, river or stream, rain water collectors), drainage (sewer, septic tank), electricity (mains, power plant), telephone.
Fence: complete, incomplete, none.
Sanitary facilities on the site: toilets, individual and collective urinals, washbasins, showers, drinking fountains (indicate physical condition of each as good, average or bad).

(ii) Construction system
Structure: concrete, metal or wood.
Roofs: concrete, metal sheet, asbestos sheet, thatch.
Walls: concrete block, brick, wood, stone, wattle and daub.
Floors: concrete, tile, wood, earth.
Windows: wood, steel, aluminum.
Finishes: walls (paint or tile), ceilings (paint or other).

D. Data on educational facilities

(i) Academic facilities
Common classrooms, multipurpose spaces, laboratories, light workshops (home economics, typing, etc.), heavy workshops, resource centre (library), inappropriate classrooms, etc. Data for each; quantity, size (length, width, height, area), physical condition (good, average or bad), construction system.

(ii) Administrative facilities
Offices and services: idem.

(iii) Supplementary facilities
Auditorium, gymnasium, storage areas, washrooms: idem.

(iv) Sports facilities (outdoor)
Basketball, volleyball and tennis courts, track and field facilities, soccer and baseball fields, playgrounds: quantity, and physical condition (good, average or bad).

(v) Annex facilities
Boarding accommodation, janitor quarters, teacher accommodation: physical condition. Agricultural and livestock facilities, areas for planting and for raising animals.

(vi) Inside comfort conditions
Acoustics (noise), thermal (climate), natural lighting, artificial lighting, natural or mechanical ventilation, sun penetration (protection), first aid services, hygiene and cleanliness, safety: comfort conditions (good, average or bad for each item).

(vii) School equipment
Workshops (tools, equipment, etc.), laboratories (installations, equipment, etc.), specialized spaces (furniture, equipment, etc.), physical education facilities (balls, nets, etc.), sound equipment (general), teaching aids (maps, rulers, etc.), and flags: conditions of each item (good, average or bad).

E. School furniture

(i) For students of school age and adults
Chairs, individual tables, double tables, double benches, desks, chair desks (metal or wood), etc.: quantity and condition.

(ii) For teachers
Chairs, tables, desks, etc.: idem.

(iii) General furniture
Moveable chalkboards, shelves, bookcases, filing cabinets, chairs, meeting tables, etc.: idem.

F. Information on teaching and administrative staff

Name, position, level of instruction and grades taught, years of service, degree or diploma.

G. Sketch of school facilities including the entire premises

(Note: Provide inventory-takers with grid paper to facilitate preparing of rough sketches to scale.).

H. Supplementary data

(i) Students (school age and adults) (indicate quantities for each item)
Place of origin: community, vicinity of school, other community.
Travel time: indicate if by foot, bus or other means
Type of transport: governmental or private.

(ii) Teachers (indicate quantities in each item)
Residence: community, vicinity of school, other community.
House: idem., indicate if owned or rented.
Services in teacher's house: idem., indicate the number of bedrooms, living rooms, kitchens and bathrooms.

(iii) The school and its environment
Location: within or outside the community served.
Means of access: street, highway, road, path, river.
Associations organized in the school: parents, teachers, boy/girl scouts, brigades, religious societies.
Maintenance and repairs: communities, parents, teachers, public works, school.
Student absenteeism: cause, time and amount.
Student dropouts: percentage per educational level per grade.

(iv) The community
Type of settlement: age, permanent or temporary.
Approximate population:
Main economic activity:
Services available: drinking water, electricity, telephone, drainage, sewerage systems, postal service, transport.
Natural disasters: type, magnitude and frequency (cyclones, tornadoes, earthquakes, floods, tsunami floods, etc.
Facilities potentially available for education: Churches, theatres, community halls, etc.

(v) Observations.

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