DEVELOPMENT OF A DESIGN EVALUATION TOOL

FOR PRIMARY SCHOOL PROJECTS

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ABSTRACT

Education should play an important role in transforming children into productive adults and members of society. School should be the environment of these transformations as an educational milieu in which children collect data through perception. School should also offer a motivating environment while concepts of three-dimensionality, size, proportion and symbolization develop in the child's mind. Therefore, the spaces in which children are educated have very special importance in their lives.

Contemporary schools should have environmental adaptation, be functionally sufficient, aesthetically attractive and structurally appropriate.

Since August 18'th 1997, new educational measures have been taking such as renovation of Turkish National Education Program and primary school education which have been extended from five years to eight years. This required capacity increase, restoration of existing school buildings and design of new projects.

Development of an evaluation tool for primary school projects has the aim of creating a basis for future primary school projects for both private and national ones. Prevailing school design concepts in U.S.A. and Europe are taken into consideration in the creation of the school design evaluation tool.

ÖZ

Eğitim, çocukları toplumun üyeleri olan üretken yetişkinlere dönüştürmede önemli rol almalıdır. Okul ise eğitim ortamı olarak bu dönüşümlerin gerçekleştiği, çocukların algıları aracılığıyla bilgi topladıkları mekanlardan oluşmalıdır. Çocukta üç boyutluluk, büyüklük, oran ve temsiliyet kavramları gelişirken, okul öğrencilere destekleyici ve bu kavramların öğrenilmesini harekete geçirici bir ortam sunmalıdır. Bu sebeple çocukların eğitim gördükleri mekanlar hayatlarında önemli bir yere sahiptir.

Çağdaş okullar çevre uyumlu, işlevsel olarak yeterli, estetiksel çekiciliği olan ve strüktürel uygunluğa ve dayanıklılığa sahip eğitim mekanlarından oluşmalıdır.

18 Ağustos 1997'de sekiz yıllık zorunlu eğitim yasasının kabul edilmesiyle Türk Milli Eğitim Programı'nda değişiklikler yapılmış, yeni eğitim programları hazırlanmıştır. Bu yasayla ilköğretim süresi sekiz yıla çıkarılmıştır ve bu okullarda kapasite arttırımı, yenileme ve yeni tasarımların yapılmasını gerektirmiştir.

İlkokul tasarımlarını (özel ya de milli eğitim yapılarını) değerlendirebilmek için araç geliştirilmesinin amacı, gelecek tasarımlara yol gösterebilmektirBatılı kaynaklarda yer alan (Amerika ve Avrupa'daki) okul tasarımları ve güncel tasarım konseptleri tasarım değerlendirme aracının oluşturulmasınında göz önünde bulundurulmuştur.

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CHAPTER 1

1. INTRODUCTION

1.1. Definition of the Problem

Education is one of the most important mediums for social transformations and has strong relationships with social, economic, political and cultural structure and heritage of a society. The school environment and spatial structure of school buildings are the fields of these transformations and improvements; furthermore, they have the role of providing the human resource for the prevailing socio-economic system. Thus, special importance should be given by architects to the design and construction of these educational spaces in which, children, future adults of a country, are educated. The first steps to the real world and society are taken in the elementary and primary schools. The aim of the thesis is to create an evaluation tool based on precedent school designs and guides. The tool will be a helping factor at the design phase of these primary school projects.

Educational theories related to social and political change have remarkable repercussions in educational spaces. That is to say, disciplinarian theories bring out disciplinarian spaces where the newly educated can accept the values of the state and the ruling class. Such spaces are readily recognizable by classrooms flanked along the corridor of the floor, spaces with no diversity at all, a large and single gathering space and authoritarian building mass, pale wall paintings... Changes in educational theories and programs turned into a direction (in western countries, gradually after the First, increasingly after the Second World War) where the emphasis is increasingly put on liberal egalitarian education and children are no more the subjects of authoritarian states and classes. Modern democracies produced multivalent spaces full of light and relatively cheaper building technologies and management systems that had been perfected during the Second World War.

There have so far occurred many social, political, economic and technological changes and the modern world has come to face important problems at the end of the twentieth century brought up issues such as the mass consumption and pollution of natural resources, the energy crisis (which had forced researchers to investigate energy sources alternative to oil, such as solar energy) gave birth to a new understanding of building design and production labeled under the banner of “sustainability”. The

concept has soon found reflections in the building design and technologies thus too in the design of schools.

The individualization and the crime rate in western countries as well as the idea of preventing child injuries stressed the importance of 'the defensible space' and security concepts in school design.

Technological developments in communication and the spread of the use of personal computers provided easy access to data (the latter is certainly very important for offices, schools and for other similar spaces). The implementation of these technological devices and systems in buildings required an electrical system design which in turn influenced spatial organizations including furniture design.

The importance given to the education of children taking into consideration of every child as an individual with his/her own personality brought up the need of art and sport spaces in educational facilities. Flexibility in classrooms, laboratories and gathering places provided multivalent spaces that can be modified according to the desired activities and the type of teaching.

Children move from home to society through schools. Therefore the spaces in which they are educated have been very special importance in the course of their lives and the process of their socialization. Although there is not strong evidence concerning the direct effects of a child's spatial perception on his/her learning, much recent research shows that the spatial qualities and organization may be a helping and motivating factor in the learning process.

Psychologist Jean Piaget has proved the effect of behavior on experience as the result of his researches on child psychology. Since birth the child has an environment created by his/her senses. He/she gets the information by these senses which can be relatively different for each individual. Nowadays researchers stress on the fact that there are different kinds of intelligences such as linguistic, logical/mathematical, spatial, musical, kinesthetic and social intelligences instead of one. The mind and the body pass through various stages within the process of development. According to Piaget, between 2 and 6 ages, the child is in the semiotic period and understands constancies of form and size, causalities, imitation, symbols, representation and mental images. The concept of number, space, time and speed develop in the concrete operations phase which is between 6 and 12 ages. Another psychologist Martin Krampen states the concrete operations phase begins from 3 years old (Gür, Şengül Öymen, 2002, p.14). Formal thought, proportion, combination and probability notions, reasoning and abstract

thought develop after 12 years old. Children at these ages spend most of their time in schools. Designers should create school spaces which can help children in the learning phase. The use of three-dimensionality, size, proportion, symbolization concepts in design and creation of both comfortable and secure but also a challenging environment can help primary school students in their learning process.

In conclusion, new economic, social and technical developments have forced countries to re-evaluate their educational programs and models. Changes in the field of education have affected the design of schools, colleges and universities in that the existing ones are no longer appropriate to the new requirements of educational technologies.

The countries of Organization for Economic Co-operation and Development (OECD) have focused on issues such as technology implementation, lifelong education, environmental education, public or private uses of school buildings and safety and security. An OECD member Turkey has developed new strategies in order to ameliorate the quality of educational spaces: renovation of existing school buildings, raising the enrolment rate, increasing spatial capacity with additional classrooms, decreasing per classroom population, enabling teachers and students to computer literate by technology implementation in schools, and teaching foreign languages.

Another change in the Turkish National Education Policy has been the enactment of the Eight-Year Compulsory Education Law, which was published in the Official State Gazette dated 18 August 1997 (Law no: 4306 numbered 23084). By this law, compulsory primary school and lower secondary school were unified. The reasons of this unification were to raise child labor and the betterment of the educational level. This continuous eight-year education gave rise to novel qualitative and quantitative spatial requirements such as the capacity increase by additional classrooms, the decrease of classroom population to 30, passage from double-session to single-session education, the addition of new courses (and their spaces) such as language and computer learning as well as the renovation and construction of spaces for extra curricular activities (such as gymnasiums, art rooms etc.). Active learning atmosphere, utilization of educational technologies and individual/group study concepts require flexible classroom spaces. Furthermore, a general overview at the primary school building stock in Turkey shows that there are some inequalities between private primary and public primary schools as well as between urban and rural ones.

Private schools are designed by architects in the private practice and the owner has few financial problems which influence the material selection, construction techniques and floor areas. Since privately owned primary schools have fewer financial constraints their overall outlay could be designed with more flexibility in terms of their suitability to the physical environment.

Primary school buildings of the Ministry of National Education are classified according to their capacity, climate zones within Turkey and their context (whether urban or rural). In each category there is only one type of school building regardless of the regional climate, microclimate, topography and urban conditions. The reason for this uniform design may be mainly the building costs. However, the inadequacy may also influence effective energy saving and may cause insulation problems, thus, in some cases waste of money. Furthermore, the influence of school conditions on student performance and achievement is an idea generally shared among western researchers.

Although the new school projects of the Ministry of National Education show plan variations, in the third dimension they are more or less similar to the previous ones.
A design evaluation tool can help designers choose the most appropriate school design among different design options and to draw the outline of a school project. The tool, different from standards and codes, serve to identify spatial qualities in the third dimension as well as at the plan base.

1.2 Aim of the Study

The aim of this study is to create a school design evaluation tool, based on precedent designs, construction guides and contemporary primary school building spaces. The tool, unlike a set of standards or a complete construction guide, will just draw outlines of the spatial structure of the contemporary primary school. Thus, the study aims at describing a tool that can stimulate architect's decisions rather than providing answers to precise questions and finally to facilitate selection of one of the design options.

1.3 Method of the Study

This study aims at forming a classification in order to evaluate school design which can be a basis for further designs or for the reconsideration of the building at the design phase. In the latter condition, such classification can help architects or designers analyze and present design options as a tool.

A design tool should facilitate the evaluation by categorizing design principles and qualities of the subject.

Design qualities of primary school space are analyzed under the heading "Approaches to Design Criteria" in four main categories: Site and Natural Factors, Functional Requirements, Design Factors and Structural System.

- Environmental conditions of a school building as natural and factors are categorized in 'Site Factors'. In 'Natural Factors', solar orientation, vegetation and climatic differences are analyzed in order to create a tool for efficient heat control. Solar orientation, topography, vegetation and structures are taken up as climate modifiers such as sun and wind 'barriers' and 'filters'. The barrier and filter function of the 'building envelope' in the urban structure is also studied in 'Site Factors'.
- School organization schemes are dealt with according to qualitative design concepts in relation with the concepts of flexibility, accessibility, defensible space, etc. Quantitative concepts are based on the United States and Turkish Ministry of National Education Handbook (1997).
- 'Design Factors' are analyzed as topological relations such as proximity, similarity, enclosure, continuity, etc. deriving from 'Gestalt Rules'. Typology of school organizations are based on Western and Turkish school types. Design concepts such as legibility, orientation and other defining aspects of the character of the architectural space are investigated.
- In 'Structural and Mechanical Systems' structure and material use and properties are discussed. Mechanical systems and their implementation in schools according to the Turkish Ministry of National Education and U.S.A. design standards. Furthermore building envelope design as filter and barrier to environmental conditions and controlled climate system design are studied.

1.4 Definitions

Keywords

Learning, perception, architectural milieu /medium, child perception, education, educational space, educational building, design evaluation tool.

Learning, in classic psychology, is taken to comprise all the processes from birth to grave by which an individual modifies her behavior and her attitude of mind as a result of experience. Jean Piaget changed this definition by claiming that learning is also the modification in experience as the result of behavior. The revolutionary idea of Piaget is that the mind never copies reality, but regulates it. Piaget classifies the development of the mind in four phases: The first phase according to is the sensory-motor phase which is comprised of the construction of reality, initial perceptions and object relations and it takes place between 0-2 ages. Second is the phase of the development of perception and the semiotic/symbolic function, language and imitation. This phase occurs between ages 2-6, and involves constancies of form and size, causalities, imitation, symbols, representation and mental images. Third comes the phase of concrete operations, which means the child is between 6 and 12 ages and understands notions of conservation, seriating, classification, and the concepts of number, space, time and speed. The socialization phase begins and moral feelings and judgments develop. Fourth, the child at 12 years old and above, is the phase of formal operations, which means that formal thought and the notions of proportion, combination and probability, reasoning and abstract thought develop (Source: Evans, 1999).

In the recent studies conducted in the United States, these age groups have been designated such as early childhood (ages 3-5), middle childhood (ages 6-9), late childhood (ages 9-11), early adolescence (ages 12-14) and late adolescence (ages 15-18). Each age group has its own physical, emotional, social and linguistic characteristics (Building Type Basics for Elementary and Secondary Schools, Bradford Perkins, 2001).

Since Piaget generated his taxonomy on the mental phases of the development of a child, scientists and researchers have classified the human intelligence in seven different forms such as linguistic, logical-mathematical, spatial, musical, bodily-kinesthetic, interpersonal “the socializer” and “the individual” intelligence. Each type is considered to have special learning ways. These new theories are based on the principle of development of the individual which have affected the western educational space designs. These different learning ways were the focus of these theories.

Perception plays an important role in the process of learning by mediating between the real world and our understanding and thereby offering us information to act in an appropriate way.

It creates a relationship between the world of objects and the mind. However, each person orients him or herself toward the same things or objects. As Christian Norberg-Schulz pointed out in his work Intentions in Architecture this may be called 'attitude', indicating a special orientation to the world of objects varying according to individual character.

Perception may further be defined as the interpretation of stimuli, as a cerebral rather than a sensory process. Especially after the information revolution, in the developed countries, in daily life, people are bombarded by all kinds of stimuli from the environment, received by various senses (such as the eyes, ears, sensory receptors of the skin, and the proprioceptors in the muscles) which are processed by the brain. The study of how humans process information about their environment and themselves has been an active area of research in psychology for over 100 years (Sanders and McCormick, 1992).

Ergonomy deals with the physical and psychological effects of the environment on human comfort or work. Since the 1960s ergonomists have accelerated research on the information theory which is used to determine the information processing capacity of the different human sensory channels and was also employed extensively in problems of choice reaction time. The information types can be categorized as qualitative and quantitative information, status information, warning and signal information, representational, identification, alphanumeric and symbolic information, time phased information. (Sanders and McCormick, 1992)

"Display is a term that applies to virtually any indirect method of presenting information, such as a highway traffic sign, a family radio, or a page of braille print" (Sanders and McCormick, p.51) Information is considered to be transmitted by display presentations: temperature, speed, approximate value, trend, rate of change, or other aspect of some changeable variable, on-off indications, stop-caution-go lights, indications of emergency or unsafe conditions, pictorial or graphic representation of objects, areas or other configurations, dynamic images such as TV. or movies or symbolic representations such as heartbeats shown on oscilloscope, static information such as photographs, maps, charts, diagrams, and blue-print and graphic representation such as bar-graphs and line graphs, color coding, verbal, numeric information such as

signs, labels, placards, instructions, music notes, printed and typed material including braille and computer printouts, time phased signals (i.e., signals of controlled duration).

An ergonomically correct visual display must be clearly visible and the design must be so that it helps the viewer correctly perceive the meaning of the display.

These aspects of information can help a given architectural space become a communicational milieu as well as help the learning process in school spaces.

Architectural space may be distinguished in relation to two kinds of uses; space as three-dimensional geometry and space as perceptual field. Concrete space consists of a series of abstractions from the intuitive three-dimensional totality of everyday experience. In order to define space in concrete qualitative terms, S.Gideon uses the distinction between "outside" and "inside" as the basis for a grand view of architectural history. Kevin Lynch penetrates into the structure of concrete space, introducing the concepts of "node" (landmark), "path", "edge", and "district" which form the basis of man's orientation in space, Paolo Porthogesi implies that the concept of space has its roots in concrete situations, even though spaces may be described by means of mathematics. The **indoor-outdoor relation,** which is a primary aspect of concrete space, implies that spaces possess a varying degree of extension and enclosure which in a wider context becomes a center, which in turn may function as a **"focal point"** for its surroundings. From the center space extends with varying **degree of continuity (rhythm)** in different directions. **Centralization, direction and rhythm** are therefore other important properties of concrete space and natural elements (such as hills) and settlements may be clustered or grouped with varying degree of **proximity.**

An architectural **"milieu"** or medium consists of the physical and social conditions which accompanies the human being. In other words it is a part of the space defined by architectural elements that one can feel, understand and judge by means of perception.

Designing an architectural milieu for children such as **an educational space** puts at the first place the importance of the child's perception of space. The final product can only be an educational building instead of an organization of educational spaces. There we may ask the question 'Can a school space teach?' Not as directly as a teacher perhaps, a book, a blackboard or a screen, but the accelerating side of perception is undeniable.

Architecture is the art of designing and constructing spaces and its product cannot be only a shelter of brick, stone or steel. It must rather constitute a space suitable to the individuals who will use it, thus suitable to students for use as an educational space.

An educational building is the concretization of educational methods and programs regulated and controlled by the state as well as a transformation or transition space from home to society, producing individuals who will join the whole system of a country.

Educational programs define the building requirements such as spatial varieties, concepts, dimensions, hierarchies etc.

In his book 'Architecture of Schools' Mark Dudek defines the school as an institution which is intended to nurture, care for and educate children within the framework of structured age-related class groups. There are many physical and psychological differences between infants, children between ages 7 and 11 and children between ages 11 and 15. Therefore, classrooms may be designed differently for each of these age groups such as an home-like environment especially for infants. Entrances even buildings may be designed separately in a campus. Shared facilities may be commonly used by all age groups. In western countries, special importance is given in educational programs to small group facilities which necessitate the design of flexible classrooms or niches and small rooms opening to the main classroom space.

Turkish National Education Program is being transformed to a program structured around self development of the child by intensification of art, sport and laboratory activities. These activities require spaces designed according to universal standards so as to obtain an educational quality:

In the UK, mathematic and language lessons require small group studies and one-to-one conversations between students or teacher and students. Drama and media education require larger dedicated spaces, acoustical problems may cause hearing problems thus learning difficulties and should be solved architecturally. A variety of books should be available within the classrooms and reading niches off the main classroom enabling better concentration and audibility. Using acoustic and visual separation screens may serve also small group and individual studies (Dudek, 2000).

"**A design guide** is a blanket agreement about fundamental programmatic requirements for a building type. The design guide identifies the basic ranges for

considerations such as the sizes of spaces and the quality of materials. A design guide is also an educational and reference tool for the project team."

'A design evaluation tool" contains detailed descriptions of required building attribute data and how they should be collected, instructions for testing to evaluate the building performance, and conformity with to applicable standards and for collecting user surveys. The evaluation tool can be applied on a building in order to create a new design guide based on the critical review of precedent design guides and standards.

CHAPTER 2

2. GENERAL LOOK ON EDUCATIONAL SPACES

2.1 An Overview of the Historical Development of Turkish National Education during the Republican Period

After the establishment of the Turkish Republic, in the field of education, new principles of social understanding were formulated. The goal was to draw a contemporary route leading to the traditional social structure through education.

The four steps of the development categories may be listed as in the follows:

1. Unifying Education

Prior to the foundation of the Republic there were three types of school; first, district schools based on Arabic, Koran and memorization, second, reformist schools of 'Tanzimat' called as 'idadi' and 'sultani' and third schools educating in foreign language like minority schools.

After the Act of the Unity of the National Education No: 430 put into force on 3 March 1924 the first type of school were closed, the second ones were developed and the third were brought under the jurisdiction of the Ministry of National Education. **Democratization** and **secularism** were the main goals of this act.

2. Organization of the Educational System

The Act of the Organization of Education dated 22 March 1926 numbered 789 is considered one of the most important legal arrangements. Thereby, the Ministry acquired absolute supervisionary power over the educational system.

The Act arranged primary-education schools were arranged as provincial, district and village schools classified as daytime or boarding. Secondary-education schools were arranged as **high schools, secondary education schools** and teacher schools.

In order to extend and develop, and 'save', the Turkish language from the influence of other languages, a **"Language Commission"** was established within the Ministry of Education.

3. Studies on the Quality of Education

Following upon the Education Convention of July 1921, the First Science Board was held in July 1923. Sixteen "National Education Summit" were held, with the first convening in 1934, the last in 1999.

*In July 1923, the term of primary education was increased to 6 years. Children were not accepted at foreign schools.

*In April 1924 the primary education was decreased to 5 years

*In 1949 Examination of primary school programs, History-Geography-Citizenship education in primary schools

*In 1981 re-unification of educational system focusing on vocational and technical education at all levels of education based on focusing more on teaching of Turkish language.

*In 1988 New technologies in education, teaching and education of Turkish and foreign languages, financing of education.

*In 1997 Compulsory Eight Year Education Law

*In 1999 Vocational and technical education

4. Extending the education

In order to increase the literacy rate and to establish unity of language centered on the Turkish Language. The Latin based alphabet was adopted and accepted on 1 November 1928 with Law no: 1353. The National Society for History and The National Society for Turkish Language were established in 1931 and in 1932. (T. C. Milli Eğitim Bakanlığı, 2001, http://meb.gov.tr)

Several attempts have been made to develop the Turkish National Education system, however many political, social and economic depressions Turkey has undergone a strong educational revolution especially in educational spaces.

Unifications in National Education produced programs and spaces for only one type of student. Moreover the quality difference between national and private schools contradicts with the equality concept. In order to change this situation, in the recent years, Ministry of National Education has been doing studies on new development plans, technology implementation and standards.

2.2 New Targets of Basic Educational Program

Basic education provides quality in education for each individual regardless of his/her age within formal or non-formal education system. (T. C. Milli Eğitim Bakanlığı, 2001, http://meb.gov.tr)

Targets of Basic Education Program:

- Raising the enrolment ratio in primary education to 100%; preschool education to16%
- Increasing the capacity of schools through additional classrooms
- Decreasing student population per classroom to 30
- Decreasing multi-grade implementation and double-session education
- Making the teachers and students computer literate
- Providing bussing in primary education where necessary
- Enabling each student to acquire at least one foreign language
- Providing continuous in-service training to teachers, inspectors, and educational managers

(T. C. Milli Eğitim Bakanlığı, 2001, http://meb.gov.tr)

New concepts of education:

Active learning atmosphere and continuously improved teaching program teaching the student how to think and how to use and generate knowledge.

-Utilization of educational technologies and equipment: Computer, slides, overhead projector assisting active learning, and experiment tools the globe and human skeleton models, as well as hands-on use of various measurement tools.

-Active participation through student-teacher cooperation

-Group Studies: Individual and group study projects based on learning, such as through design projects in science, social and visual art fields, evaluation of learning activities under the supervision of the teacher; Increasingly rational use of time rationally and increased student activeness in the learning process.

-An award system for students at sports, cultural activities, and academic success.

-Open Area Learning and Experimentation: Free activities and program for integration with the environment program includes observation, investigation and research tours, camps, excursions in the natural environment, using maps in the field, observing the growth of plants and animals which will help students acquire ability to observe and consciousness of environment.

-Benefit from society:

This program includes group or individual interviews by students, discussions, tours, observations, and public-opinion activities that will be effective in the development of personality, bring meaning to learning and help the students to socialize.

-Utilization of games and simulations in the classroom:

By use of information technology and teaching materials developed in class, shows illustrating lives, various games and performances may be organized.

-Integration of art and cultural activities with education programs:

In order to develop the aesthetic understanding of students, fine arts will not be only part of drawing and music lessons, but also be incorporated in other lessons and in free time as well.

(T. C. Milli Eğitim Bakanlığı, 2001, http://meb.gov.tr)

This plan and its programs are revolutionary indeed. However, they call for educational spaces appropriate to them. Active learning, group studies, technology implementation and development of personal skills require attractive, flexible, ergonomic, and effective design.

2.2.1 International Projects That Turkey Has Involved In

Turkey is participant in educational, scientific and cultural collaboration pacts with 71 other countries and work concerning these agreements continues. Currently, works on six projects continued by Educational Committees of member countries of the European Council:

European Council Cultural Cooperation Committee's program was accomplished in 1993. The Southeast Mediterranean Project (SEMEP), which aims acquiring environmental consciousness. World Inheritance in Young Hands Project and UNESCO Sister Schools Project and Globe Program are other programs that Turkey has involved.

The Ministry of National Education also participates actively in the Organization for Economic Cooperation and Development **(OECD)** (and of which Turkey is a member), Education Committee and the activities of the Center for Educational Research and Innovation **(CERI)**:

OECD and CERI created the comparative educational system indices according Indicators of Education Systems **(INES)** which, among other things, enables the evaluation of the educational system by obtaining student success data; the evaluation of the educational system from the point of view of business market; and **creation of a**

school environment and school process indices and evaluating educational input and output are aimed.

2.3 Trends in School Planning and Design in the World

"Traditional classroom design, with its rigidly arranged seating, high-silled windows on the left, and authoritarian location of the teacher was based on several assumptions: That all students were right-handed. The daylight beamed on just few rows was enough for the whole room. That neither teacher nor students should ever move into groups, or change location. That teacher-to-student lectures, recitations, and at-desk study were the sole activities in the classroom. That the world around the classroom had nothing to teach student… Today's classroom design (should be) based on other principles, most basic which is flexibility-flexibility to keep pace with changing concepts of education's role in society, and of the teacher's role in the learning process. Also the classroom must reflect the teaching methods of the school; it must be an efficient tool and a suitable atmosphere for education, regardless of the educational approaches used" (Perkins 2001, p.99)

In 1950s and 1960s, the western world had started developing a novel kind of educational consciousness. Studies in child psychology, critical reviews of educational theories and spaces had prepared a basis for modern conceptions.

Educational researches have been realizing in a continuous process, because the present is the one of rapidly accelerating social, economic and technical changes. Many aspects of change in the field of education have affected the design of schools, colleges, and universities. Existing educational buildings and tried and tested approaches for new buildings proved to be no longer appropriate to the emergent needs.

In order to find solutions to the new demands, several design factors were given priority.

OECD (The Organization for Economic Co-operation and Development) has stated school design criteria as follows:

1) Schools should provide an environment that will support and enhance the learning process, encourage innovation and be a tool for learning.
2) Educational facilities should seek to minimize running and maintenance costs:

   Projects with clean simple lines, clad with durable materials are likely to have lower long-term maintenance costs.

3) Environmental education can be supported by a school site linked to surrounding parks and playing fields, becoming an extension of the public open space available to the community
4) Variety of course options in educational programs generates a wider range of group sizes and type of teaching spaces.
5) Creating projects involving public/private partnership
6) Put emphasis on historic and cultural importance
7) Improved access and circulation routes making the building more accessible and easier to use and improving safety and security.

   "One aspect of security which is of increasing concern in some locations is that theft and the threat of attack or abduction by intruders. The use of the buildings themselves to enclose secure and protected areas, such as the internal courtyards, glass-roofed atria and internal streets" (OECD, 2001, p.12)

Design factors that influence most schools:

- Making the school an inviting place for children and adolescents
- Making the school work as a community center
- Technology implementation
- Energy conservation
- Sustainability
- Security and defensible space design
- Flexibility
- Classroom design and school sizes
- Storage
- Regional Influences

CHAPTER 3

3. APPROACHES TO DESIGN CRITERIA

3.1 Site and Natural Factors

From the early ages of history, humans have strived to regulate and control the intensity of their relationship with the environment; to protect themselves from nature, (climatic conditions, animals, enemies...) but they have also desired to communicate with others, to be a part of a cultural structure.

The architecture uses its elements to form physically and socially comfortable and secure spaces for man. This spatial environment is a part of a larger system constituted from the nature, network of houses, city... including physical-functional and social-cultural relations.

Physical control is one of the most measurable aspects of the regulations because any relational concept can correspond to an architectural element.

The control or exchange of energies between the building and its surroundings can influence the expansion of walls and usage of insulating elements.

"An opaque wall thus serves as a filter to heat and cold and as a 'barrier' to light. Doors and windows have the character of 'switches', because they can stop or connect at will. In general we define a connector, as a means to establish a direct physical connection, a 'filter' as a means to make the connection indirect (controlled), a 'switch' as a regulating connector, and a barrier as a separating element...The structural properties of the dimension physical control are thus described in terms of elements and relations. The elements are 'energies' (existing and desired) the relations 'filters which transform the existing energies into desired ones" (Norberg-Schulz, 1997, p.113)

3.1.1 Natural Factors

Natural factors can be considered as climate, topography and vegetation. These factors are closely related when they become physical conditions which have to be controlled for user comfort.

Architectural space elements such as ceiling and wall behave as boundaries between natural 'energies' and indoor conditions having barrier or filter character.

Solar orientation or solar access is part of energy conserving design. The position or location of the building on a given site can influence the amount of artificial lighting required, the potential solar heat gain, the ability to use natural ventilation, and other factors. Topography and vegetation can also be used as barriers or filters for energy transformation.

Creating a microclimate especially around a school building is very important for its users, thus children.

More than one microclimate design according to different 'regional climates' such as cold, temperate, hot humid and hot arid regions are among factors to be considered. Each region represents a bio-climate, in other words four different temperature and humidity conditions.

(Harris and Dines, 1998, p.220-6)

Cold Regions:

Characterized by (>10-20C/50-60F) in summers, and very cold winters (<0C/32F). Annual precipitation is typically low. Region is subject to extreme freezing/thawing action. Site planning and design should seek to control winter winds, and promote solar gain and storage. (Fig.3.1 (a))

Temperate Regions:

Characterized by hot, often humid, summers (>20/68F) and cold winters (<0C/32F). Annual precipitation is fairly high. The region is subject to repetitive freezing/thawing action, and significant seasonal temperature fluctuations are common. Site planning and design should seek to promote shade and evaporative cooling in warm periods, and block winds and promote heat gain in cool periods. (Harris and Dines, 1998, p.220-6)

Hot Humid Regions:

Characterized by hot summer temperatures (>20C/68F) and mild to cool winters (>0C/32F). Annual precipitation and humidity are high with frequent rain showers. Freezing temperatures are uncommon.

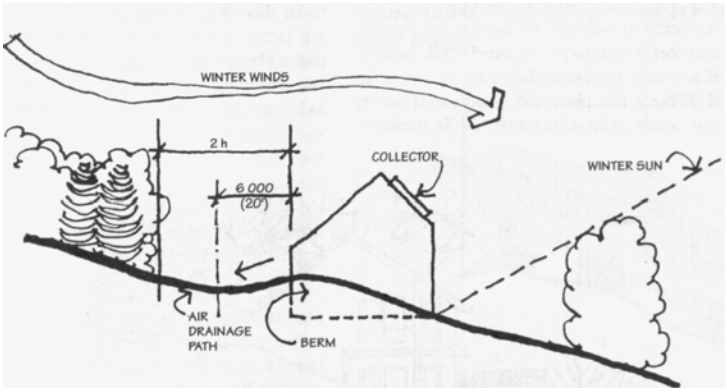
Site planning and design should seek to increase shade, cooling from evaporation and breezes. (Fig.3.1. (b))

Hot Arid Regions:

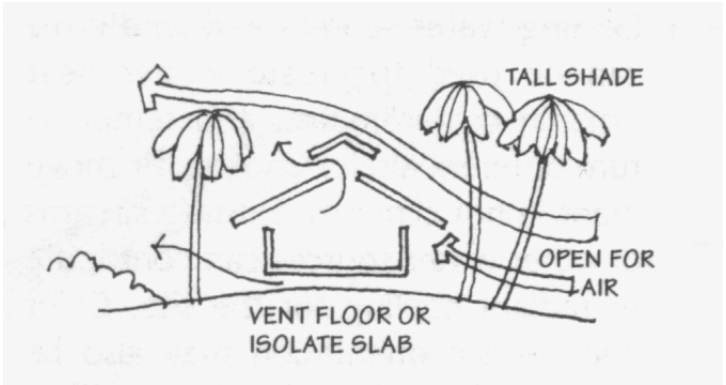
Characterized by dry, hot summer temperatures (>20C/68F) and mild to cool winters (>0C/32F)

Site planning and design should seek to balance daily temperature extremes by storing energy, increasing humidity and diverting desiccating winds. (Fig.1 (c))

(Harris and Dines, 1998, p.220-6)



(a)



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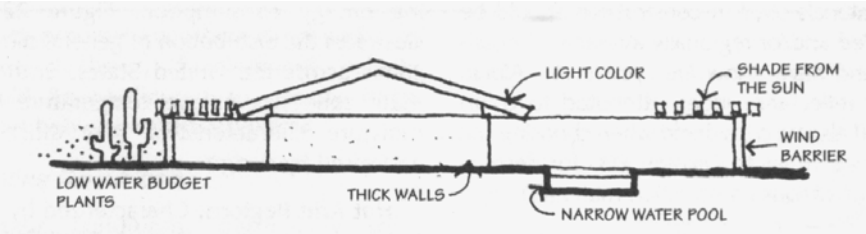


(c)

Fig.3.1. *(a) General site design strategies for hot arid regions-(b) General site design strategies for hot humid regions-(c) General site design strategies for hot arid regions (Source: Harris and Dines, 1998, p.220-6)*

3.1.1.1. Topography:

Topography as climate modifier:

- In Hot Arid Regions, the school building should be sited at the top of slopes for exposure to cold air flows at nights.
- In Hot Humid Regions the building should be sited at top of slopes for exposure to breezes.

  -Site should not be situated next to sea or lake. Evaporation is a factor that should be avoided in humid regions.
- In Temperate Regions the building should be sited on southerly slopes for solar gain in winter.

  -sited on middle to upper slope for access to light winds, but protection from high winds.

  -landforms, plants, and structures can be used to divert northerly winter winds while allowing cooling summer breezes.

  -use earth shelters to protect from winter winds.
- In Cold Regions the building should be on southerly slopes for solar gain in winter.

  -Steeper slopes have better solar access.

  -Topographic depressions that collect cold air should be avoided.

  -Earth shelters can be used to protect the school building from winter winds.

3.1.1.2 Vegetation

Vegetation is a good sun and noise barrier or filter. Furthermore, indoor-outdoor transitions can be softened by vegetation.

Existing vegetation may be used to moderate weather conditions and provide protection for native wildlife. Vegetation can be used to provide shade and transpiration in summer and wind protection in winter.

- Vegetation as wind barrier: especially in hot regions, vegetation can be used to block hot winds. In Hot Humid Regions breezes can be maximized through the use of high canopy trees or vegetation can protect from winter winds.
- Vegetation as sun barrier: in hot and temperate regions, trees provide shade in summers, especially in afternoons.
- Play areas should be shaded by trees
- Vegetation can be used as open space boundary in order to give sense of enclosure to a variety of spaces.
- Vegetation can be used as separation element between play and pedestrian areas and traffic flow

3.1.1.3 Solar orientation

The siting of the building according to solar orientation can influence the amount of artificial lighting required, the potential solar heat gain, the ability to use natural ventilation, and other factors.

The building should be oriented so as to take advantage of solar energy for passive and active solar systems. The building should take advantage of shade and airflows for cooling in summer, and of passive solar energy for heating and wind protection in winter.

The solar orientation can also influence also the organization of spaces in all four directions North, East, West and South.

If solar collectors or photovoltaic systems are proposed, orientation should allow maximum access to sunlight. (Harris and Dines, 1990, p.220-5)

- building entrances

The entrances should not be located on a windy side.

The entrance should be well shaded and be located in a supervisible and controllable area.

- location of study areas and service areas

Service areas can be at NE and NW of the building in order to protect other parts from winter winds.

Study areas should be at S, SE areas in order to protect these spaces from afternoon sun and to allow for classrooms opening toward southern gardens (outdoor class especially for elementary and lower classes).

- location of ceremonial area

The ceremonial space should be protected from the western sun. The afternoon shade can be provided by building mass.

3.1.1.4. Structures and building design as climate modifier

- Shelters should provide shade especially in hot areas.
- In hot regions, large area of exposed glass on 'space boundaries' such as walls, should be avoided.
- In Hot Regions access roads, planting, grading, and auxiliary structures should be designed so as to channel wind toward main buildings for cooling, or in Cold Regions away from them to reduce heat loss (Harris and Dines, 1998, p.220-5).
- Solar heat gain through uninsulated building roofs is an important cause of overheating. Especially in developing countries, where cost-effective but thermally efficient building concepts are needed, heat gain is an exceedingly important consideration..
- In hot countries, roof insulation is an important first step in combating overheating. Parts of the building which are exposed to direct sunlight can be painted bright colors to reflect solar energy.
- Rectangular shaped buildings can be constructed with their long walls facing north and south. In the summer, the sun shines on the shorter walls in the morning and evening, and on the roof during the day. This minimizes the degree of heating of the building by the sun. Contrarily in the winter, when the sun is

low in the sky, the long walls and roof are exposed to the sun during the day which helps warm the building (Bridger, 1995, p.224).

- Large windows may cause fast heat loss and gain.
- The heat transfer properties of building materials vary considerably depending on their mass. Lightweight materials store very little heat themselves. Heat transfer through them depends on their thermal conductivities and the temperature differential across them. Heavyweight materials have greater ability to store heat; heat gained during the day warms the material itself before being transferred to the air inside the building. Similarly at night, heat is lost from the building materials themselves and the interior of the building remains warmer for a longer period of time. This is called 'flywheel effect' because heavy materials act like a flywheel to smooth out the effects on the indoor climate of daily variations in external temperature (Bridger, 1995, p.244).

3.1.2 Site Factors

3.1.2.1. Site accessibility

- Bus-stops and service-bus drop-off areas should be as near the student entrance of the school building as possible. (Fig.3.2.)
- Traffic roads around the site should be wide enough so as to be capable to respond heavy traffic flow in peak times especially for service bus access.
- Pedestrian access to the school site should be easy and secure (i.e. traffic signs).

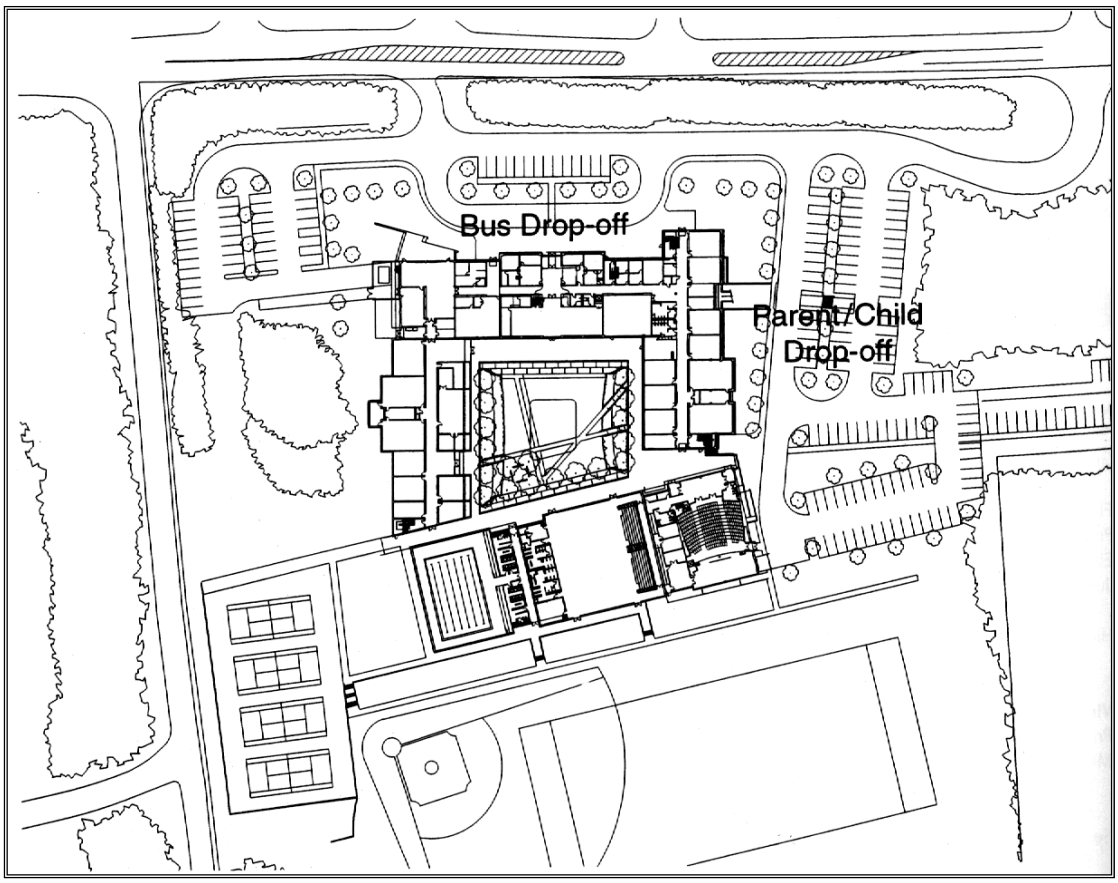


Fig.3.2 *Shows a school site with appropriate parking and bus drop-off areas and play fields are legible in the plan. (Source: Perkins, 2001, p.102)*

3.1.2.2. Site Limitations

Building location in urban context may cause limitation in building expansion. In a limited urban area, circulation and structure develop vertically. However, other school buildings in large areas may be expanded and designed with semi-open and open areas. In schools designed as separate buildings, for example in an educational campus, the organization allows children to move from building to building throughout the day. In this case elementary, primary and middle school, a student center building housing the gym, cafeteria, auditorium and other parts may be designed as separate buildings.

The campus type also allows children to interact with the natural environment. (vegetation design)

- The appreciation of the site limitation is important for the quality of design regardless of it is a large or small site.

3.1.2.3 Noise

Especially in an urban environment if the site is situated beside heavy vehicle traffic flow the noise is a remarkably disturbing factor.

- Vegetation can be used as noise barrier.
- Walls also can be used as noise barrier.
- Organization of different function-spaces from the less-private to the most private beginning from the noisy area.

3.1.2.4. Air Pollution

Urban environment and smoke caused by vehicles and industrial complexes may cause air pollution disturbance:

- Site selection should be made carefully.
- In air-polluted areas building design should be introverted or compact.
- Vegetation can filtrate smoke.

3.1.2.5. Security

- Separation of vehicle and pedestrian ways:

Walking routes of children must be clear of the vehicular circulation area and also from bus drop-off and parking areas.

- Roads must be wide and long enough for access by emergency vehicles especially during peak traffic.

3.2 Functional Requirements

Any human action needs space. Architectural spaces are made for specific actions. Each space has its own role in the functional structure. Minimum space requirements for human actions are measurable, which means that functions determine size of spaces.

"Form follows function" is one of the famous rules of Modern Architecture, but today's architecture is less strict about the concept that form is closely related to function. However we cannot deny that formal organizations determine the appropriateness of the functional frame to building program for example if the program dictates some spaces should be closely related, the formal grouping or sub-grouping can be chosen accordingly.

The architectural theorist Christian Norberg-Schulz enumerates these formal concepts as 'rows' (series), 'clusters' and 'groups' as action-structures.

"(…) In the first case (rows) the actions follow each other in linear successions…Clustered actions, instead, are actions which have to take place close to each other without necessarily having defined interrelations (…)The term 'grouped functions', finally, designates an organization where the character and position of each element is precisely determined." (Norberg-Schulz, 1997, p.116)

These action-structures may be combined in numerous ways according to different concepts such as flexibility, accessibility, security as qualitative aspects.

Functional continuity is one of the most important aspects of functional requirements. The functional frame should be considered with inside-outside (building-surroundings) relations in this continuity concept.

3.2.1 Qualitative Requirements

3.2.1.1. Flexibility and allowance for growth

School designs should be adaptable and allow growth and contraction in future enrollment as well as on changes in average class size and technology, teaching concepts, curricula and other issues that will require significant adaptation. For instance, flexible classrooms are suitable if larger group studies are in the educational program. The concept of the flexible open-plan has been known since the 1960s, as it was developed against reflections of traditional teaching approaches.

Primary school designs in Turkey are in urgent need of the qualities flexibility and adaptability, which will cohere with the new educational policies. The Eight Year Educational Law dictated capacity increase in primary schools. Furthermore, the Ministry of National Education educational programs confirm the need for technology implementation in schools.

- Plans that facilitate the combination of spaces
- Circulation patterns and site planning that allow for future additions
- Technology distribution that facilitates replacements and expansion
- Increased use of demountable partitions to permit reconfiguration of space (such as demountable and mobile partition walls)

- Mechanical and electrical distribution designs that can easily accommodate changes in the partition layout (changeable/removable floor material, lighting, acoustics, heating and ventilation.) (Perkins, 2001).

3.2.1.2. Security as defensible space

Defensible space design gives priority to the elimination of spaces that are not visible by supervisors or teachers. It furthermore requires functional locks and other services to discourage opportunistic crime and vandalism. In some particularly difficult areas, schools have to be designed so as to provide a safe island (Perkins, 2001).

- Visibility/ Surveillance

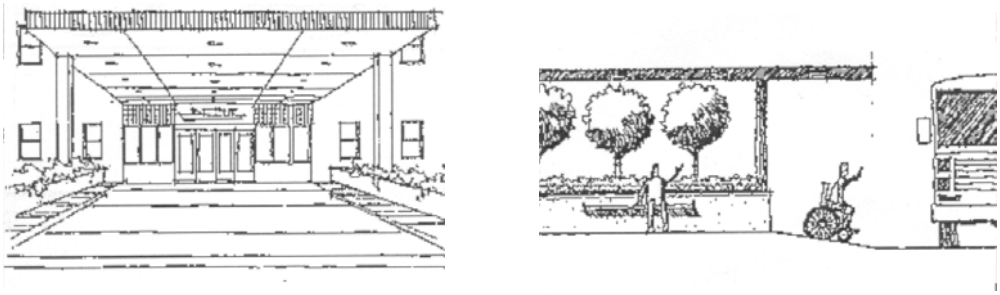
-The main point of entry should be easily visible from the administration area; hence sufficient windows and glazed doors should be provided.

-The main entry and administration should be designed in a combination so school entries, stairs, and hallways can be supervised.

- Sheltered entry and outdoor design

-The entry space should be easily accessible, well lit, and sheltered (Fig.3.3. (a)).

-The entry area should have a paved, non-slip surface and be sloped to connecting drives and sidewalks for handicapped accessibility (Fig.3.3. (b)).



(a) *(b)*

Fig.3.3. *(a) Figures of sheltered school entry (b) with seating places and handicapped accessibility.*

(The Florida Center for Community Design+Research, 1993, http://www.fccdr.usf.edu)

-There should be seating areas on either side especially at the prime bus loading zone.

-Multiple sets of doors to create vestibules can help reduce heat and air loss, as well as increase security.

- Circulation paths

-A door opening on a corridor can obstruct the circulation path

-90 degree corners allow people to hide and cause others run into each other. Chamfered corners allow better visibility as well as smoother pedestrian traffic flow. (Fig.3.4. (b))

-If door niches are provided, they should also be chamfered to allow a smooth passage from classrooms to the circulation path.

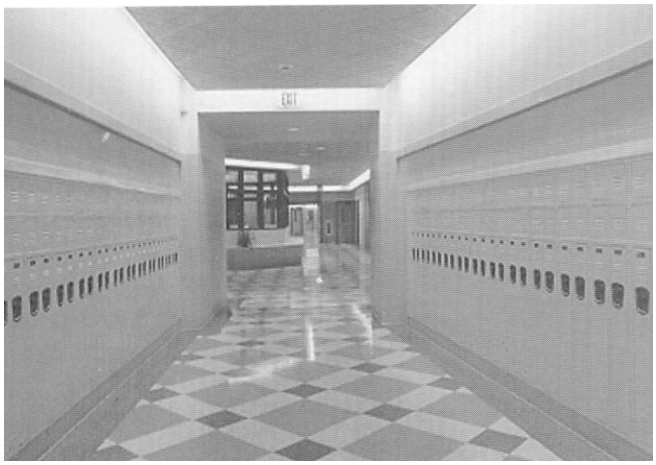
-Main stairs must be wide enough and well lit with adequate foot-candles of illumination.

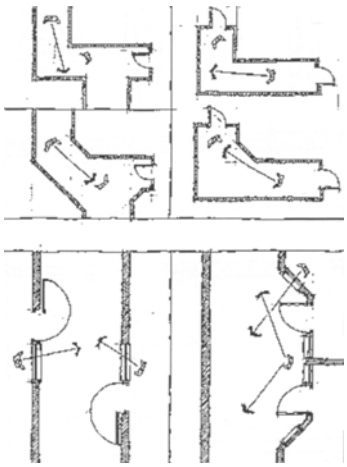
-Solid handrails create hiding places on stairs and landing areas. Open handrails allow visual access to immediate areas on both sides of the stairwells. Handrails should be designed to discourage people from sliding on them.

-Riser and step dimensions should be adequate and the area under all stairs should be inaccessible for any use (Fig.3.5.).

-School corridors should be wide enough to allow students to evacuate the building quickly.

-Obstacles on corridors such as water coolers, vending machines, trash containers, and lockers should be low profile or flush with the wall (Fig.3.4. (a)).





(a) *(b)*

Fig.3.4. *(a) Lockers along corridors (Perkins, 2001, p.181) – (b) Betterment of visibility by chamfered corners and through windows (The Florida Center for Community Design, 1993, http://www.fccdr.usf.edu)*

Fig.3.5. *Security precautions of stairwell along handrails in Fairley House School Pimlico, London, UK (Source: Jestico + Whilo, Educational Spaces, 1998, p.14)*

- Durability of materials

-The use of hinges with non-removable pins and strike plate covers on doors reduce the potential for forced break-ins. Wire-glass openings should be used for visibility.
-Materials should be durable to repeated cleaning and graffiti. Markings and game lines can be provided beforehand so that children will not be tempted to make their own.

- Crime prevention

-Accessibility both to the roof and in to the school from entry points of the roof should be minimized. Solid or fixed light diffusers can prevent entries from skylights.
-While designing windows, prevention from thefts and providing daylight should not be forgotten. As a solution, glass block and clerestory windows can be used together.
-Larger windows divided into small panes allow natural day lighting and ventilation and make forced entry difficult (Fig.3.6.).

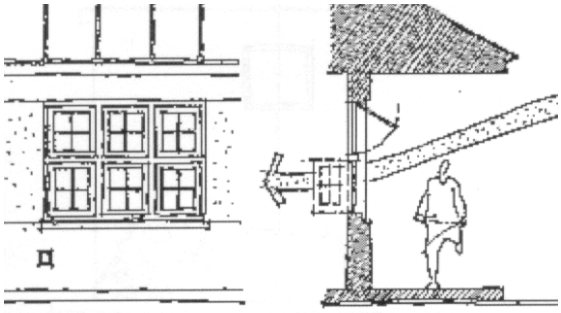


Fig.3.6. *"Larger window assemblies divided into small (25,4cmx30.48cm) panes allow natural daylighting and ventilation and make it difficult for after hours forced entry" (The Florida Center for Community Design+Research, 1993, http://fccdr.usf.edu)*

-Narrow windows around doors or sidelights increase safety by allowing a person to see what is on the other side of the door and allow teachers to keep an eye on.

-Exterior walls should be unclimbable in increased security conditions.

-Circulation paths at the ground floor should allow closing to outsiders by barrier elements (Fig.3.7.).

Fig.3.7. *Middle school prototype, Broward County Florida: As transparent security element, ,grills are used between indoor and outdoor circulation paths. If the grills are removed the school is open.*
(Source: Perkins, 2001, p.190)

3.2.1.3. Accessibility of spaces

Internal circulation design indicates distances and vertical and horizontal distribution and the hierarchy of spaces in the building. Direct access, school size, cost, and natural light are the other influencing factors in circulation design. (Perkins, 2001)

* Centralization and sub-grouping minimizes travel distances:

-In ‘Centralized resources with double-loaded classroom wings’ plan type

The essence of this concept is the centralization of all shared resources, from auditorium and gymnasium to school administration. Centralization of these functions minimizes travel distances. In this type, the common spaces become a visual centerpiece.

-In ‘Centralized resources with single-loaded classroom wings’ type plan:

This configuration allows for visual differentiation of corridors and increased opportunity for sub-grouping of classroom areas.

-In ‘Spine with double loaded classroom wings’ type plan:

In this model, double-loaded classroom wings are organized perpendicular to the main corridor spine. This model allows the designer to form subgroups of classrooms and outdoor spaces for quiet courtyards, play areas.

Subgroups minimize travel distances and provide security for lower class students.

-Another sub-grouped classroom model is ‘Centralized resources with classroom clustering’. According to this concept a small number of classrooms are formed around central nodes. These nodes are programmed for functions that are shared by the surrounding classrooms. The cluster model enables forming sub-groups of classrooms allowing special group studies and the nodes which can include such program elements as faculty offices, tutorial rooms, project areas, and other essential functions such as toilet rooms and stairs.

-The centralized part may also consist of courtyards. This is a type generally used in large school buildings in the city. The number of courtyards with single or double loaded classroom wings is one or more due to requirements of the building. The circulation is provided by vertical circulation nodes and horizontally around the courtyard which shortens the travel ways or at the circumference of the building. In that case circulation occurs not only through corridors but also through stairs, ramps and elevators. Courtyards allow secure open areas, which can be programmed to serve as reading areas and other academic supportive functions. In courtyard design special care must be taken to ensure that the functions surrounding the courtyard and the uses for courtyard are compatible and do not disturb each other and these open spaces must remain sunny and usable (Perkins, 2001).

-Another model which is good for accessibility is ‘Courtyard with classroom clustering’. This model is the combination of courtyard and cluster models. Major circulation is differentiated from secondary circulation feeding the classrooms. This helps enable **sub-grouping and avoid heavy traffic in front of classroom doors.**

-However, ‘Double loaded classroom wings’ shared facilities are placed at either end of double-loaded classroom corridor. In this model the travel distances are too long from classrooms to common facilities. Moreover there are fewer sub-groupings.
-In the ‘Campus type’ plan, the main function-structure is divided into separate buildings that form a campus. This model is appropriate in areas where the weather facilitates outdoor circulation. In multi-grade campuses elementary, middle, and high school grades may share the same campus, with each one in different buildings.

3.2.1.3. Usage of Natural Light

One of the most critical physical characteristics of the classroom is lighting because the visual environment affects a learner’s ability to perceive visual stimuli and affects his/her mental attitude, and thus, performance.

- Researchers have observed that the eyeball is not damaged structurally by bad lighting, either insufficient quantity or poor quality.
- Under full spectrum fluorescent lamps with ultraviolet enhancement, students have better attendance achievement, as well as growth and development than students under other light. Researchers found that fluorescent fixtures were better than incandescent ones for glare reduction (Jago and Tanner, 1999, http://www.coe.uga.edu/sdpl).
- The Illumination Engineering Society recommends 50 foot-candles for regular class work and 100 foot-candles for instruction at a chalkboard.

  Daylight is the most efficient light source and produces high contrast. In a classroom supplied with 60 foot-candles of electric light, sunlight may introduce 8,000 to 10,000 foot candles, thus a large contrast (Perkins, 2001).
- A minimum of 1 window per instructional space contributed to the increase of a quality educational environment. The SDPL recommends at least 20% of the wall space be devoted to windows

Psychological aspects of lighting:

- There is evidence that people dislike uniform lighting. Artificial light is considered as uniform light source. However, light from windows varies

throughout the day. The intensity and the spectral composition change in the course of the day. Reflections from objects and buildings add also variety.

- Natural light also arranges body rhythms of children

(a)

(b)

Fig.3.8. *(a) Diffusion of natural light into the building through 'skylights' (Source: Karabey, 1998, p. 79)*

(b) St. Michel's Primary School (Source: Alfred Wong Partnership, 1998, p.17)

- It has been found that fluorescent lighting increases hyperactivity among children (Jago and Tanner, 1999, http://www.coe.uga.edu/sdpl).
- In the Northern Hemisphere south-facing windows can be designed with brise-soleils "eyebrows" or shades against the summer sun, and winter sun can be used to advantage for solar warming. West facing windows should be avoided where feasible.
- Diffusion of light in the interior space is important. Skylights and translucent walls formed by glass blocks allow light enter in interior space (Fig.3.8. (a) and (b)).

Fig.3.9. *Photograph shows natural light use in a classroom. Fluorescent lamps are also hanging from the ceiling for equal lighting. Rumsey Hall School, Washington Depot, Connecticut.*
(Source: S/L/A/M Collaborative, 1998, p.18)

-Classrooms should be well lit by windows or clerestory windows.
-Daylight should be controlled at South, West and East-facing classroom façades
-Classroom width is important for natural light access (Fig.3.9.).
-Natural and artificial lighting at circulation ways can prevent injuries at peak-time student flows (Fig.3.10.).

(a)

(b)

(c)

Fig.3.10. *Naturally illuminated circulation paths (a) et (b) Clear paths-often using natural light-should form the major circulation (Source: Perkins, 2001, p.194)-(c) (Source: Siegel, 1998, p.116)*

3.2.1.5. Color

Although no qualitative measures have been identified in relevant researches, color is believed to influence student attitudes, behavior and learning, particularly student attention span and sense of time.

"It is also believed that carefully planned color schemes can influence absenteeism, promote positive feelings about the school and, if students like the colors, can also influence muscular tension and motor control." (Fisher, 2001, http://www.dest.gov.au/schools/Publications/2001/digest/building.htm).

Color choices may also have impact on the teaching and learning process. Researchers have found evidence that color affects a student's attention span and both the student's and the teacher's sense of time (Jago and Tanner, 1999, http://www.coe.uga.edu/sdpl/sdpl.html).

"Papadatos (1973) suggested that the proper use of color in schools can convert an atmosphere that is depressing and monotonous into one that is pleasing, exciting and stimulating. He concluded that such change in color schemes in schools would reduce absenteeism and promote positive feelings about schools." (Jago and Tanner, 1999, http://www.coe.uga.edu/sdpl/sdpl.html)

It has been also found that warm colors cause slight elevations in blood pressure in children whereas cooler colors cause slight drops in blood pressure.

"Likewise, Faily (1979) reported findings that optical stimulation by the use of warm colors and brilliance of lighting will cause increases in muscular tensions, respiration rate, heart action, blood pressure and brain activity. Cool colors and dim lighting bring about reverse effects such as muscles relaxing more and sleep being facilitated." (Jago and Tanner, 1999, http://www.coe.uga.edu/sdpl/sdpl.html)

3.2.1.6. Thermal comfort and ventilation of indoor

"Indoor climate may be defined as the collective whole of all the physical properties of a room which influence a person's heat balance and perception of thermal comfort." (Bridger, 1995, p.248)

There are temperature and humidity limits for a human being to be able to work or study healthily in a closed building space. Especially young (and old) people are more sensible to temperature and humidity variations.

- For an average person, the ideal sedentary work conditions are temperatures of 19 to 23C at relative humidity between 40 and 70 percent (preferably 50 to 60 percent). (Bridger, 1995, p.245)
- In an office building at temperatures of 24C and above, workers may begin to feel lethargic. At temperatures of 18C or lower, shivering may commence in sedentary or inactive workers. (Bridger,1995) This type of disturbance may affect children in classrooms where generally sedentary study takes place.
- "Relative humidity, temperature and ventilation are the key determinants of how air quality is perceived. The threshold at which air is perceived as stuffy begins at a relative humidity of 60 percent at 24C and 80 percent at 18C. Dehumidifiers can be used to lower the relative humidity in a building to acceptable limits." (Bridger, 1995, p.246) Contrarily, low humidity, for example less than 30 percent, may cause bodily secretions to dry up. Humidifiers should be used.

***Air quality:**

'Building sickness syndrome' is used to describe buildings with poor air quality. Mechanically ventilated buildings may be permanently or temporarily 'sick'.

All buildings enclose a finite volume of air. If they are not properly ventilated, the air quality will be spoiled because in order to conserve energy with heating and cooling outside air, these systems keep the air which is already in the building. This may cause health problems caused by contaminants such as carbon dioxide, carbon monoxide and ozone as examples of inorganic contaminants, as well as formaldehyde and other hydrocarbons, living organisms such as bacteria, fungal spores and mites as organic contaminants. (Bridger, 1995)

School buildings should be naturally ventilated as possible for protecting students from diseases.

Ventilation:

"The main purpose of ventilation is to provide fresh air and to remove accumulated noxious gases and contaminants. Ventilation helps remove heat generated in a working area by convection and cools the body." (Bridger, 1995, p.246)

In schools, indoor gathering spaces should be ventilated because heat and humidity caused by moving bodies makes these spaces stuffy and uncomfortable.

- Air speeds less than 0,1m. per second cause stuffiness even at relatively low temperatures.
- In cold conditions air speed greater than 0,2m. per second may be perceived as drafty
- In hot conditions (more than 24C) air speeds 0,2 and 0,5m. per second will aid body cooling, particularly when the relative humidity is high.

(Bridger, 1995)

Sources of air pollution:

- Air entering the building from outside. (Carbon dioxide, carbon monoxide, and lead from leaded gasoline)
- The building itself may be a source of pollution emitted by the construction materials, furniture and fittings
- Business machines and cleaning chemicals are another source
- The occupants themselves; people give off carbon dioxide, water vapor, microorganisms, dead skin cells, unpleasant odors, and sometimes tobacco smoke.

3.2.1.7. Acoustic quality of spaces

"Acoustic waves can be defined as pressure fluctuations in an elastic medium (…) The amplitude of the acoustic wave is expressed in units of force per unit area (newtons per square meter) or in pascals. The threshold of hearing (lowest amplitude of pressure oscillations in air detectable by human ear) is taken to be 0, 00002 N/m2 at a frequency of 1000 Hz." (Bridger, 1995, p.287)

A healthy young person can hear sounds between the ranges of 16 to 20,000 Hz. A logarithmic scale is used to express the intensity of sound because the range of sound pressure level (SPL) to which the human ear is sensitive is very wide; between 0,00002 N/m2 to 20 N/m2. The decibel (dB) is a dimensionless unit related to the logarithm of the ratio of the measured sound pressure level and 1 dB is the smallest noticeable difference in intensity between two sounds. Sound can be measured objectively however noise is usually defined as a sound or sounds at such amplitude as to cause annoyance or to interfere with communication. (Bridger, 1995)

The sound pressure level of an average conversation is 60 dB, in a quiet room 40 dB, and in a library 35 dB. Above 130 dB the sound pressure causes ear damage.

According to the table below, in a classroom space, below 50 or 40 dB seem to be an acceptable SPL. However in 1963, Fitzroy and Reid conducted a study to determine the minimum acoustical separation necessary to permit a group or an individual teacher to work effectively. They found that school buildings would be completely acceptable for teaching and learning if built with noise reductions between classroom areas of 18 and 20 dB with classrooms near optimum reverberation periods and articulation indexes of 0,01 or less. (Jago and Tanner, 1999, http://www.coe.uga.edu/sdpl/sdpl.html)

In 1980s, the positive influence of background music was discovered. Christie and Glickman (1980) found that children's performance at many classroom tasks will vary as a function of classroom noise levels. They concluded that 70 dB of sound constitutes a noisy classroom while 40 decibels would be the appropriate measure for a quiet classroom.
(Jago and Tanner, 1999, http://www.coe.uga.edu/sdpl/sdpl.html) (Fig.3.11.)

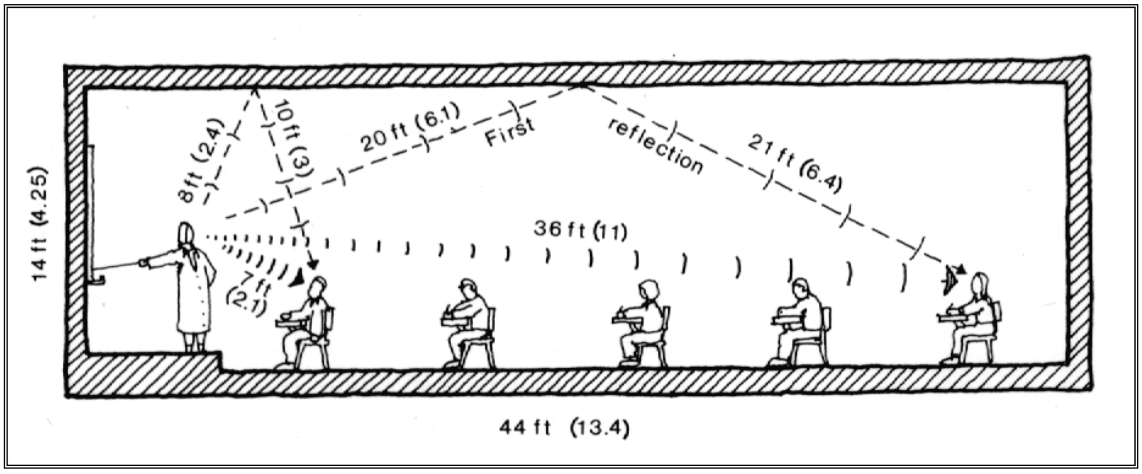


Fig.3.11. *The picture shows the maximum path-length difference between direct and first reflection which is 36 ft. in a typical medium-size lecture room. (Source: Perkins, 2001, p. 157)*

The acoustic quality of an educational space is an essential problem to be solved. In the learning process a child should hear clearly what is said before understanding it.

"The acoustical design of a space involves the attenuation of unwanted and disturbing sounds and the enhancement of desired sounds to the point at which they can be heard properly" (Perkins, 2001, p.155)

Solutions to the acoustical problems should be found at the design phase of a building. Sound spreads in an architectural enclosure as waves of water and it is reflected, absorbed or transmitted by the boundaries of the defined space. As a result, the construction type, the material used, distances, the sound of the mechanical systems and the shape of that space should be thought before the application of isolation materials and techniques.

"The best acoustic isolation occurs when isolation is not needed" (Perkins, 2001, p.155)

The background noises come from heating, ventilation, and air-conditioning (HVAC) systems.

"Reverberation is the persistence of sound after the cause of sound has stopped, or the ear's reaction to echoes in an enclosed space, giving an impression of 'liveness' or 'deadness' "

Reverberation is an important factor because it can be so high that a teacher's speech may be distorted by the overlaying of reflected waves. According to new educational approaches, anywhere in the facility can be an educational space; however classrooms are places where this activity is more intense. Consequently special care should be taken in classroom design.

Table at p.157 in ESD

"Three main criteria determine how effectively a student can hear and understand in a given space (…)

1. Distance of the student from the signal or source, and the effects of interference or loud background noise on the signal

2. The level of background noise from HVAC and lighting systems, or from sounds generated within or outside the room

3. The effects of reverberance" (Perkins, 2001, p.158)

Design quality factors in classrooms:

- External sounds

  External sounds should be minimized with the right choice of location before the design. External walls, windows (e.g. double glazed) should filter disturbing sounds.

- Location

  Classrooms should be located away from noisy spaces inside the building such as gymnasiums and mechanical rooms.

- Materials

  Adequate acoustic isolation in partitions, ceilings, windows and doors should be used. Concrete surfaces reflect most of the sound waves. Acoustic tile fixed on the ceiling, drapes, carpet absorb unwanted waves and let the direct waves reach listeners.

  A study developed by Conrad and Gibbons at Ohio State University in 1963 showed that carpeting affects the total sonic environment. It was found that students in the carpeted rooms showed greater achievements than those in other classrooms.

  (Jago and Tanner, 1999, http://www.coe.uga.edu/sdpl/sdpl.html)

- Form and dimensions

  There are no strict rules for classroom shapes and proportions as, for example in auditoriums, but to avoid the flutter of sound that can be caused by parallel side walls, furnishing or wall finishes can be used to break up direct sound waves.

- Background noise

Noisy light fixtures, HVAC systems or furniture and students themselves may cause unwanted sound inside a classroom. Applying additional acoustic material, especially on the walls, may attenuate these sounds.

- Reverberance

  According to the table above, in an elementary classroom the reverberation time in seconds should be between 0.6 and 0.8 which is not far from the recording and broadcasting studios and near to lecture and conference rooms. The teacher's voice should be heard clearly at any place in the classroom.

Music rooms, auditoriums, gymnasiums, laboratories, dining areas and mechanical rooms are the other main spaces where acoustical control should be exercised (Fig.3.12.).

Fig.3.12. *Special acoustic treatment is required in music rooms. The location of acoustic elements on ceiling, wall and floor should be carefully considered. Pine Ridge High School, Deland, Florida. STH Architectural Group (Source: Perkins, 2001, p. 42)*

3.2.1.8. Sustainability

Sustainable or 'green' design has emerged in the last two decades as a major consideration in the planning and designing of all building types.

"In many places, the land is more damaged than previously believed. Soil erosion, groundwater contamination, acid rain, and other industrial pollutants are damaging the health of plant communities, thereby intensifying the challenge and necessity to restore habitats. As only one component of an independent natural system, the human species must develop a respect for the landscape and expend more effort understanding the interrelationship of soils, water, plant communities and associations, and habitats, as well as the impacts human uses of them"
(Hart, 1994, http://www.nps.gov/dsc/dsgncnstr/gpsd/toc.html)

Sustainable design strategies requires; Recognition of Context, treatment of landscapes as interdependent and interconnected, integration of the native landscape with development, promotion of biodiversity, restoration of already disturbed areas, making a habit of restoration.

Sustainable design balances human needs with the carrying capacity of the natural and cultural environments and it minimizes environmental impacts and the importation of goods and energy as well as the generation of waste.

- The design should respect the ecosystem and cultural context by minimizing the impacts of any development.

Some design teams are placing greater emphasis on reducing the building footprint, decreasing disturbance of site areas, and protecting a site's important natural features. (Perkins, 2001)

- Reinforce and exemplify appropriate environmental responsiveness by educating users about the resource and appropriate built responses to that environment, interpreting how development works within natural systems.
- The use of simplest technology appropriate to the functional need, and incorporation of passive energy-conserving strategies responsive to the local climate into the building (Fig.3.13.).
- Renewable building materials should be used to the greatest extent possible.

- The use of environmentally damaging, waste producing and hazardous materials should be avoided.

  Many schools in the USA are trying to reduce the quantity of solid waste and have increased the amount of recycling and use of materials with recycled content. These measures require extra spaces in these schools and affect the choice of materials (Perkins, 2001).
- Optimizing use and flexibility of spaces so overall building size and the resources necessary for construction and operation are minimized.
- Avoid resource consumption and material waste. Increasing opportunities for recycling.
- Considering development phasing and allow for future expansion.
- Materials and components should be chosen that can be easily reused or recycled

  (Jago and Tanner, 1999, http://www.coe.uga.edu/spdl/spdl.html)

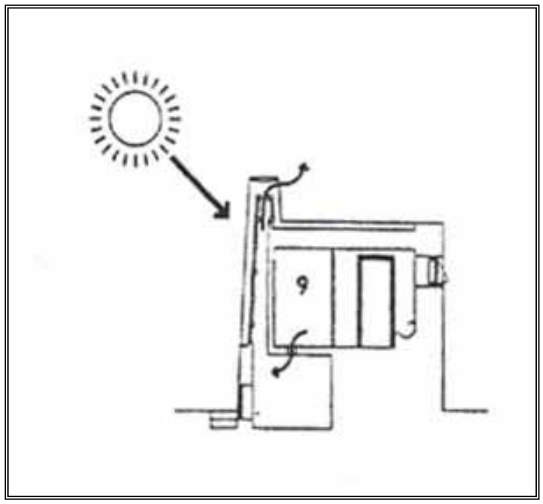


Fig.3.13. *Cross section showing VIP lavatory principles from Ladakh School, Kashmir designed according to passive solar heating principles. (ARUP Architects & Engineers)*
"Lavatories have ventilated improved pit (VIP) latrines in which solar energy collected in black south facing walls heats a long duct so that air is drawn through the latrines and expelled up the duct above roof level to obviate fly and smell problems" (Source: Davey, 2002, p.54)

The materials used in renovation or new construction should respond these questions:

1) Are they produced locally?
2) Are they developed from sustainable or renewable resources?
3) Are they salvageable if the structure is demolished later?
4) Are they manufactured in a process that creates toxic by-products?
5) Are they used in a way that results in post-installation off-gassing?
6) Are they easily maintainable and durable?

3.2.1.9. Play areas and organization of open areas

Recreational facilities such as play areas in primary schools have a role as important as classrooms in the development of a child. Outdoor play sets are appropriate for younger children. When the child is physically developed, he or she prefers play fields such as tennis courts, volleyball and basketball areas for sportive activities.

Play sets for younger children are generally in outdoor school area. Play equipment can be traditional or modern, which encourages the child to challenge and live more adventurously. Play sets should broaden the imagination because many researches show that 'play' has an important effect on personality development.

The new understanding in play equipment design, sets child development objectives as;

Play equipment should provide motor skill development; In other words, large and fine muscle development, eye-hand-foot coordination, should allow decision-making, give opportunities for learning, for dramatic play, for social development and give fun. "Smiling faces and laughter are the clearest indicators of a successful play setting." (Moore, 1992, p.3)

Main site design criteria for play environment should be as follows:

- Microclimate:

Settings should protect users from excessive wind, rain, sun, shade, and noise and also from smoke and provide for year-round body comfort.

Vegetation (trees, shrubberies) and structures as walls are important climate modifiers. (Fig.3.14.) There should be a variety of sunny areas, shady areas, wind breakers and channels.

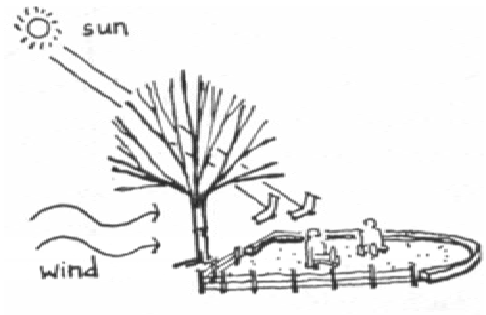


Fig.3.14. *Trees are perfect 'barriers' and 'filters' of sun and wind. In addition they provide shade in hot climates. (Source: Moore, 1992, p.134)*

-Wind speeds on the crest of a ridge may be 20% greater than on flat ground. Wind also tends to speed up around the sides of buildings.
-Shrubs and trees reduce wind velocities by more than 50% for a distance downwind of ten times their height and by 35% for twice that distance.
-Structures can block winds, channel winds, or create unpleasant wind tunnel effects.
-Shading by evergreen trees
-Deciduous trees provide summer shade and sun in winter.
-Proper drainage should help dry play areas quickly after rain.

- Accessibility:

Play areas should be both physically and psychologically accessible (attractive and secure).

Main pathways should be connected with main entrances, exits, meeting areas to provide a clear mental image of the facility.

- Safe challenge

A challenge is a risk the child can see and choose to undertake or not. However, a hazard is something a child does not see and may get hurt. Play areas should provide highly challenging settings with many different events for the upper body, balance, and coordination without exposing children to unnecessary hazards. (Moore, 1992, p.10)
Play elements developing upper body:
Rings, turning bars, horizontal bars, climbing trees, swinging ropes, things to lift
Balance settings which stimulate the inner ear:
Tire swings, climbing surfaces, bridges, narrow rails and walls
Coordination and judgment settings:
Horizontal ladders, stepping logs, climbers, tunnels, banister slides

- Defensible space:

Eye accessibility is an important aspect of defensible space design. Unsupervised and partly supervised areas may encourage criminal behavior. Each level should accomodate both supervisor and children.
-Boundaries should be defined, but transparent.
-Spaces and equipment must be designed and placed to allow views over, under and around. Private play spaces should be semi-enclosed with enough openings to see a child from any angle.
-Structures or vegetative barriers should be open for two-thirds of their enclosure.

- Diversity and clarity

Play settings should stimulate curiosity and exploration. Some aspects should change continually; others should be predictable to foster feelings of security. In other words a well-designed play set should offer both something new and something familiar.

- Graduated challenges

-Difficulty stages: steep, steeper, steepest

-Accomplishment: high, higher, highest

-Providing enter and exit for each level

-Next level should be apparent

-Avoid hazard and danger

- Flexibility:

The environment should allow for easy rearrangement of elements for different programs and the addition or removal of special equipment for particular activities. Methods of supporting flexibility: modular systems, mobile equipment (inflatable, hoses, buckets, pulleys and ropes), mobile play bases, and so on.

- Multisensory Stimulation:

"Settings should expose users to the greatest range of colors, smells, textures, shapes, sizes, sounds, objects, materials, interactions, people, climate, time, space, movement and change." (Moore, 1992, p.14)

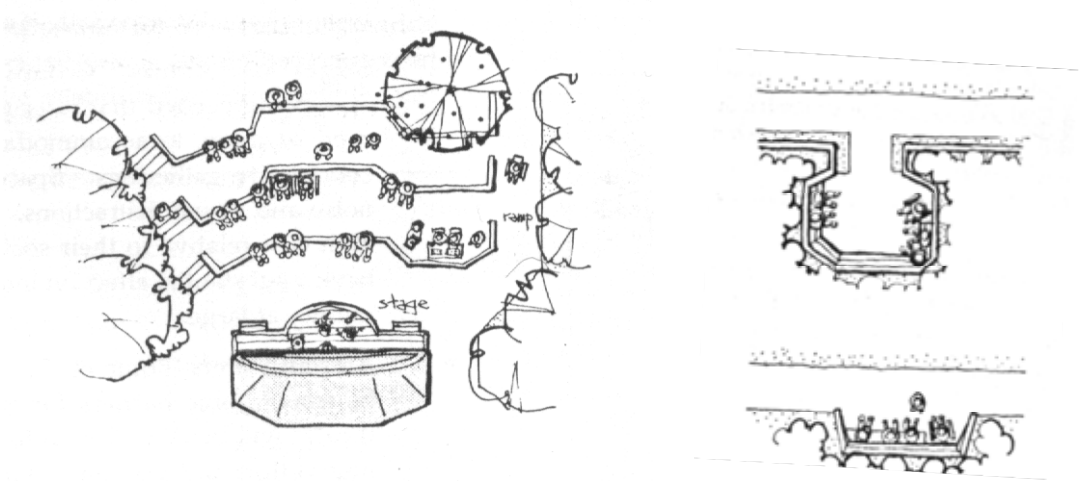
Sound, touch and sight can be used to gather information.

- Variety of Social Spaces
- Location should be accessible by teachers or school personnel responsible for children in emergency cases or for surveillance.
- Toilets should be near the playground.
- Structure and material of the equipment should be durable and secure. Paving should be shock absorbent in order to avoid injuries.
- Soil drainage should be well designed.
- Play set should serve active and passive play types.
- Equipment should be flexible for future arrangements such as subtraction of damaged parts, repairs, and additions of new play sets.
- Play set should be anatomically ergonomic. Swings should be appropriate to different age groups.

Ministry of Natural Education states outdoor activity spaces as:

- Main gathering space

-A large gathering space is a socialization and play space for all age groups. It should be accessible and centralized (Fig.3.15. (a)).



(a) *(b)*

Fig.3.15. *(a) Amphitheater accessible to wheelchairs (b) Spaces provided for groups of different sizes (Moore, 1992, p.178)*

-Seating clusters should be provided for small group activities. (Fig.3.15. (b))

-There may be ramps, seating elements or ramps and large stairs that can be seated.

-Gathering spaces for children between 6-10 ages should be nearer for easy surveillance (max.21 meters).

-Platforms, fences, ramps and grading should be used

(T. C. MEB, 1997, p.59).

Also vegetation can be used as space barrier and learning tool in common areas (Fig.3.16.) and (Fig.3.17.).

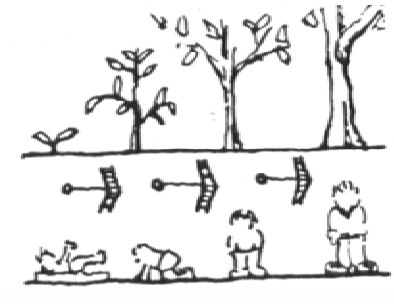


Fig.3.16. *As plants and children grow together, the contemplation of this process can carry educational value. It is important for students to see real life and compare it to information in their books. (Source: Moore, 1992, p.134)*

Fig.3.17. *Primary School in Vienna- Each classroom has its own garden. The school structure is formed by succession of small courtrooms which also enables surveillance.*

- Play Sets

Elements of play sets listed by the Ministry of National Education's design handbook are slide, swing, climbing, seesaw, complex play sets.

- Creative Play Area

-Suitable for all age groups

-Painting, using tools, playing with mud can increase creativity.

-Protection of these areas from wind, rain, sun should be provided.

-Large scaled geometric shaped modular objects such as cubes, cylinders, wood planks.

(T. C. MEB, 1997, p.61)

- Quiet Play Areas

-Semi-open or open spaces with barriers enables 1-4 children to play in small groups.

-Quiet areas can be near sand pool and plant raising areas.

-The space barriers (fences, laurel, curtain, etc.) should be 60 cm. maximum.

(T. C. MEB, 1997, p.61)

- Sand and Water Play Areas

-Suitable for children in the age group between 6-10 years.

-There should be in an increased level pool (Fig.3.18.).

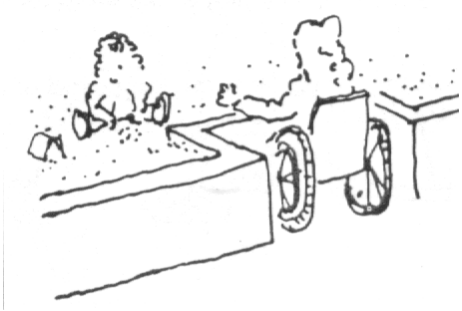


Fig.3.18. *Elevated level sand pool should be accessible to handicapped students. It is also important for them to interact with others for their socialization process. (Source: Moore, 1992, 164)*

-Seating elements should be placed around sand pools for surveillance.

-Sand pool depth should be between 35 and 45 cm.

-Sand pool should be well raised (90 cm. min.) in order to enable accessibility to handicapped children. Arm accessibility of handicapped children on a wheelchair is 50 cm.

Fig.3.19. *Water supplies should be located near sand pools for easy access. (Source: Moore, 1992, p.164)*

-Water spaces can be near sand pool. (Water depth should be max.20 cm.) (Fig.3.19.)
(T. C. MEB, 1997, p.61)

- Hard Surface Play Areas

-Hard surface ball play areas are appropriate mainly for children10-14 years old.

-These areas can be centrally located because at these ages children want to socialize and demonstrate their abilities to others.

-Area required for each play field:

Basketball…… 35m2

Tennis court……... 135m2

Football…….. 130m2

-There should be seating elements around play fields.

-Lighting elements should be placed around play fields.

-Hard surfaces should be also appropriate for wheeled toys, roller-blades and bicycles.
(T. C. MEB, 1997, p.62)

- Open Grass Area

Soft surfaces such as grass areas enable other group plays which may cause injuries on hard surfaces (T. C. MEB, 1997, p.62).

- Plant Raising Area

Children should reach plants in the raising area as a part of their education.
(T. C. MEB, 1997, p.62)

- Circulation Paths

-Circular and curved circulation paths prevent children to run fast and hurt themselves.
-Paving and drainage should be well designed.
Other areas sited by Turkish Ministry of National Education are: seating sets, elevations, rocks and plants (Table 3.1.).

	Circulation Paths	*Plant Raising Area*	*Open Grass Area*	*Hard Surface Play Areas*	*Sand and Water Play A.*	*Quiet Play Area*	*Creative Play Area*	*Play Sets*	*Main Gathering Space*
Main Gathering Space	**S**	**NS**	**S**	**S**	**S**	**NS**	**S**	**I**	**I**
Play Sets	**S**	**NS**	**NS**	**S**	**NS**	**NS**	**NS**	**I**	**-**
Creative Play Area	**S**	**S**	**NS**	**NS**	**S**	**S**	**I**	**-**	**-**
Quiet Play Area	**S**	**S**	**NS**	**NS**	**S**	**I**	**-**	**-**	**-**
Sand and Water Play Areas	**S**	**S**	**NS**	**NS**	**I**	**-**	**-**	**-**	**-**
Hard Surface Play Areas	**S**	**NS**	**S**	**I**	**-**	**-**	**-**	**-**	**-**
Open Grass Area	**S**	**NS**	**I**	**-**	**-**	**-**	**-**	**-**	**-**
Plant Raising Area	**S**	**I**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Circulation Paths	**I**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
S: *suitable* **NS: *not suitable*** **I: *irrelevant***									

Table.3.1 *Organization of outdoor school facilities, (Source: T. C. MEB, 1997, p.64)*

3.2.2 Quantitative Requirements

3.2.2.1. Proportion of floor areas of different spaces

Several studies concerning effects of school density on student achievement show that in crowded schools the rate of success is lower than in others. (Tanner, K., 2000, http://www.coe.uga.edu/sdpl/research/territoriality.html)

Area/student proportion indicates the minimum action space that one student needs for realizing that action correctly. For example in art rooms, gymnasiums, gathering spaces etc., each action requires more space than an action in a standard classroom.

Another aspect is social distance. Social distance is psychologically appropriate or comfortable distance between an individual and others. It differs according to social and

cultural conditions, age, and sex. However, social distance may require more space when compared to minimum action distances. Research conducted in the U.S.A. at the University of Georgia, directed by C. Kenneth Tanner, has shown that area of classroom/student allowable for social distances is approximately 5 m2 (~53,2 square feet) (Tanner, K., 2000, http://www.coe.uga.edu/sdpl/research/territoriality.html) whereas the area for action space for U.S. classrooms is 3 or 3,2 m2. (Ö. Alıcıgüzel, 1999).

In Turkey this number ranges between 1,2 and 1,7 mainly because of economic conditions, but also as a consequence of the educational program. Western countries regard classroom space as a flexible multipurpose area which requires more m2 than would be necessitated in regular teaching sessions.

- **Classroom area/student**

In the new educational program proposed by the Ministry of National Education, the classroom population was decreased to 30 as density exceeding this number of students may cause difficulties in the learning process.

Furthermore, in many developed countries student number per classroom is 30 or below 30 (Table 3.2.).

Unfortunately, in Turkey this spells need for extra classroom areas and the construction of additional spaces that leaves smaller outdoor space available especially in limited urban plot areas.

Capacity of classes and class area in primary schools in different countries:

Country	*Student no.*	*Area (m2)*	*m2/student*
Denmark	30	48-60	1,6-2
Holland	30 max.48	56-115	1,2-2,4
Sweden	25	60	2,4
Belgium	24-30	54	1,8-2,2
U.S.A.	25-30	80-90	3-3,2
Italy	25	45	1,75
England	30	48	1,6
Brazil	40	48	1,2
Switzerland	25	57	2,3
Germany	30		
Turkey (Ministry of Pub.Works.pro.)	40	48-55	1,2
Turkey (Ministry of N.Educ.pro.)	30	52	1,7
Turkey (Private Sch.Law)	max.40	min.20	min.1,2

Table 3.2. *Student number and classroom capacities of primary schools in different countries (Source: Alıcıgüzel, 1999, p.52)*

U.S. psychologists have shown that 17 students per classroom is the appropriate number for elementary schools and in secondary schools this number is 14-15 for a 1024 square feet (~100m2) classroom.

(Tanner, K., 2000, http://www.coe.uga.edu/sdpl/research/territoriality.html)

M2/student

Total building area per student in primary schools varies among from countries to countries:

Country	*m2/student*
Sweden	7,4
Germany	4,9-8,7
England	3,2-4,5
Denmark	6,2
U.S.A.	8-15,0
Holland	3,1
Brazil	3,7
Turkey	8

Table 3.3. *(Source: Alıcıgüzel, 1999, p.55)*

Large spaces allow the design of multi-purpose classrooms; however, each additional m2 increases the building cost.

- **Circulation area m2/total building area m2**

According to Turkish educational standards, total circulation area per total building area is 40% and total circulation area per functional area is 68%. (T. C. MEB, 1997, p.28)

- **Playground area m2/student**

Country	*Area (m2)*	*m2/student*
England		
50 student	2000	40
100-200 student	6000	30
280	12000	40
Italy		20
Germany	3000-7500	25
Belgium	10000-15000	50
U.S.A.	12000-16000	56
Holland	1500	5
Turkey (A.N.P.B.proposal)	9500	19
Turkey (Private Sch.Law)		1,2-5
Turkey (Ministry of N.E.pr)		8

Table 3.4. *(Source: Alıcıgüzel, 1999, p.57)*

Playground area is very important in developed countries. Proposed playground area by the Ministry of National Education is 8 m2 per student. (Ö. Alıcıgüzel, 1999, p.56)

However, open area plays essential role in a child's environmental and physical development (Table 3.4.).

- **Lot area**

Taking into consideration that primary school buildings tend to be 2-3 storied, the proportion of construction floor area to the lot area should be 1/3 (T. C. MEB, 1997, p.28).

Country	***m2/student***
Germany	30
France	15
England	25
U.S.A. (pr)	54-128
U.S.A. (sec)	65-100
China	15
Bulgaria	40
Portugal	28
Poland	16
Denmark	38
Holland	20
Brazil	14
Venezuela	8
Turkey (Ministry of Public. proposal)	20-25
Turkey (A.N.B.P. Pr.s. Proposal)	22,5
Turkey (A.N.B.P. Sec.sc.proposal)	25
Turkey (Ministry of N.Educ.proposal)	10

Table 3.5. *(Source: Alıcıgüzel, 1999, p.59)*

- **Ergonomics**

"Ergonomics is concerned with the design of systems in which people carry out work" (Bridger; 1995 p.1)

"Ergonomics aims to ensure that human needs for safe and efficient working are met in the design of work systems" (Bridger, 1995, p.1)

There is a series of research on building-user interaction which demonstrates the existence of a relationship between student comfort and student achievement. In schools, human needs are student needs, and the work-system consists of everything with which the student enters into contact for realization of the learning action. Not only tables, desks, chairs, computer furniture, computers, blackboards, doors, windows, handrails, and 'panic barres', but also indoor climatic conditions such as humidity, heat, cold and light, air quality etc. are comfort conditions that a school should provide students as ergonomic qualities. Play sets and playgrounds moreover should be ergonomically appropriate to children's size because the play activity bears important role in the learning process.

Children should feel comfortable in doing and acting at school. Furniture should be appropriate to children's size. Computer tables should allow students to reach the computers. Age influences the height and size of furniture, durability of construction and materials and activity levels of the student. For example in an art class, furniture material (surfaces) should be durable and cleansable. Furniture should be adaptable to the educational program, say if it requires flexibility in order to form student groups (i.e. tables, partition walls).

Aspects influencing the selection of furniture:

* Teaching the class at once to the entire group or dividing it in sub-groups. (the latter requires flexible tables and chairs)
* Frequency of reconfiguration of furniture
* Size, number and properties of learning materials (books, computer, laboratory equipment)
* Flexible electrical power and computer cabling distribution in the classroom
* Cabling allows furniture reconfiguration
* Materials should be durable, safe and maintenance-free
* Gathering spaces should accommodate children of all sizes.
* Furniture should preferably store students' books and materials.

(Perkins, 2001, p.186)

3.2.2.2. Handicapped accessibility

"Universal design provides equal access to all spaces regardless of an individual's abilities."

Schools should integrate disabled students into the mainstream student population. For example, ramps can be centrally located and serve all students. Research shows that disabled students learn better when they are among other children.

If this idea of integration is part of the educational program, it may require for example a larger classroom as well as furniture that allows wheelchairs to move easily. (Perkins, 2001, p.191)

Main design decisions and dimensions for handicapped accessibility are:

Entry

- Accessible parking areas adjacent to the entry
- Accessibility of all educational and social facilities

- Main entry should be appropriate to handicapped access with ramps centrally located.
- Automatic entry doors with accessible vestibule areas

Circulation

- If the building has two stories or more, there should be an elevator of adequate size for a wheelchair.
- Vertical circulation should be centralized.
- Wider circulation paths in the classroom wings should be used in order to accommodate various user groups. Width of corridors should be minimum 1,5 m. (TS 9111). (T. C. MEB, p.57)
- Doorsills may obstruct wheelchairs. If they are necessary for protecting indoors area from rain, they should have a maximum height of 2,5 cm., and be colored and curved.

Fig.3.20. *Ramp and stairs should be designed together. Handicapped students need to interact and not be discriminated. (Source: Karabey, 1998, p.83)*

Ramps and handrails

- Ramps should be maximum 8% (Turkish Standards 9111). (T. C. MEB, 1997, p.57)
- The ideal ramp slope is 5% for wheelchairs with a minimum width of 1,2 m.
- Handrails should be at both sides of the ramp at a height of 1 m.

- All handrails should be fixed to the walls and floors and should be continuous.
- Sharp turnings should be softened by plastic covered applied on metal surface.
- Handrail diameter should be between 3,2 and 3,8 cm. (Fig.3.20.).
- At the top and the bottom of the ramp there should be a 30 cm. long horizontal handrail.

Elevators

- Elevator cabin dimensions should be minimum 1,40 x 1,10 m.
- Space left in front of the elevator door should be min. 1,50 x 1,50 m.
- Handrails in the cabin should be 85-90 cm. of height.
- Materials should be durable in order to resist damage caused by wheelchair.
- Elevator doors should be 91,5 cm. of width.
- Control panels should be max. 120 cm. of height and 60 cm. away from the door.
- There should be a telephone in the elevator.

Furniture

- Adjustable furniture and work surfaces to accommodate wheelchair.
- Graphics with information should be given in large print and braille.

Toilets

- At least one of the toilet cabins should be designed for disabled children.
- Dimensions should be min. 2,00 m. of length and 1,50 m. of width.
- The door of the toilet cabin should open to the outside of the stall.
- Door width should be min.81,5 cm.
- Center of toilet seat should be 40 cm. away from walls. The toilet seat should be min. 95 cm. away from the cabin wall.
- Height of the toilet seat: 35 cm.
- Handrails around the seat: 55 cm. height behind and from 65 cm. to 140 cm. beside.
- Seat cover should be load resistant.
- Sink height should be a 73,5 cm. minimum and accessible by wheelchair.
- Behind the sink there should be an area of 76 x 122 cm.

Doors

- Sliding doors are not preferable.
- At corners 60cm. Min. 30cm. of distance between wall and door is required.

- Classroom doors should be min. 81,5 cm. and main entry doors 90 cm.
- Door handle should be installed at 1 m from the floor. For disabled children there should be a handrail at the same height.

(Turkish Standards 9111) (T. C. Milli Eğitim Bakanlığı, 1997, p.57)

3.3 Design Factors

The most important faculties of human beings are their ability for manipulating the environment, and adaptability. Humans constructed shelters in order to regulate their relations with the nature. Furthermore, this defined and functionalized space that they constructed had meaning beyond its functional properties. Symbolization and abstraction are other faculties that separate human kind from other kinds of animals. The degree of participation in a culture and in a social structure may be measured by the human capacity of understanding symbolic structures (language, other expressive behavior, objects of art etc.). As a child grows up, at first his or her perception functions so as to create direct relations between objects and meanings. Later, the child learns more complex symbolic systems transmitted by culture as well as the tools of this system and thus becomes a member of the society to which child belongs.

As the work of art, the architectural space is the concretization of symbolic meanings and is at once based on human actions, needs and wishes. Perceptual space consists of human beings' understanding those symbolic meanings and functions by perceiving relations. The perception of such relations may also be analyzed in terms of the apprehension of topological relations deriving from Gestalt principles. Gestalt Rules aim to bring a methodology to the perceptual environment. They have been used by many designers starting with the 1950s. The methodology categorizes some of these perceived relations as proximity, similarity, enclosure, size constancy, separation, succession, continuity, etc.

Kevin Lynch uses the concepts of node, path, edge and district to analyze humans' orientation in space:

"To orient himself, man needs above all to grasp such relations, whereas geometrical relations develop much later, to serve more advanced purposes." (Norberg-Schulz, 1980, p.223)

Geometries based on these relations may consist of clusters and groups (proximity-separation), rows (succession-continuity), and their combinations. There are

also spatial organizations which have been used and experienced in the course of the history of architecture:

Centralization around a focal point indicates a gathering space or the most important part of the organization where the main activity occurs. The ideal form for focus has a round shape. Spaces along an axis create a structure with a direction between two points.

"The places are goals or foci where we experience the meaningful events of our existence, but they are also points of departure from which we orient ourselves and take possession of the environment." (Norberg-Schulz, 180, p.224)

That is, organization may constitute from combinations of centers and axes, or a network of directions in a coordinate system.

Rob Krier in his book 'Architectural Composition' classifies the organization of space as central and axial, linear, axial and linear, fork-like, network, superimposition, labyrinth.

Vertical directions indicate rising-up (as for example, in Gothic architecture) or falling down, whereas horizontal direction indicates span or parallelism with the earth surface. Vertical element on a horizontal plane has a symbolic meaning or shows a special place in the organization (entrance, node, and the like).

The relation indoor-outdoor may be based on the range of private space to public space. According to design concept, the indoor-outdoor relation can be at visual or physical levels or at both of them.

Architectural space is also organized by "spatial qualities" determining the character of the design. Design concepts such as closure, openness, width, narrowness, somberness, luminosity, etc. depend upon plastic modeling, proportion, rhythm, scale, dimension, material texture and color which constitute qualitative and quantitative aspects. (Norberg-Schulz, 1980)

Qualitative concepts cannot be measured. Their importance and effect on the totality spatial design cannot be explained by numbers and numerical operations.

3.3.1. Formal Aspect

At the beginning of the design process, the architect possesses a random collection of information, requirements, intentions and assumptions in order to obtain a proposal of building form.

Theories of form are concerned with how this building form is obtained. Some of the theories of the origin of architectural form are:

-An architectural form is shaped by its intended function:

"According to this view, the form of a good building is shaped by the various physical, social, psychological and symbolic functions it is expected to perform." (Gelernter, 1995, p.3)

The design should respond to the architectural program perfectly.

-The architectural form is generated within the creative imagination.

"According to this theory, an idea for an architectural form originates within the inner resources or intuitions of the designer." (Gelernter, 1995, p.7)

The personal resources of each architect are different. As no one entirely resembles another, the results of their education, their culture and professional approaches vary. This diversity reflects on the end products of the designers. Furthermore, some of them clearly possess a more sensitive feeling for form and manage to invent more original forms than others.

-The architectural form is shaped by the prevailing Spirit of the Age.

- The architectural form is determined by the prevailing social and economic conditions.

-The architectural form derives from timeless principles of form that transcend particular designers, cultures, and climates.

According to this theory, building types derive from geometrical possibilities such as the basilica, the courtyard, the atrium, etc. Other types generates from the combination of these forms.

None of these theories is the sole answer to the question of what the origin of form is. Although all of the ideas affect the designer's formal solution, generally one of these theories is more dominant on the others.

Functional aspects seem to have affected school design because public buildings follow strict rules and codes, the amount of users is generally high, and economic funds are limited. However, new educational theories suggest that school buildings should be attractive in order to motivate children. At this point the creative imagination of the designer is required. Furthermore, the harmony of the building with its environment (its context) is left to the taste and understanding of the architect.

These organizing and enclosing principles can vary according to concepts or design characters such as accessibility, flexibility, security, and so on. In school design the function sourced formal organizations are based on educational programs or theories

as well as environmental and site effects. In order to increase accessibility linear forms may be shortened and the organization may be multi centered. Formation of subgroups by reducing the length of corridors may be the result of the principle of 'education in small groups' or an increased security of surveillance especially on younger children. Flexibility may order a mixture of network and other organizations because formal flexibility should bring to the system open-endedness. If 'growth' is planned in the educational program homogeneity in the distribution of functional spaces and open ended axes can render the system flexible. The indoor and outdoor activity organization cause formal organization types. For example, in a cluster model the structure is organized around an open play space. Indoor activity space and outdoor activity space may be related, the structure may be related with the outdoor space by the entry space or directly by the classroom clusters, which allows outdoor classroom activities and strengthens the child's relationship to nature. The plan organization can be constituted also from the series of activity/play spaces. (figures p.16-17 ESD)

3.3.2. Geometry

Different formal types in architectural compositions are formed by a variety of relations between architectural elements; in other words, by characteristic units of an architectural form.

"As an architectural 'mass-element' we dominate a body which is separated from its environment in such a way that its extension can be described by means of a Euclidean co-ordinate system" (Norberg-Schulz, 1997, p.135)

Norberg-Schulz also defines space-elements in his book 'Intentions in Architecture' in terms of topological closure: "While we characterize a mass as more or less concentrated, we say that a space is more or less closed." (Norberg-Schulz, 1997, p.146)

The character of an element is determined by its degree of concentration or by its ability to join other elements. The formal relations defined by Gestalt principles; proximity, continuity etc.

Proximity relation forms 'groups' while the collection of elements ordered by the continuity relation form a 'row'.

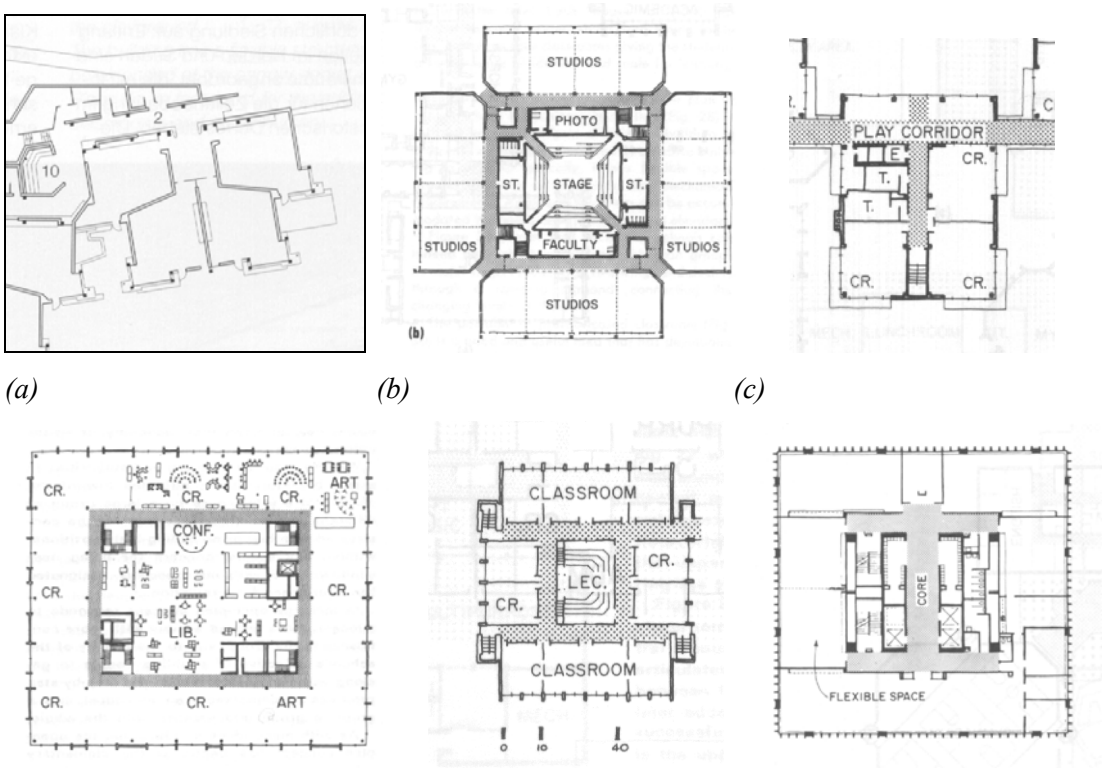
-Clusters and groups:

When a group's mass-elements are ordered by means of proximity relation with low degree of articulation, the form is called 'a cluster'.

A cluster is always an 'open' form, as the elements by definition are independent and may be taken away or added. A group, instead, may be open or 'closed'.

Generally, classroom organization defines the relation type and form of the school building. Clusters are preferred in order to enable accessibility between classes and also between classes and service spaces. Furthermore clustering creates controllable groups especially suitable for lower grades (Fig.3.21.).

This relation type may yield a sense of rhythm in the overall design of the building mass.



(a) *(b)* *(c)*

(d) *(e)* *(f)*

Fig.3.21 *Classroom cluster models: (a) Primary School in Victoria, Canada (Source: Wiegelmann, 2003, p.177)-(b) Shared facilities are centered in the plan for easy access through the entry court (Source: De Chiara and Callender, 1990, p.221)-(c) Cluster with simple stair circulation (Source: De Chiara and Callender, 1990, p.219)-(d) Flexible space organization with centered facilities (Source: De Chiara and Callender, 1990, p.220)-(e) (Source: De Chiara and Callender, 1990, p.222)-(f) School space designed as an office building; Flexible space around the core of circulation and mechanical requirements (Source: De Chiara and Callender, 1990, p.224)*

-Rows

Rows are organized according to the continuity and succession principle.

“A row may also be open or closed, while an enclosure by definition is a closed form. Rows and groups are additive or divisive, that is, organized from ‘below’ or from ‘above’.” (Norberg-Schulz, 1997, p.147)

Classroom wings formed by a succession of classrooms form linear organizations

-Combinations

That rows and groups may be added or divided levels the form combinational possibilities.

Grouped spaces around a center interconnected with linear classroom wings are combination types.

-Hierarchy

“A formal structure generally consists of primary and secondary elements, or exhibits a still more complicated hierarchy. The primary elements are by definition basic to structure; if they are taken away the composition desitegrates.” (Norberg-Schulz, 1997, p.150)

A primary element of the composition can dominate other elements by its size. In a co-ordinate system, primary elements define points and directions of the grid. In an axially determined structure, the primary elements emphasize the direction and the possible goal of the axis. The secondary elements may be joined with or be free from the primary ones; they are less articulated.

The ideal classroom shape may be related to the educational program and teaching methods: Small group studies, self studies and one-to-one conversations between students and students and the teacher and diversification of learning activities require multiple focal points in the classroom space. A total flexible space fragmented by separation walls or furniture or a space fragmented itself with small rooms opening to the main classroom area. These small rooms may contain some bookshelves, computers or anything which provides self-study.

“Today children move around much more freely than they did in previous generations, partly an effect of more relaxed teaching methods which were in turn reflecting the spirit of more socially liberated times.” (Dudek, 2000, p.58)

Open classrooms may provide a rich learning experience and encourage social interaction by enabling children to move around freely, see each other and chat. However, this open plan system may cause over stimulation and control problems.

Acoustic and visual separation elements should be used in this type of organization. Closed systems enable control on students; however they weaken the frequency of interaction. In closed classroom organizations there should be places suitable for communication between different age groups such as atriums, stairs, corridors, courts and other gathering spaces.

3.3.3. Typology

The number of possible combinations for school organizations is limitless. However, designers have to choose one of them according to the design criteria set. Similar organizations define school typologies.

Main function groups (classrooms, shared facilities, classroom nodes such as project rooms, faculty, offices, lavatories, and service areas) generally dominate the design. Environmental factors, codes, structural system choice and conceptual decisions influence modern school design.

Linear organizations:

- Successions of classrooms form linear organizations.
-This type is ideal in schools where teaching action takes place mainly in classrooms.
- The organization can be either **single-loaded** with spaces aligned only on one side of the circulation path, or **double-loaded** with spaces aligned on both sides. (Fig.3.23.) and (Fig.3.24)
- The main circulation path can also divide functionally the school facility as classrooms and other shared spaces.
- Shared facilities can also be located at the end of the corridor.
- If the shared facilities are situated at both ends, the corridor traffic, thereby crowdedness and noise, will be reduced with design of the facility.
- The classroom clustering model will reduce the circulation load on the main path by means of secondary corridors and classroom nodes. This type is more appropriate for younger students because as the child grows s/he will need more socializing and gathering spaces. (Fig.3.22.)
- Linear organizations enable direct solar access from one side (or more sides in classroom clusters)

- In some cases the circulation path in single-loaded organizations is designed by architects as a sun and noise barrier.
- Linear organizations are more appropriate for relatively small number of pupils.

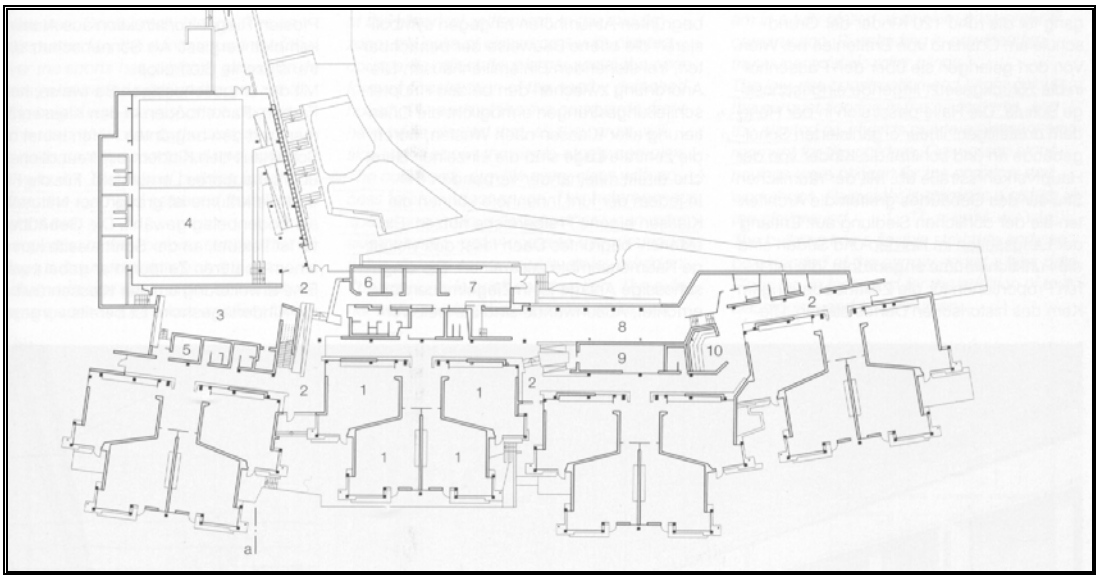


Fig. 3.22. *Primary School in Victoria, Canada: This school organization is linear along the main axis. Classroom clusters are on the side of the double-loaded corridor each linked in a slightly different angle which also brings spatial quality with multiple via on the main corridor. (Source: Wiegelmann, 2003, p.177)*

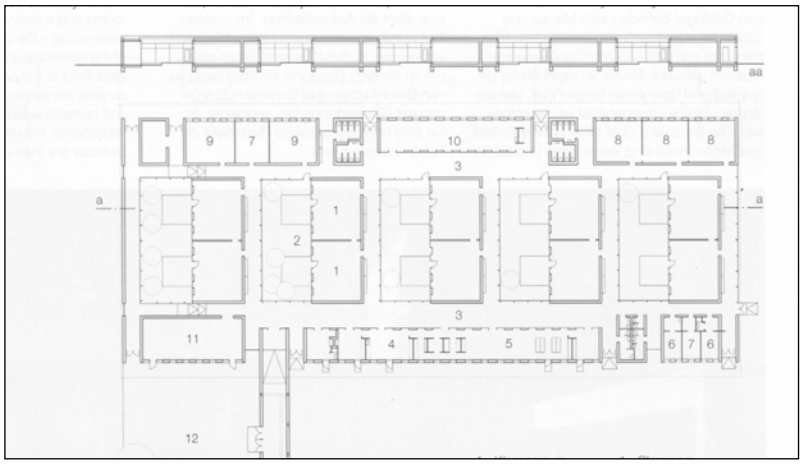


Fig.3.23. *Primary school in Vienna. Classrooms are centered into linear and parallel double corridor system. Each classroom has its own 'secret garden', an open court with vegetation for outdoor studies. (Source: Wiegelmann, 2003, p.179)*

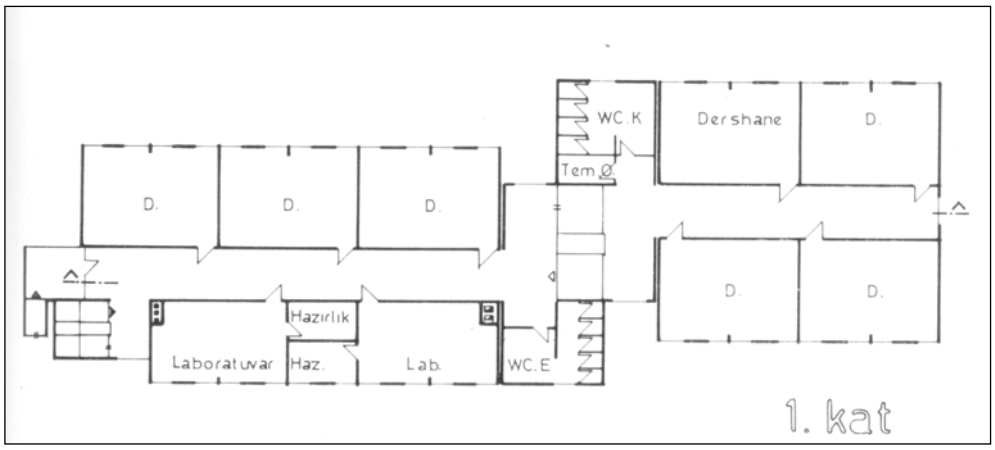


Fig.3.24. *Drawing shows prototype primary school plan with 16 classrooms in a linear plan organization. (T. C. Milli Eğitim Gençlik ve Spor Bakanlığı-Eğitim Yapıları, 1986, proje no: 735/A)*

Central organizations:

- Linear forms can be organized around a large gathering space which can also be closed by a roof glazing and thus create an atrium (or open space create courtyard) (Fig.3.25. and Fig.3.26.).
- The central space should be accessible physically but according to the designer's decisions can also be visually accessible by circulation path or some of the spaces opening up on this gathering place.
- The introverted school type is generally preferred in city school sites where security and environmental conditions dictate this organization (Fig.3.27.).
- This type can be appropriate for relatively crowded schools
- Shared facilities may be centralized or along one side.

(a) *(b)*

Fig.3.25. *(a) St. John School Project, England (Source: Erkılıç, 2000, p.73)*
(b) Upper floor plan and central hall of secondary school: Auf dem Schafersfeld, Lorch, 1973; Architects: Behnish & Partner, Stuttgart (Source: Behnish and Sabatke, 2003, p.149)

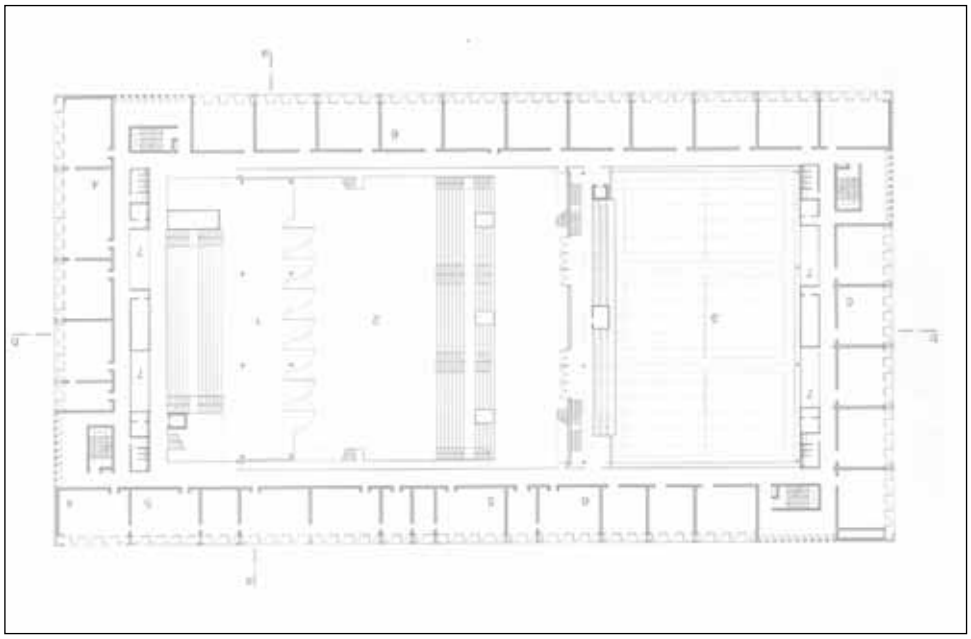


Fig.3.26. *Secondary School in Markt Indersdorf: Classrooms around an multi leveled atrium all directly opening to the main circulation corridor via this activity area. (Source: Wiegelmann, 2003, p.174)*

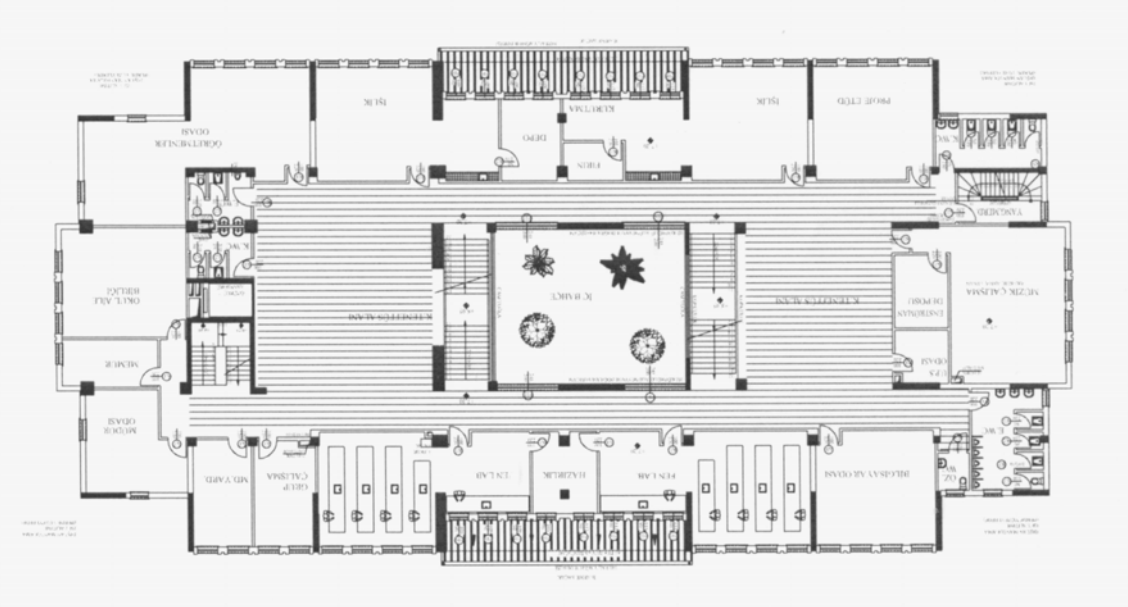


Fig.3.27. *Mimar Sinan University, Primary School for 960 pupils, İzmir-Buca-Tınaztepe, (Source: T. C. MEB, 1997)*

Combined linear organizations:

- **'comb-like' school type**

- The comb-like organizations are formed by two or more linear tracts meeting at an angle (Fig.3.28.).
- In this type, separate tracts may serve to form functional sub-groupings (mainly classrooms for different age groups). One tract may be left for installing shared spaces such as the cafeteria and gymnasium.
- At the intersections, meeting places and shared facilities may be placed. Building entrances may be placed at these areas (Fig.3.29.).
- Comb form can also be two sided like a spine (Fig.3.30.).
- In comb-like type different age groups may become gradually socialized and do not disturb each other during class hours.
- The comb-like form leaves between tracts open areas that can serve as a discrete court for each group. Classrooms may directly open on these courts at the ground level as well as serve as open learning spaces.
- Separate branches work as sun blockers for special courts.
- In this organization type all classrooms can have south facing facades and terraces (or open classrooms.
- The idea of learning from nature may be put to work in these open spaces.

- At the end each circulation path of tracts, fire exits can be provided.

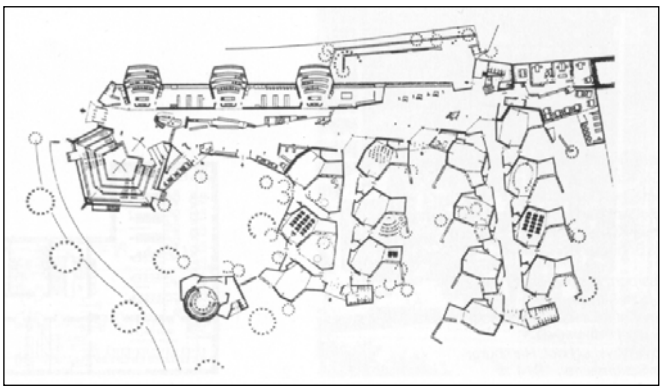


Fig.3.28 *Layout plan of Geschwister-Scholl School, Lünen; Hans Scharoun, 1962. (Source: Wiegelmann, 2003, p.168)*

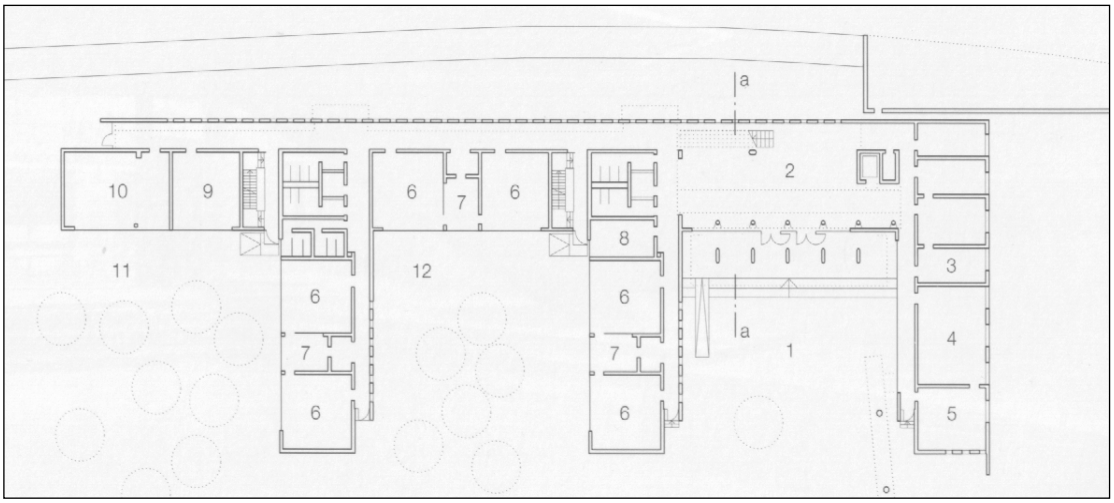
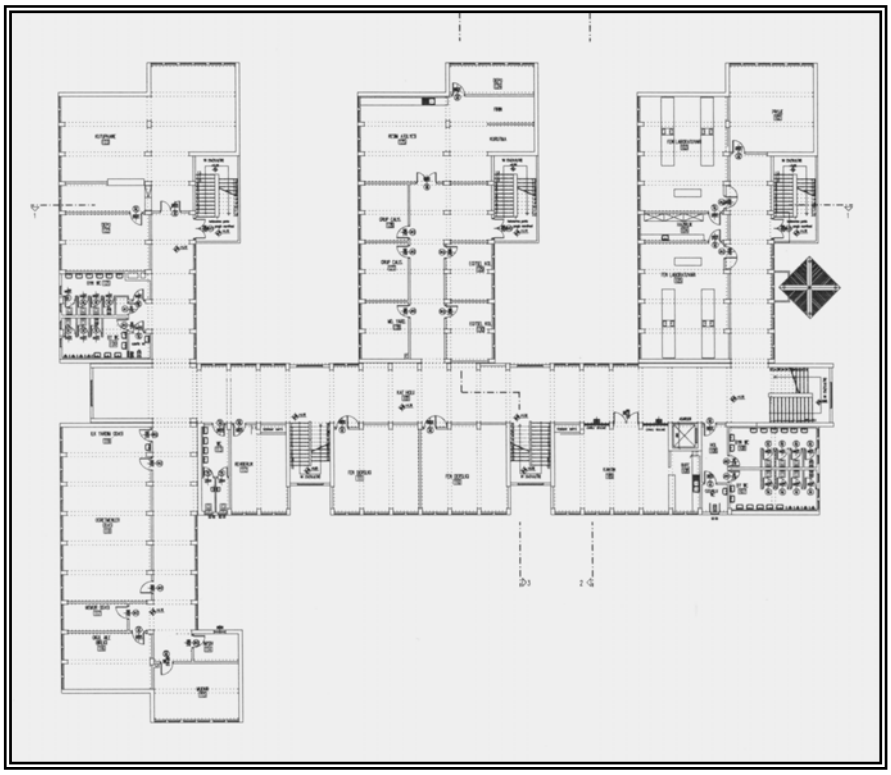
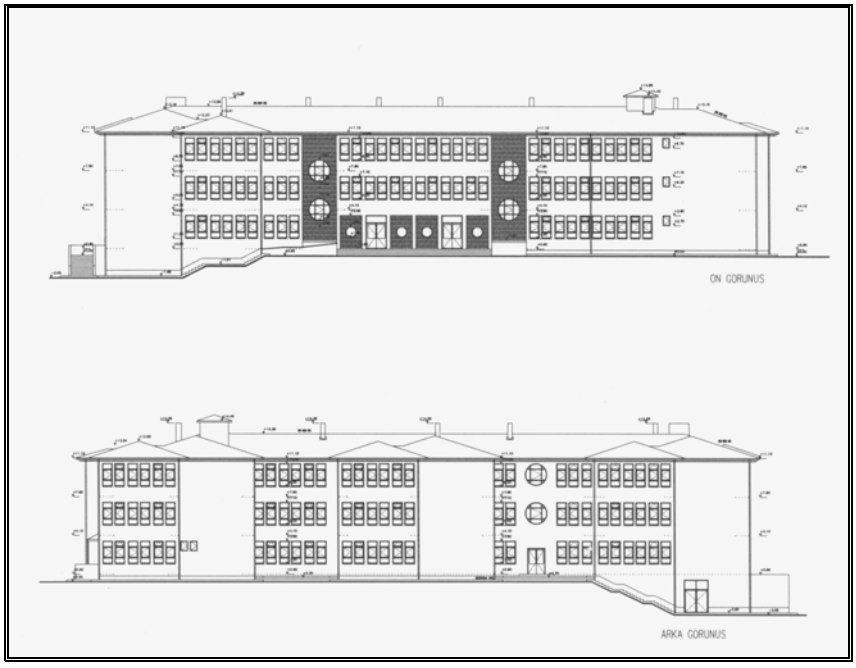


Fig.3.29. *Ground level plan of Special Pedagogic Center in Eichstatt: A typical example of comb-like plan. (Source: Wiegelmann, 2003, p.182)*



(a)

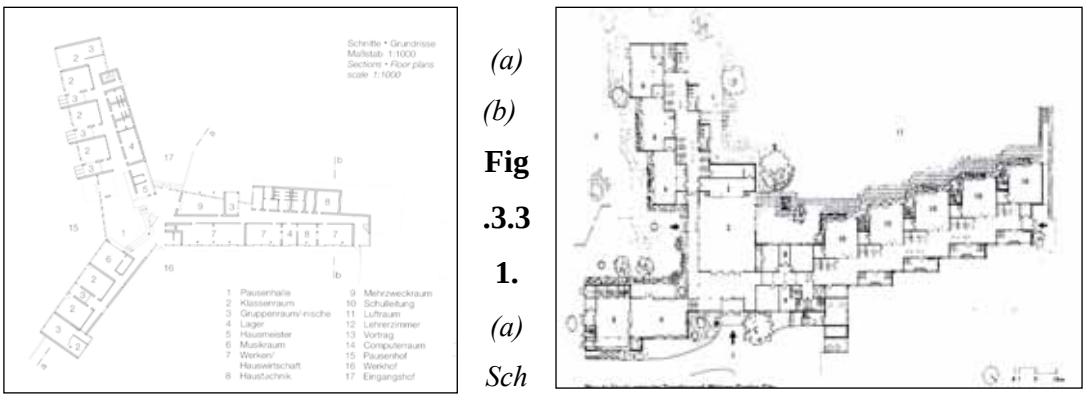


(b)

Fig.3.30. *(a) plan-(b) elevations of Gazi University, Eight Year Primary Education School for 960 pupils, İzmir-Karşıyaka-Şemikler (Source: T. C. MEB, 1997)*

- **Central-linear organizations: (Linear organizations with central focus)**

- In this type of organization linear tracts radiate from a central part (Fig.3.31.).
- Tracts show linear organization properties.
- Tracts can be longer and more comprehensive when compared with comb-like organizations (Fig.3.32.).
- Mutual disturbance is avoided in this type.
- Open courts are less defined than comb-like organizations.



(a)

(b)

Fig .3.3 1. *(a) School for Individual Educational Support in Alzenau (Source: Wiegelmann, 2003, p.185)-(b) Primary school plan: Templewood, Welwyn Garden City (Source: Wilson, 2002, p.92)*

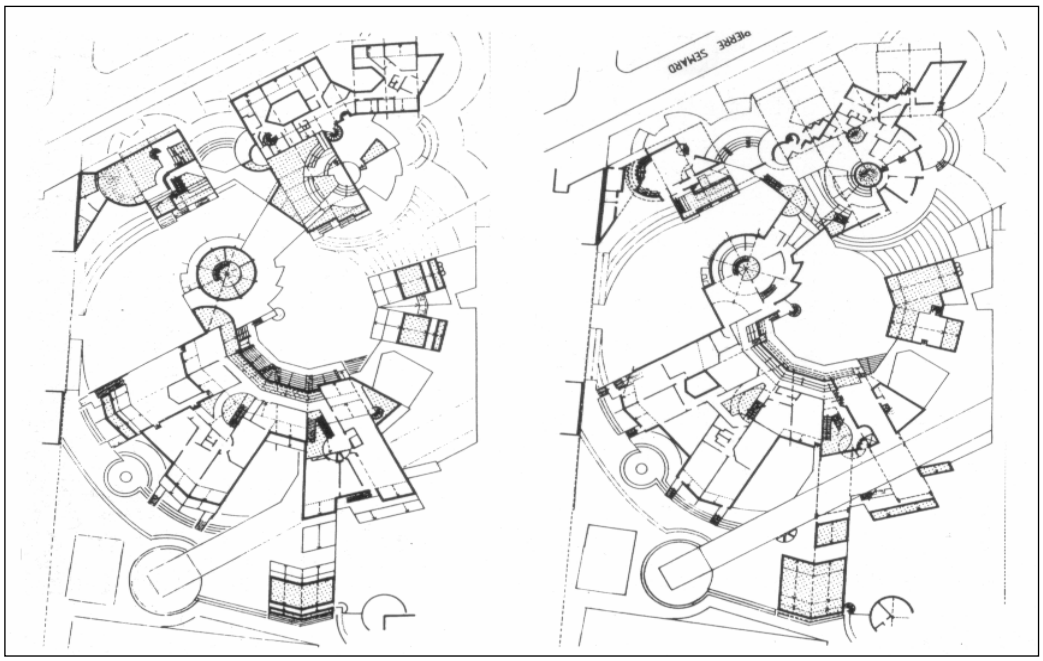


Fig.3.32. *College Pierre Semard (Source: Paganelli, 1998, p.11)*

- **Additive organizations**

- In this type, tracts are organized in a compact form and linked by corridors that meet the main circulation path at an angle, thereby forming a grid system of corridors (Fig.3.33.).

- This form can lead designers to create modular systems because the building organization is like a succession of spaces, sequences along the main axis.

- The structure enables to build new additions along the axis. This property lends the school building flexibility.

- Secondary corridors may contain some service areas, entrances or exits and vertical circulation elements (stair, ramp, and elevator)

- Spaces between sequences may provide natural light inside the building.

(D-p. 186 Heller)

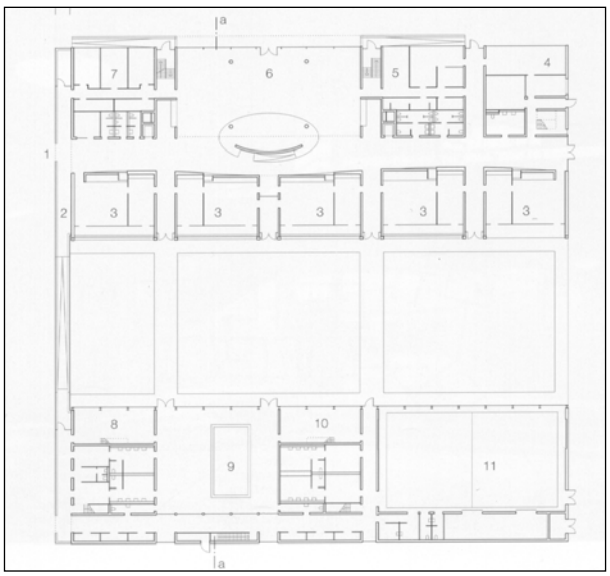


Fig.3.33. *School for Disabled Children in Hellersdorf, Berlin (Source: Wiegelmann, 2003, p.186)*

- **Compact organizations**

- Compact organizations are generally appropriate for relatively crowded city schools.

- Compact city schools usually have atriums which also possess central organization. There are, moreover, also school structures having a glazed space at one façade covering all types of circulation elements and terraces. In these types, this space can also pose as a noise or sun barrier between city conditions and main learning spaces (Fig.39 (a)).

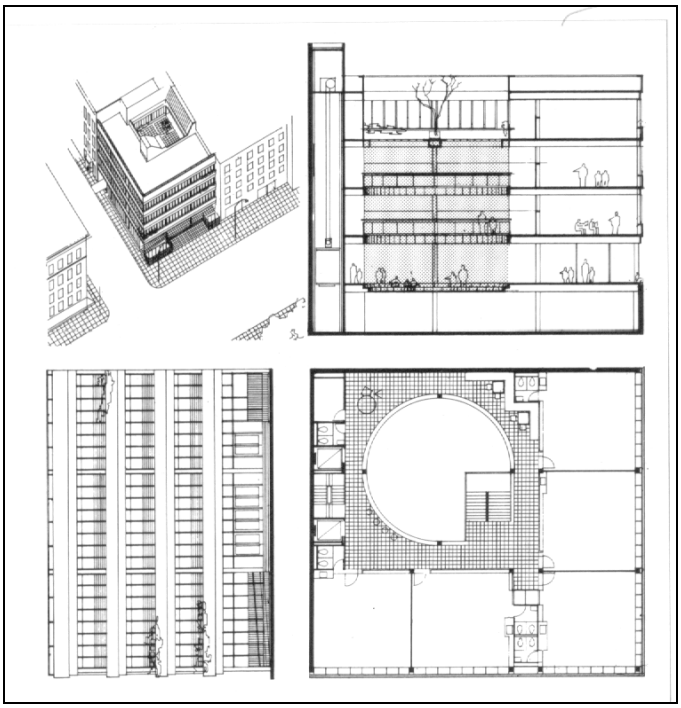
- In multi-storied types, vertical circulation is one of the major problems. Circulation nodes may be placed at corners or in atriums at one side of the building.

- Natural light for classrooms and other spaces is provided by skylights and facades.

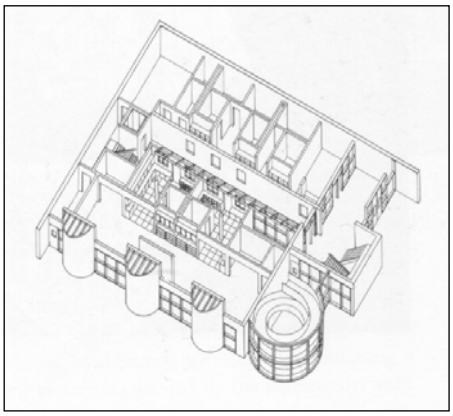
- Socialization poses the more difficult problem to solve in these types because of the multi-layered structure. Circulation spaces around atriums and balconies help children contemplate each other and the activity at the gathering spaces.

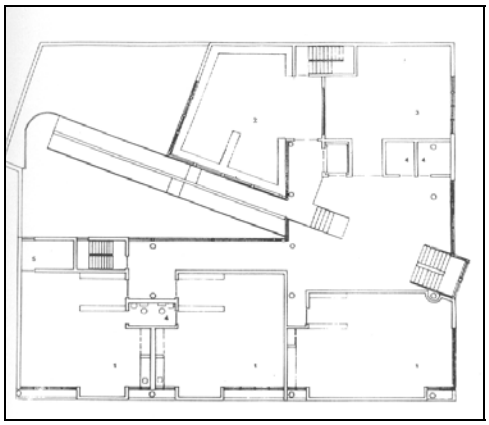
- Security conditions should be maintained in circulation zones. Lower age group learning spaces are generally located at base and first floors.

- Handicapped accessibility is another problem to solve in multi-layered structures. Ramps with appropriate slopes should be designed and elevators should have enough capacity to accommodate wheelchairs (Fig.3.34. (b) and (c)).



(a)





(b) *(c)*

Fig.3.34. *City schools from New York, U.S.A. (a) Atrium School-Clockwise from top left: axonometric, section, plan and façade detail.-Design for a site in Washington Heights in New York by architect Martin Della Paolera (Source: The Architectural League of New York, 1992, p.121)-(b) Axonometric view of the fifth floor of a design for the site in Washington Heights by HMFH Architects (Source: The Architectural League of New York, 1992, p.127)-(c)Design for the site in Washington Heights by Karahan/Schwarting Architecture Company +10 and +15 plan (Source: The Architectural League of New York, 1992, p.129)*

Open plan organizations:

- This type of organization is appropriate for relatively small scaled and single storied schools.
- Under the main compact building structure there are no classroom walls. Boundaries are made by furniture or other mobile elements (Fig.3.35).
- The idea is to spread out learning among different levels, and facilitate socialization by subtracting from separation and barrier elements. The importance given to student interaction is more emphasized by the open-plan organization.

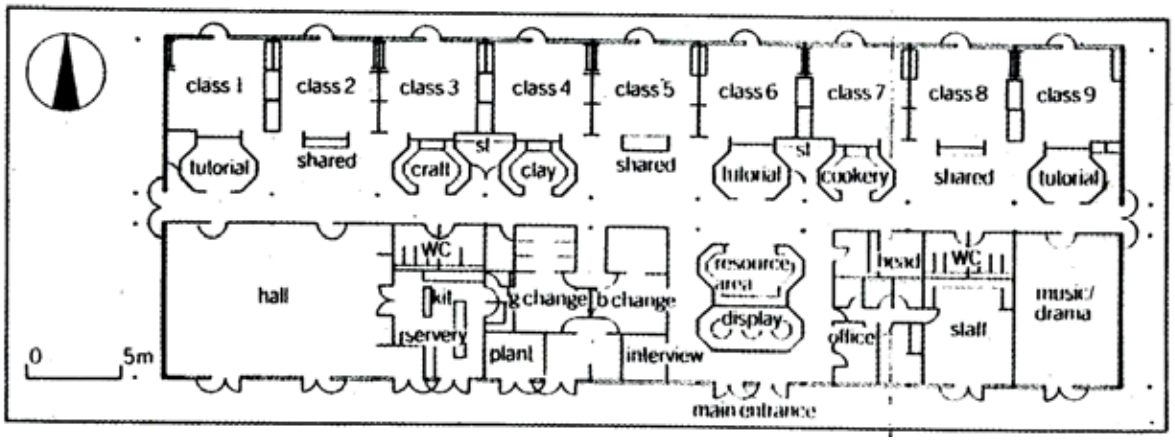


Fig.3.35 *Queen's Inclosure.- School with open classroom system. Steel structure enables flexibility (Source: Öz, 2000, p.64)*

City-like organizations:

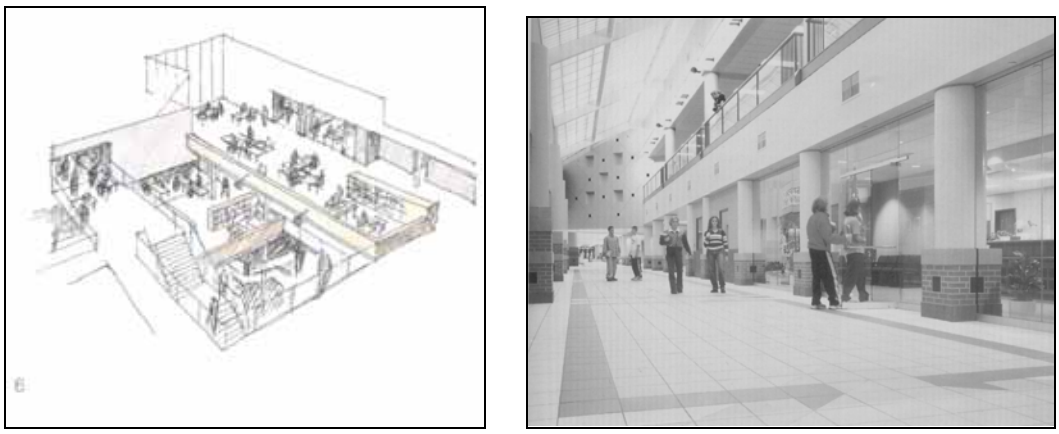
"I believe a school should be a kind of polis, a microcosm. In my spatial concepts, therefore, I am particularly concerned with the zones outside the classrooms. Through greater openness spatially, I ensure that corridors are not just circulation routes."
(Herman Hertzberger, Ein interview mit Hertzberger, Detail, March 2003, p.154)

- Some designers think that the school organization should imitate the city structure or be city-like. The idea comes from the understanding which emphasizes that the school is the transition space mediating between home and society and children should be both physically and socially prepared for the real world.
- Channels of movements (paths), boundaries (edges), areas of recognizable identity (districts), places of intense activity (nodes) and points of reference (landmarks) should be legible in this type of organization (Lynch, 1993, p.46).

- School campuses offer the ideal structure to implement the concept of the city-like school concept.
- In single buildings the organization of atriums, large halls, shared areas, circulation elements help design the city system of activity such as public places, and traffic zones (Fig.3.36. (a)).

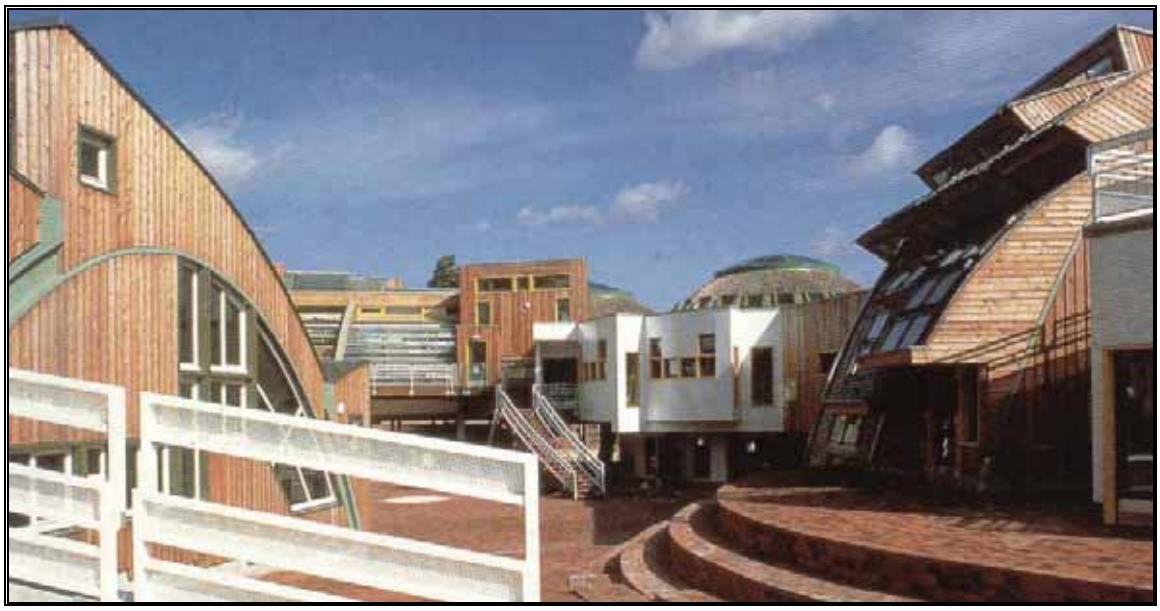
As in a city structure, indeterminate areas may be left to the children's interpretation of space.

- With main halls and atriums, urban three-dimensionality is imitated by architects. In daily life people move about in cities proceeding from one place to another and up and down, seeing spaces from different vistas. The linking staircases and balconies (some of them may not positioned directly above each other according to the design) which enables a series of visual links. (Fig.3.36. (b) and Fig.42)

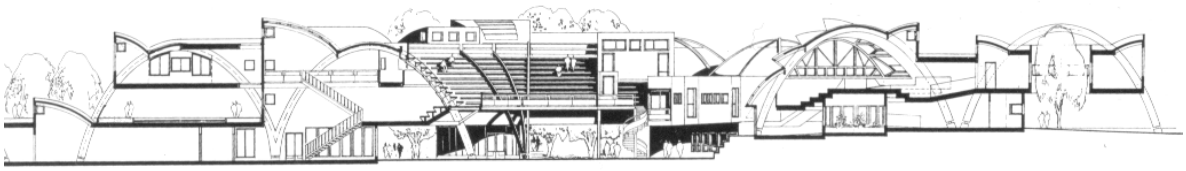


(a) *(b)*

Fig.3.36. *(a) Atlas College, Hoom, 2002-04 (Source: Dray and Bergers, 2003, p.154)*
(b) Clear circulation paths, can be dynamic streets where students interact between classes. Fanning/Howey Associates. (Source: Perkins, 2001, p.197)



(c)



(d)

Fig.3.37. *(c) and (d) College Pierre Semard: Integration of students and teachers is the essence of College Pierre Semard's design concept. The school structure offers students and teachers a chance to meet together and exchange views. While the administration building faces the road (and the city) with wide glass surfaces. In contrary the interior section (Fig. (d)) is designed in a urban design scheme, featuring an alterning combination of teaching-recreation facilities (such as a restaurant, film projection room, library and gymnasium).*
Furthermore overhead walkways, subways and steps form a suggestive 'architectural promenade' converging towards the central square. (Source: Paganelli, 1998, p.10)

- In this concept, there is also the idea that the school space should be familiar. Children should be able to sit wherever they want and use spaces in their own way and differently. For example they may use stairs to sit or study, corridor niches to sit in groups and chat, etc. (Fig.3.38.).

(a) *(b)*

Fig.3.38. *(a) Landings become luminous chatting spaces similar to sitting rooms. (Source: Roth and Moore Architects, 1998, p.20)*

(b) Niches in corridors scaled for children become personal study spaces. (Source: Perkins, 2001, p.179)

Campus type organization

- In hot climates the campus type allows semi-closed areas such as sun shades which also cover circulation paths between buildings.
- Separate buildings house education spaces for different age groups (Fig.3.39.).
- Outdoor gathering spaces are the more commonly used areas.
- Outdoor boundaries and barriers

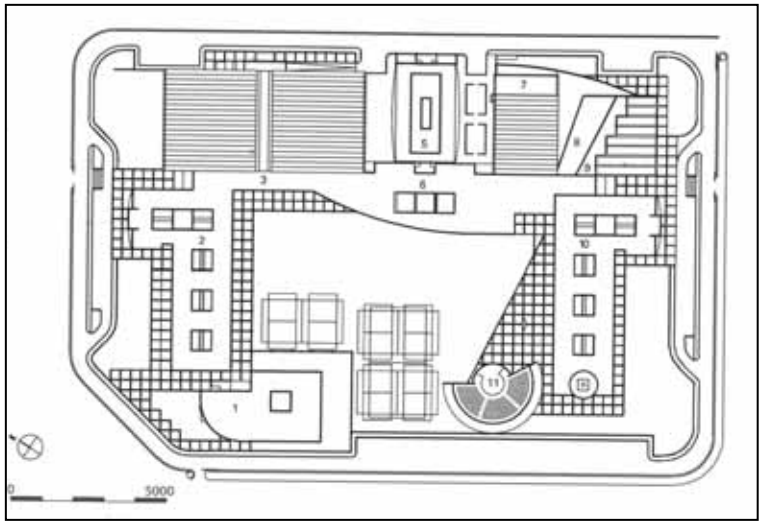


Fig.3.39. *Işıkkent Education Campus. Architect: Haydar Karabey. (Source: Öz, 2000, p.66)*

3.3.4. Legibility

Legibility is an aspect that determines the quality of a structure at formal and semiotic levels. The formal articulation derived from the function-structure or the course of action of the designer increases legibility inside or outside of the space boundaries. Legibility provides a communicational milieu among the structure, the user, and the users' orientation.

Visual links, color, material, signs, hierarchy of circulation paths, articulation of spaces in the total composition are helping factors of legibility. They may indicate differentiation of function, location, adaptation (to physical environment).

The designer may choose to articulate the structure by leaving the system exposed as an architectural expression (Fig.3.40. (a)). The visible-structure system enables legibility and gives students sense of security.

(a)

(b)

Fig.3.40 *(a) Secondary school: Auf dem Schafersfeld, Lorch, 1982; architects: Behnisch & Partner, Stuttgart (Source: Behnish and Sabatke, 2003, p.150) functional spaces are accentuated in plan and elevations*

(b) 'Çırağan' private primary school, Istanbul, Turkey. (Source: Yürekli & Yürekli, 1999, p.67) Impossible read function of the building and different spaces.

-Hierarchy:

Dimensional differentiation of mass-elements and space-elements lends the school building legibility. Gathering spaces having different capacities can be articulated in the third dimension. Different function-spaces or those having similar functions (i.e. classrooms), their linearity or grouped forms may also be articulated. Variations of rhythm and solid/void on façades may indicate functions and building entrances.

-Material differentiation

Material differentiation may indicate transition from one space to another. Surfaces of exposed concrete, steel, stone, wood and brick and other construction elements have their own natural surface texture and color as well as degrees of hardness and softness. Coverings and clad elements will introduce their own colors and texture.

Contrast materials such as steel and wood and exposed concrete and wood create an artistic contrast in color as well as in softness/hardness of materials.

-Color differentiation

Color design lends buildings legibility and makes them comprehensible both indoors and outdoors (Fig.3.41.).

Color differentiation indicates transition spaces, circulation zones, prohibited areas for children, or danger (electricity, mechanical rooms).

Application of colors in harmony or in contrast, balances creates a joyful energy in indoors and outdoors by strengthening the architectural expression of the design in the third dimension.

"I use color spontaneously, ignoring theories and economic and psychological constraints. I am receptive to various constellations: a field of energy, for example which can make it possible to juxtapose opposing charges… The harmony of material and immaterial energy is decisive for spatial form. Some visionary can perceive the circulation of the resonance zones by a field of color. The sensibility of the visionary determines the depth of perception."

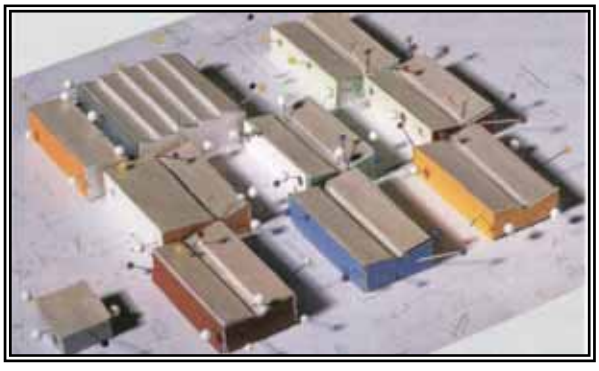


Fig.3.41. *Special Support School, Schunk Ullrich Architecten, München. (Source: Schunk, 2003, p.217)*

3.3.5. Orientation and identification

Cognitive mapping: cognitive maps are psychological impressions or representations of individuals' ability to understand space and the organizing elements by which they orient themselves.

Lynch categories the elements people ordinarily use to map an environment as follows:

Paths (channels of movements), edges (boundaries that break or contain or run parallel to the forms, districts (areas of recognizable identity), nodes (place of intense activity), landmarks (points of reference) (Lynch, 1993, p.46).

Cognitive maps usually combine several of these elements that are simply not indicated in a floor or site plan, but three dimensional characteristics of a space, the material choices, the colors, and the lighting can all impact the formation of edges, districts, or nodes.

Signs can be used in identification of places such as color, graphics and texts for small children scaled to their age and number, change of wall color, type or texture, change in flooring, use of lighting to highlight or minimize areas, change of ceiling treatments, furniture arrangement or type.

In a school building spaces should be both familiar and new. Children should feel homely atmosphere in particular places created by objects, colors, materials and other aspects of design which help them identify 'their home'.

Colors may indicate students their path and lead them to specific learning spaces or the place of excitement and activity zones where they can learn by discovering (Fig.3.42.).

As an element of 'safe design' color can indicate as well danger or spaces where entry is forbidden to children; but it can also signal a fire exit or a similar function.

(a) *(b)*

Fig.3.42 *(a) Color use in circulation paths for identification and orientation. School for Individual Educational Support in Alzenau. (Source: Wiegelmann, 2003, p.185)-(b) (Source: Wiegelmann, 2003, p.187)*

3.3.6. Flexibility

A flexible structure is a structure whose elements may be added or removed, thus allowing it to shrink or grow without losing its formal composition. Open rows or groups particularly make this possibility. Furthermore, flexibility may imply that elements themselves and their interrelations are changeable.

Each form is considered to have its own ability to join with others. The more concentrated the form, the less it has this ability. A straight line and a plane surface define directions. However, the closed curve returns to its starting point. A form which can be extended along a line or direction can formally shrink or grow, For example, an upright cylinder can be extended in one, while a cylinder laid out on its side in two directions while the sphere has maximum concentration. The pyramid has more ability to join other units when compared with a cone because of its plane surfaces. Symmetry also stresses the concentrated form and in itself is a complete form. Any deviation from symmetry has to be distinct to be formally active.

Two adjoining surfaces treated in similar fashion obtain continuity and help stress the concentration of the building mass. On the contrary, the continuity disappears and the concentration is weakened. Concentration also depends on the design of the corners. While round corners stress concentration, broken or unclear corners bear opposite effect. If the openings in the bounding surfaces have niche character, they will stress

massivity. If the holes are increased to the maximum possible, the mass becomes transformed in the skeleton. Otherwise, small openings stress massivity.

Fig.3.43 *School mass is lightened by discontinuity of the surface differentiated by texture and color. Montessori College Oost in Amsterdam (Source: Bergers, 2003, p.228)*

Illumination, color and texture are other elements that influence the concentration of mass elements. As a texture, a polished surface can make the mass dissolve, otherwise it may stress its concentration (Fig.3.43.).

3.3.7. Originality of the design

'Style' is the formal character of a system of forms giving each one a meaningful frame.

The concept of style can be defined as a 'statistical ensemble'. Architectural elements and their combinations within a symbol-system appear with varying degrees of probability. That means that certain elements and combinations appear frequently, others rarely. Furthermore, elements and combinations which are foreign to the system and which belong to other systems may be included in the system:

"Two kinds of probability are relevant. Firstly we have the purely formal or syntactical probability which is described through an investigation of the properties of the *system*. Secondly we have the pragmatic probabilities resulting from the actual use of the forms. If a form with a low syntactical probability is repeated often, it will lose its originality, and if, on the other hand, a probable (banal) form is avoided it will seem interesting or even ingenious, when it is finally used." (Norberg-Schulz, 1997, p.156)

If a work of architecture is original on one formal level and conventional on another. The hierarchy of formal levels is the determinant of total originality. A work of architecture original at all levels is considered revolutionary.

"The original creation, hence, does not consist in breaking the system *itself* in such a way that it unveils 'hidden' possibilities."

An element can also create the originality with its place in the structure.

"A system which consists of one level only and which employs simple elements and relations, therefore only permits revolutionary or banal solutions." (Norberg-Schulz, 1997, p.157)

School designs have relatively strict architectural programs. There are repetitive spaces like classrooms or laboratories which have to offer users more or less the same conditions. However, new design concepts accentuate the importance of socialization and gathering areas as well as small group study spaces. The rise of the concept moreover, of learning from nature in the field of education has forced architects to create outdoor classrooms and courts that include vegetation. Solar energy use, building envelope design and other technologies have changed the appearance of the school building. The stress of transparency in new educational theories, the need for security in western schools has produced transparent spaces that seek to create multiple visual links. In the light of these concepts, several designers created with usual, well known and new school spaces more or less original designs revealing 'hidden possibilities'.

3.3.8. Variation

Two principles are important in 'variation': 'repetition' and 'deviation'.

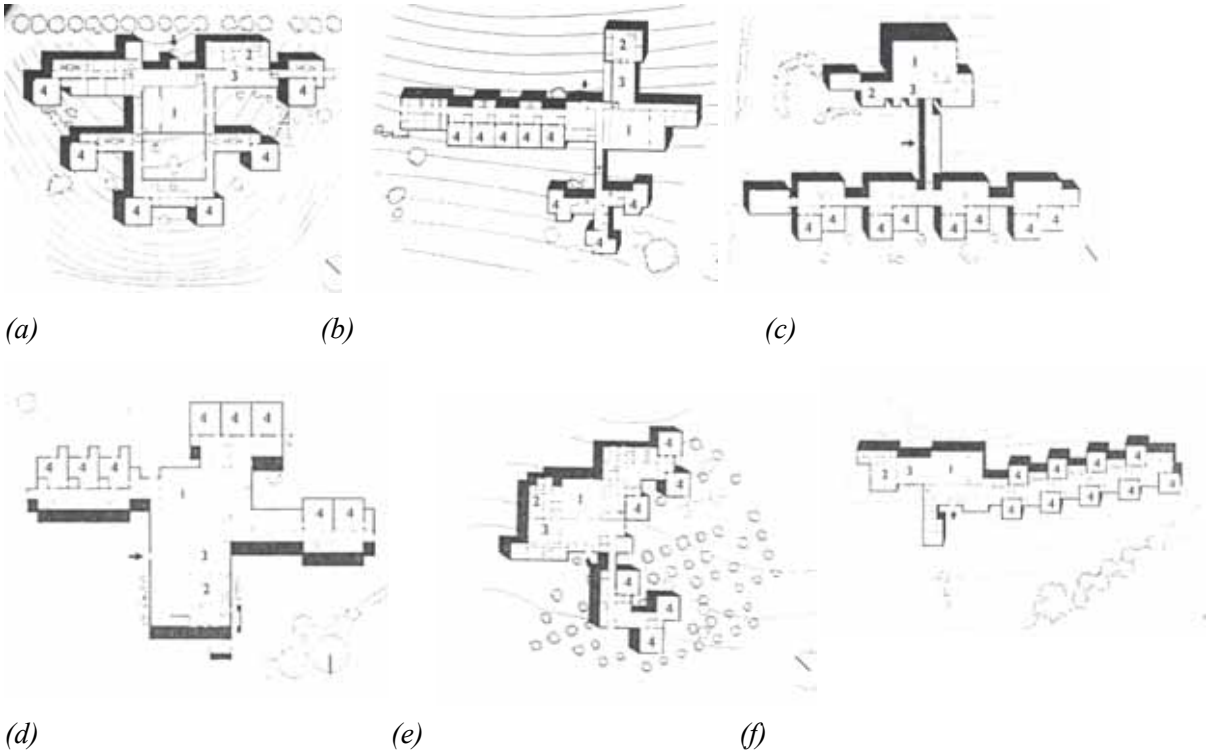
"Groups, rows, and enclosures may not only be varied at infinitum by means of simple or combined relations, but also through variation of the elements. The elements within a group, for instance, may be similar or dissimilar and create relations of repetition, contrast or dominance." (Norberg-Schulz, 1997, p.150)

Variation ought to nevertheless follow the principle of form constancy. In other words, certain properties ought remain the same in order not to break the balance of the whole composition (Fig.4.45.). Fig.3.44. shows variation of functional spaces according to topological relations. However classrooms may also be varied by deviations from the main form or in a hierarchical order.

"In general the word 'rhythm' denotes the relational property of succession, while 'variations' denotes element-properties derived from a common basic source. Themes with variations may appear on any formal level…Within the individual building the

theme can be a pregnant mass-element, space-element, or surface-element." (Norberg-Schulz, p.153)

Successions of elements should not, however, render the composition 'banal' with repetitions. Variations may appear on the surface level, or on mass and in the architectural space.



(a) *(b)* *(c)*

(d) *(e)* *(f)*

Fig.3.44. *(a) Monkfith Infants School, East Barnet,(b) Cowley Hill School, Borehamwood, (c) Belswains School, Hemel Hempstead,(d) Morgans Walk School, Hertford,(e) Aboyne Lodge Infants School, St Albans,(f) Spencer School, St. Albans (Source: Wilson, 2002, p.92)*

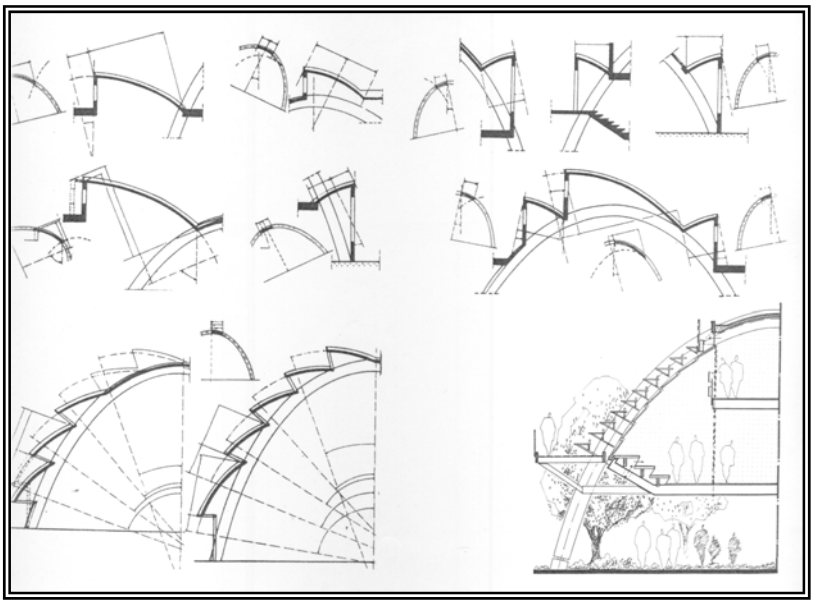
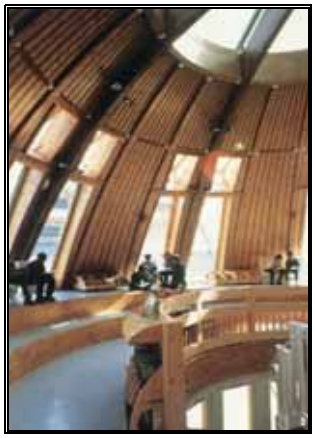


Fig.3.45. *College Pierre Semard: Structural fragmentation and formal variety is aimed in the design of classrooms which are all quite different from each other. "Some of them feature conservatories, while others border on a small amphitheatre. The curved façade design creates a series of easily identifiable building volumes and improves the internal lighting"*
Formal variety also serves identification of spaces and orientation. (Source: Paganelli, 1998, p.10 and 12)

3.3.9. Attractiveness of the design

A building should serve user needs by means of its functional structure, but it should also appear attractive in order to make them psychologically comfortable. Especially elementary and primary school buildings are the transition spaces for children from home to a more complex social milieu. They ought thus facilitate this intermediary phase by distracting them through stimulation of curiosity. School buildings should be formed by exciting spatial sequences that in various ways form a stimulating environment for learning. A beautiful landscape or a waterfront space can be distracting while a colorful space and objects can be stimulating.

Colors can also be used as calming or concentrating element especially in classrooms. There are extant several research that demonstrate the effects of color on children's blood pressure. Furthermore, a school space ought at once constitute a communicational milieu by stimulating the entire spectrum of the human senses. In addition, many educational theories draw the attention to the role of 'play' in the learning phase. Attractiveness is also important mainly for young children.



(a) *(b)*

(c)

Fig.3.46. *(a) North Fort Myers High School, Fort Myers Florida.(Source: Perkins, 2001, p.68)-(b) A gathering space from College Pierre Semard (Source: Paganelli, 1998, p.13)-(c) LEGO Child Care Center, Enfield, Connecticut (Source: Perkins, 2001, p.63)*

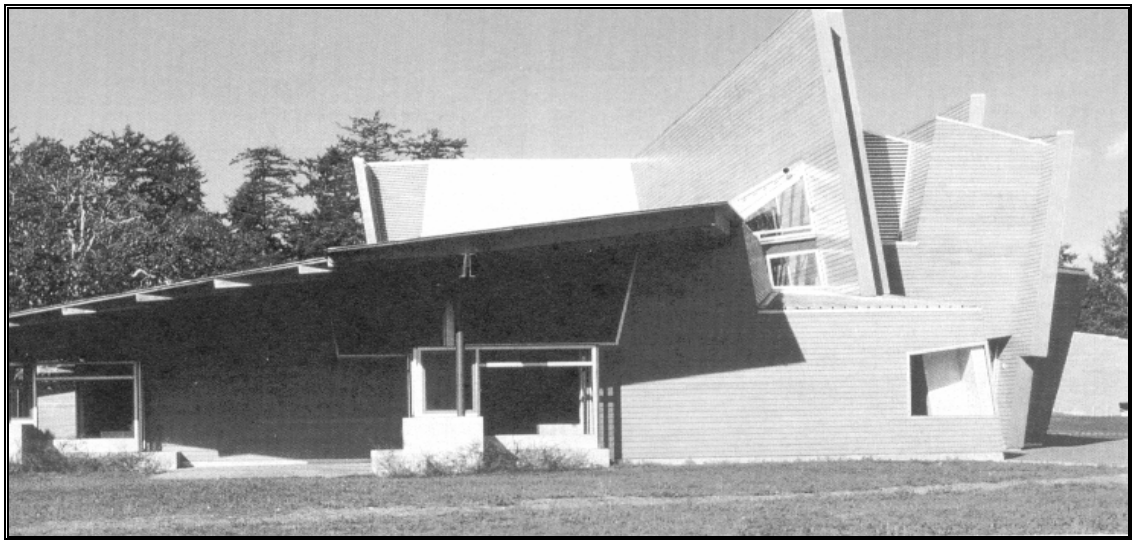


Fig.3.47 *Primary School in Victoria, Canada (Source: Gür, 2002, p.113)*

3.3.10. Course of action of the designer

If the definition of the work of art is the concretization of a symbol-system which is formed by meaningful messages containing a certain moment of surprise without breaking completely with the expectation, a creative individual can be defined as possessing the faculty for producing these concretizing symbols. Norberg-Schulz further describes the effect of work of art as:

"The work of art concretizes intermediary objects, where our emotional reactions only form one of the components. Other symbol systems, such as religion and certain ideologies, also concretize value-objects." (Norberg-Schulz, 1997, p.68)

The role of the 'creative individual' is thus to concretize symbols and possible complexes of new combinations formed by known elements. The intentions of the artist are the important part of the creation process. The complexity of symbols to be concretized determines the succession of these intentions. Real creative activity continues Norberg-Schulz, of course, transcends the repetition of known reproductive schemata. Generally it has to be characterized as a deviation from 'normal' behavior, and important artists rarely find immediate recognition. But the deviations should not be accidental.

Each project has its own set of requirements such as an architectural program, and cultural, environmental, technological, and aesthetic contexts that constitute a unique situation for a precise site. The architect or designer teams collect data from the site and its environment and analyze them in order to create the design options. In the synthesis phase, the combination of all this data or information is unified into one solution.

At this synthesis phase designers choose one combination of the collected data according to their own intuitions and experience. In fact very few designers will use equally all the information.

There are also external effects which influence the designer's choice such as available technology, materials and codes, client's wishes and desires, etc.

As internal effects, the designer's education, cultural formation and his or her own design style can be considered:

"Any experienced designer will note the importance of the nonrational, the nondescribable, and the poetic in the creation of a successful building design. At key points, judgment, taste, intuition, and creative talent take over." (Perkins, 2001, p.78).

This statement implies that; sometimes function follows form according to the designer's own vocabulary of formal and aesthetic ideas.

3.3.11. Regional Influences

Regional influences include national models, regional formal vocabulary, influences between different cultures (generally as a result of trade), regional materials, and environmental influences (climate and other variables).

Culture may be defined as the common order which is the result of collaboration and the transmission of information. In such order culture may come to be shared and thus may be said to admit of being taught and learned. Participation in a culture, points out Norberg-Schulz, "means that one knows how to use its common symbols."

School buildings may use the advantages of regional materials remaining in harmony in form and scale with the regional building characters.

3.4 Structural and Mechanical Systems

3.4.1 Structural System

Turkish design criteria for school structures are classified by Ministry of National Education as: Structure loads, soil examination, alternative structure systems (flexible, modular systems), structural materials, seismic considerations, fire resistance and prevention, circulation systems (elevators, shafts etc.)

In developed countries generally primary school buildings are two or three storied. Many different structural systems may be applied in the school construction as well as beside the concrete construction, masonry-bearing wall, wood frame, poured-in-place concrete, precast concrete, steel frame and Teflon-coated fiberglass fabrics are just a few of the systems employed (Fig.3.48.).

(a) *(b)*

Fig.3.48. *(a) 'The Wilbert Snow Elementary School in Middletown, Connecticut designed by Jeter Cook & Jepson Architects, illustrates the aesthetic potential of an expressed wood structure.' (Source: Perkins, 2001, p.126)-(b) Lincoln Elementary School, Lincoln, Massachusetts. Steel structure used for aesthetic effect. (Source: Perkins, 2001, p.127)*

Ten of the typical factors which school systems and their design teams consider in evaluating structural systems are building life, fire safety, seismic considerations, flexibility, cost, aesthetics, long span spaces, prefabricated and pre-engineered structures, foundations and special issues such as structural systems for swimming pools and sport areas, fiberglass roofs design and construction for these large spaces.

- Building life
- Fire safety:

Usage of fire-resistant structural systems, such as fireproofed steel, concrete, glue laminated beams etc.

- Seismic considerations:

Seismic design can affect the choice of systems as well as their cost and flexibility.

- Flexibility:

"A bearing wall structure particularly when the partitions between classrooms or the corridor walls are load bearing is one of the least flexible systems." (Perkins, 2001, p.124)

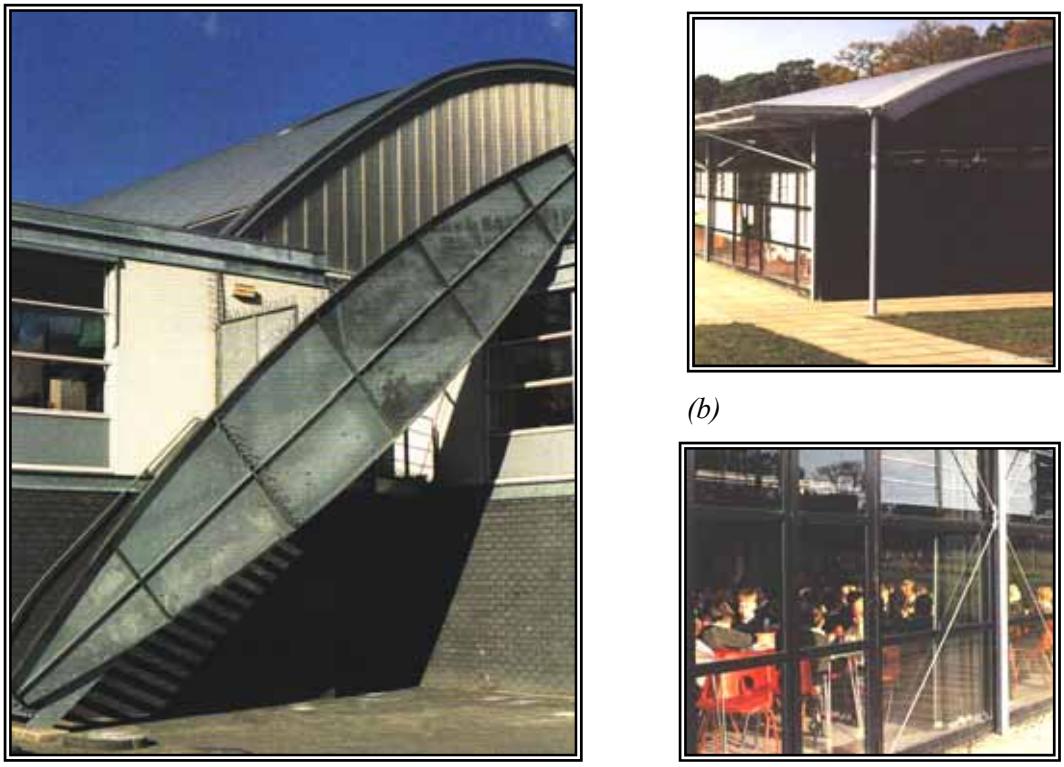
The structural system should allow for future additions and modifications according to new educational programs.

- Cost:

The structural system cost constitutes 10 to 15 % of the construction costs. "The cost-effectiveness of any system will vary according to changes in market conditions, regional preferences, code requirements, relative labor and material costs, and other factors. Nevertheless, the choice of lowest cost is typically the system that combines the local construction industry preference with simple fabrication and readily available materials." (Perkins, 2001, p.124)

- Aesthetics

"The structural system can be a major aesthetic consideration in the design of schools."(Perkins, 2001, p.124) (Fig.3.49. (a))



(a) *(b)* *(c)*

Fig.3.49. *(a) Anne Frank School, architect: H. Hertzberger (Source: Güzer, 2000, p.51)-(b) Queen's Inclosure (Source: Güzer, 2000, p.52)-(c) Queen's Inclosure (Source: Öz, 2000, p.63)*

- Long span spaces

Steel, trusses, precast concrete and glue laminated beams can be used in the construction of spaces such as cafeterias, gymnasiums, auditoriums, swimming pools, etc. (Fig.3.50.)

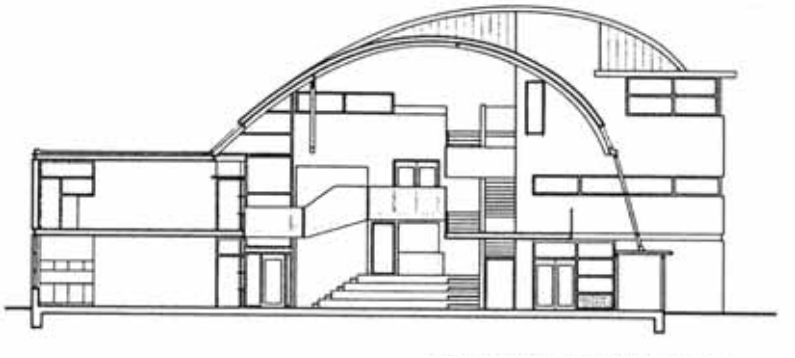


Fig.3.50. *Anne Frank School: Steel structure used to cover circulation and gathering spaces. (Source: Öz, 2000, p.60)*

- Prefabricated and pre-engineered structures

Their attraction mostly consists of the acquisition rather than of cost or quality. Although the cost of pre-engineered structures is not significantly different from other alternatives, the major advantage of them is the reduction in design, fabrication and delivery time. The disadvantages of pre-engineered systems are that many require pitched roofs with greater volume to heat and cool and more complex partitioning. Furthermore, much of the metal siding and roofing used as exterior cladding material generally have limited lives and are viewed as unattractive.

- Foundations

Poor soil conditions may cause problems. Therefore the geotechnical analysis should precede the design phase.

- Special issues (structural systems for swimming pools, budget for flexible systems, fiberglass for roofing large places such as tennis and pool areas etc.)

(Perkins, 2001, p.127)

3.4.1.1. Appropriateness of materials and methods of construction to design (The choice of the optimum construction material and system)

"The materials used to construct a school building should be durable and maintainable. They should withstand years of use and abuse while continuing to provide an atmosphere conductive to learning." (Perkins, 2001, p.147)

However the problem is not only to choose the most durable materials. Settings in schools in the U.S. and other western countries are generally vinyl tile floors, painted concrete walls, cold fluorescent lighting, and numerous wall and corner protection accessories that generally do not create a homely or friendly atmosphere. Dark corridor walls painted in grey, hard surfaces, colorless classrooms and insulation problems are common properties of most of the national schools and many private schools in Turkey.

In other words, Turkish schools have extra problems apart from the quality of physical space because of inappropriate material selection and details. One of the reasons is that they were thought to cost economically less in the short term. However, in the long term, the appropriate material use proves more cost-efficient.

Some of the standard school material options for U.S. schools (Table 3.6.):

Roof	***Structure***	***Exterior Walls***
Membranes	*Concrete block*	*Clay masonry*
Built-up system	*Concrete*	*Cast/precast*
Shingles	*Poured*	*Concrete block*
Slate	*Precast*	*Prefaced block*
Metal	*Steel*	*Stucco*
	Stone	*Panel Systems*
	Wood	*Stone*
		Glass

Interior walls	***Floors***	***Ceilings***
Concrete block	*Resilient tile*	*Acoustical tile*
Gypsum board	*Hard tile*	*Gypsum board*
Plaster	*Carpet*	*Exposed structure*
Wood	*Wood*	*Metal*
Metal	*Sheet flooring*	*Wood*
Glass	*Poured floors*	
Tile	*Concrete*	
Partition	*Terazzo*	
Glass block	*Stone*	
	Cork	

Table 3.6. *Materials (Perkins, 2001, p.148)*

Fig.3.51. *Wooden structure of an elementary school:. Edinburgh Steiner School. (Source: Erkılıç, 2000, p.72)*

Fire codes, design loads, health regulations, regional influences, and contaminant materials are other aspects affecting material selection.

- The classification of fire resistant materials should be based on the **flame-spread rating** of the material. Turkish design codes recommend steel doors and stairs at fire exits.

- Design loads, site, soil and weather conditions and seismic property of the area are influencing factors in structural material selection.

SBS is the 'sick building syndrome' caused by poor IAQ, in other words by poor indoor air quality. Some materials can be air contaminant sources such as adhesives, upholstery, carpeting, copy machines, manufactured wood products, cleaning agents, pesticides, combustion products.

- The Volatile Organic Compound (VOC), which is found in adhesives, finishes such as paints and varnish, carpet and carpet padding, treated wood, some pressed composite wood products, some roofing materials, various insulation materials, and pesticides are indoor air contaminant sources that outgas once installed in a construction project.

- For a sustainable environment, low or non-volatile organic compound-containing materials should be selected. Water-based or natural finishes that do not contain formaldehyde, halogenated solvents, mercury, lead, or chromium are preferred.

- Natural and natural based materials such as brick, stone and natural wood (cedar, redwood, black locust have decay-resistance) should be preferred over chemical-containing materials.

3.4.2 Mechanical Systems

Mechanical systems have a direct effect on the school's occupants because their role is to make ergonomically comfortable, and a well-designed system with appropriate heating, cooling, humidity control, air cleaning and ventilation can support the learning phase.

The school building should support a sophisticated mechanical staff or the appropriate system.

The systems should be both easily understandable and maintainable. Boilers, chillers, pumps, and air-handling equipment ideally should be in easily accessed and enclosed rooms, with space around the equipment adequate for service and replacement of major components when needed. (Perkins, 2001, p.129)

Generally, few mechanical systems are used in schools in Turkey mainly because of economic problems. However, a well-designed system can be cost-effective in the long term. In order to lower cost, in selecting systems, schools should be aware that **energy savings and lower maintenance costs often justify the higher first costs of more efficient systems.**

These systems should also be flexible. In other words, they should possess the ability to accommodate growth and change because schools often in fact have to grow and change. For example:

-Piping should not be buried in concrete, mechanical rooms should be expandable…

-Boiler equipment should be designed in modules so as to be easily expandable and to provide redundancy, with no unit providing more than two-thirds of peak heating demands. (Perkins, 2001, p.129)

3.4.2.1 Appropriateness of building systems to the energy efficiency issues

The Turkish Ministry of National Education categorizes energy efficiency issues in primary school buildings such as: Heat transfer, building envelope design, HVAC systems (heating, cooling, ventilation and acclimatization systems), water heating, waste management and solar energy usage, lighting and sustainable energy. (T.C. MEB, 1997)

Energy efficiency is one of the major issues in school design because energy saving provides lower construction and occupancy costs. Thus this issue constitutes a major part of the sustainable design understanding. In USA energy conservation in schools has focused on the six major consumers of energy: lighting, heating, air-conditioning, domestic hot water, ventilation, other pieces of mechanical and electrical equipment (pumps, elevators, computers, kitchen equipment, audiovisual equipment, etc.)

Lighting:

- Use of double circuiting so that only the number of light fixtures required is turned on.
- Photocells also are used in some areas such as the major public areas and circulation spaces. More automatic adjustments of light levels using this technology may be justified.
- The use of time clocks and motion detectors to turn off lights automatically.
- Use of low-energy fixtures, such as light emitting diode (LED) exit lights and high pressure sodium lamps for parking lots.
- Turkish school design criteria recommend fluorescent lighting and incandescent lamps in uncommonly used areas such as library corridors and storage spaces etc.
- Outdoor lighting elements should consist of high pressure sodium lamps or fluorescent lamps. (T.C. MEB, 1997)
- Fluorescent lamps ought not be used in mechanical rooms. (T.C. MEB, 1997)

Heating:

- Tightening the performance of the building envelope by adding wall and roof insulation. Building vestibules for the main entrances.

- Improved controls, including direct digital controls, which more quickly and efficiently adjust heat levels in space so as to reflect changes in occupancy and solar gain.
- Low E window coatings.
- More efficient boilers and related systems reduce energy costs through fuel gas heat recovery, fuel dampers, dual-fuel combustion, high efficiency combustion, and other features.
- More efficient distribution systems, such as variable speed pumping, and independent zoning for temperature control help to reduce the heating and cooling energy lost in distribution.

Ventilation:

- Heat recovery systems that transfer the exhaust heat to the incoming cold air or, reciprocally, the exhaust "cooling" to the incoming hot humid air.
- Installing a warm-up cycle during fan start-up on cold mornings.
- The installations of relief vents and exhaust systems.
  (Perkins, 2001, p.113-116)

ASHRAE is the abbreviation of 'The American Society of Heating, Refrigerating, and Air-Conditioning Engineers'. The State of New York's Manual of Planning Standards based on ASHRAE Standard 62.1 recommends for schools the following ventilation values:

Occupied areas	**15 cfm** *per occupant of perimeter area*
Locker and shower rooms	**1 cfm** *per sq ft of floor area*
Toilets	**2 cfm** *per sq ft of floor area*
Kitchen-dishwashing	**100-150 cfm** *per sq ft of floor area*

cfm: *cubic feet per minute*

Table 3.7. ASHRAE *ventilation values. (Perkins, 20, p. 129)*

More ventilation is needed for kitchens where heat and odors may cause problems. Occupied areas such as the classroom need more ventilation than do toilets, locker and

shower rooms because of the indoor heat that needs to be conserved, and thus less ventilation is needed.

3.4.2.1.1 Solar Energy:

-Active and passive solar systems:

Active and passive solar systems are two ways for solar heat technologies to control solar energy. Active solar systems, which are a hardware addition to the building, may increase the construction cost of the building. These systems are alternative means of producing space heating, cooling, or service water heating and are usually well adapted on conventional systems, whereas passive solar energy control is provided by building envelopes designed to reduce solar gain for cooling and increase solar gain. Obtaining low construction costs in passive buildings depends on the effect of the interaction of disciplines on the design team.

"If a more expensive building envelope significantly reduces the size of the mechanical heating and cooling system required, no construction cost savings will occur unless the mechanical engineer recognizes the reduced building load." (H. T. Gordon et al., 1990, p.335)

- **Building Envelope Design**

A building envelope is any surface that separates the thermally conditioned interior of a building from its environment. The building envelope includes roofs, exterior walls, floors, slabs on grade and foundation walls.

The building envelope is also an aesthetic function and a tool of architectural expression (Fig.3.52). A building envelope can either be load-bearing or designed with, or separated from, skeleton systems. In addition it bears barrier function between environmental effects. A filter, for example, can be waterproof and water vapor resistant; it can provide thermal comfort, good air quality and control the transmission of ambient noise and light (Fig.3.53.).

Fig.3.52. *Building Envelope structure. Queen's Inclosure (Source: Güzer, 2000, p.53)*

The envelope functions;

-as a thermal valve: through its thermal resistance the envelope regulates the flow of thermal energy from the interior to the exterior environment.

-as a radiant filter: the envelope transmits, absorbs or reflects radiant energy. This is true for other wavelength radiations such as ultraviolet, the visible spectrum, infrared or terrestrial radiations.

-as an air infiltration filter: the design of the envelope determines the air infiltration level into a building. It can filtrate air pollutants and involuntary odors. The air can enter into a building intentionally by vents and fans and should be either heated or cooled to obtain the desired temperature.

-as an energy collection or distribution: the envelope regulates energy flow to the building interior. Many solar thermal systems collect radiant energy at the building envelope to enhance the building's thermal performance. (In some commercial buildings the exterior walls house ductwork, 'light shelves' that distribute natural light or plenums that collect and distribute thermal heat.) By adding photovoltaic devices, electrical energy can also be collected by the envelope.

-as a thermal, electrical or chemical store: the building envelope can store energy. Some passive solar applications (such as mass walls) use the skin of the building to provide thermal capacity in which heat can be stored for later use. Generally, this capacity is provided by massive materials such as concrete block or brick.

"…envelopes may soon become even more intelligent dynamic filters by using computer controlled devices for selective shading or movable insulating systems, or by using building materials whose properties change in response to changes in the environment." (Prowler D. and Kelbaugh D., 1990, p.83)

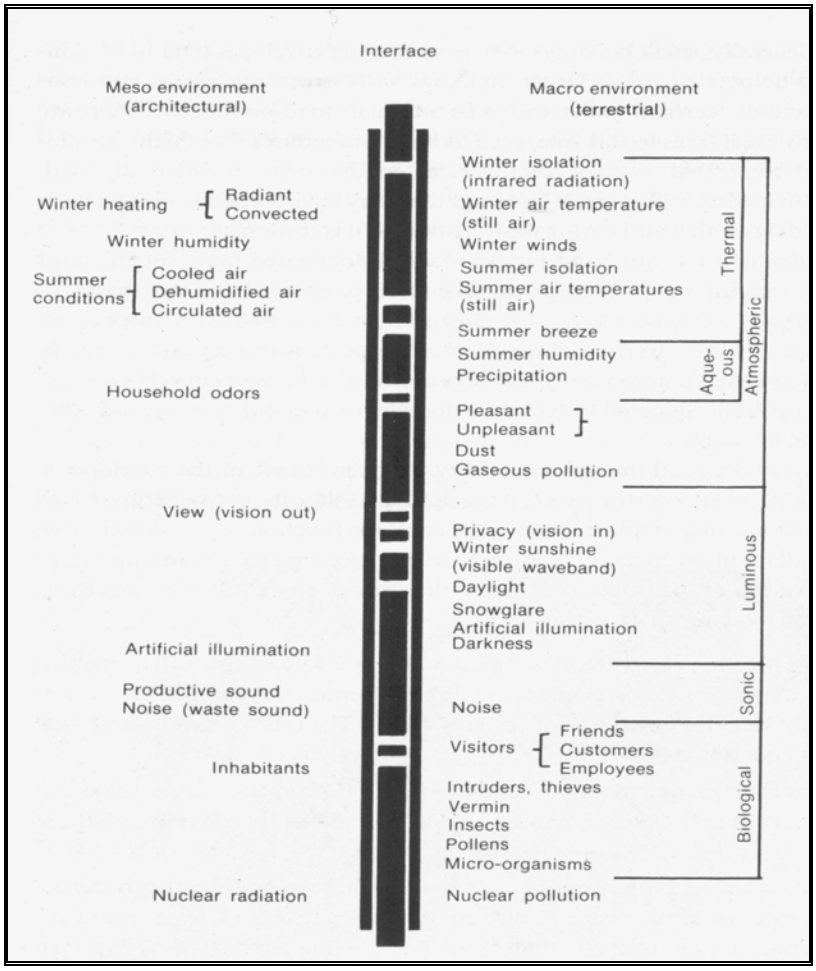
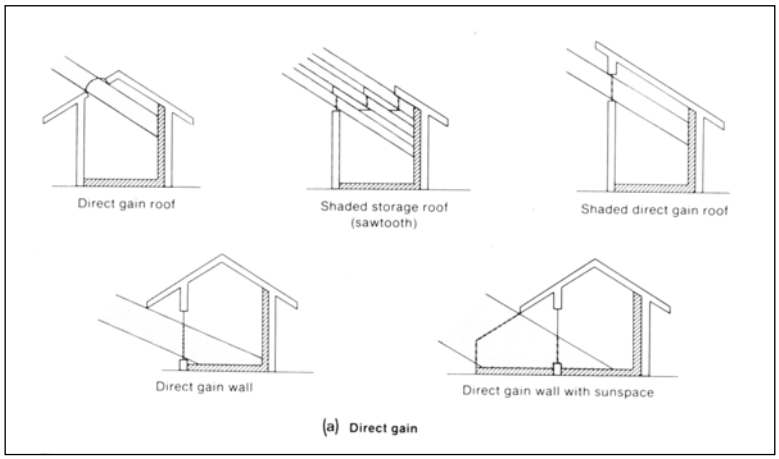


Fig.3.53. *Building Envelope (Source: Prowler and Kelbaugh, 1990, p.79)*

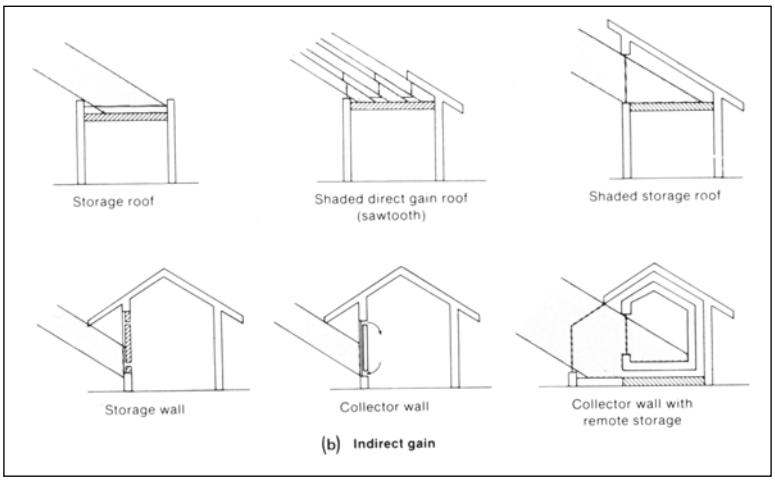
Passive Solar Design Considerations

Unlike active solar systems, which are additions to the building for collecting energy, passive systems usually make use of the elements of the building itself to collect and store energy (Fig.3.54.) (H. T. Gordon at al., 1990, p.321).

- Conceptually, passive systems are often thought of as load modifiers (rather than load suppliers, as in the case with active systems)
- They change the building's fundamental need for heating
- Although active systems have a minimum effect on the occupants of building, passive solar systems are normally integral elements of the building and can directly affect occupants



(a)



(b)

Fig.3.54. *(a) and (b); Direct and indirect passive solar gain from roof and walls. (Source: Howard and Fraker, 1990, p.170-171)*

Active Solar Design Consideration

Active systems can easily be used in a conventional building.

Many solar heating systems were constructed because they were readily understood and could be made to work reasonably well with the conventional heating systems in the building. (H. T. Gordon at al., 1990, p.317)

Active solar systems can provide an economic advantage where natural gas or electricity is used for heating.

Solar panels are often tied into a school's conventional hot-water production system and also serve heat loading. (Perkins, 2001)

The implementation of active solar collection systems in nonresidential buildings may pose some problems for designers because they are relatively larger and more collectors are needed for heating/cooling systems. (Fig.3.55.) Architects have to find ways of dealing with a major visual element:

- The most common approach is to place the collectors on the roof.
- Integrate the collectors with the overall form of the building either by creating bold sloping planes that accommodated the collectors.
- Or by separating the collectors from the building and using them as part of another functional element, such as a covered walkway.
- Wind and snow loading on collectors should be well thought.
  (H. T. Gordon, 1990, p.317)

Fig.3.55. *Solar energy collectors on the roof of St. George's School (Source: Gordon et al., 1990, p.319)*

Photocell-controlled lighting:

This technique can reduce lighting energy demand in a school building with the efficient daylight design. Photocells serve to control the amount of lighting in the classrooms and in parking areas.

Photovoltaics (PV):

These systems are designed in combination with normal grid-supplied electricity. For example in a school building, it is possible to use the system to run the electric pumps and blowers of a solar thermal desicant air-conditioning system at high speed on a sunny afternoon, and then switch over to grid-supplied power for the low-speed, nighttime demand. (Perkins, 2001, p.118)

Other energy technologies used in schools may be geothermal energy and wind-generated energy.

3.4.2.1.2. Controlled climate: heating and cooling systems

Basic classroom HVAC needs:

The basic components of classroom HVAC systems recommended by ASHRAE (The American Society of Heating, Refrigerating, and Air-Conditioning Engineers) include:

- Heating and ventilation in all classrooms.
- Air-Conditioning for classes used year-round in warm, humid climates.

- Summer dehumidification in humid climates.
- Economizer cycles for use during winter months.
- Separate temperature-control zone for each classroom.

  (Perkins, 2001, p.132)

In elementary schools the ventilation of some spaces need to be more carefully examined because of the complexity of their programs such as gymnasiums, auditoriums, computer classrooms, science classrooms, and art rooms etc.

- Locker rooms, toilets and showers in gymnasiums should be directly vented to the outside because these spaces require a great deal of ventilation.
- Odors, such as those caused by animals in science rooms and some art media, require adequate ventilation. At higher degrees, science classrooms may require fume hoods with special exhaust systems. At minimum, the ventilation system should be carefully designed to maintain negative pressure relative to adjacent spaces. Independent temperature control should be provided for each science classroom.
- Libraries and media centers should be air-conditioned because in most climates these spaces should be better air-conditioned in order to better preserve books and other materials.
- Humidity control should be installed in computer classrooms.
- In auditoriums proper placement of air-supply intakes and exhaust outlets (low in space) can facilitate stratification of much of the generated heat above the occupied zone. Some air should be exhausted near or in the ceiling to remove pockets of hot air. Mechanical rooms should be isolated in order to avoid acoustical problems. Lobbies and ancillary spaces such as toilet rooms should have different heating and cooling requirements and should probably be served by separate systems or temperature-control zones. Unusual loads created by lighting and the activities on stage should be taken into consideration.

  (Perkins, 2001, p.131-132)

As mentioned before, in order to conserve energy in heating and cooling outside air, some of the air, some of the air already in the building is re-circulated and under certain circumstances, this recirculation can cause concentrations of everyday substances to reach unacceptable levels which may cause health problems.

Some of the main air pollutants are:

- An ozone hazard caused by photocopiers should be avoided by extractor fans or open windows in order to protect users from eye irritation.
- Visual display terminals.
- Humidifier fever: Some humidifier systems can provide a breeding ground for bacteria and other microorganisms, as can accumulation of water in cooling systems and air ducts, particularly if the water contains organic substances from other sources.
- Low relative humidity (less than 40 percent) may also increase the risk of respiratory infection.
- Formaldehyde in many manufactured wood products, including particle boards, and in ceiling tiles, carpets, and urea-formaldehyde foam.
- Much of the dust in occupied buildings consists of dead skin cells.
- The air in modern buildings may be deficient in negatively charged small air ions. Air ions are charged molecules of the various gases found in the air. In offices, air ions are destroyed by contact with metal air ducting, dust, smoke and static electrical charges on visual display unit screens.

  Introduction of negative ion generators into office reduce the incidence of dizziness, nausea, and headaches.

  (Bridger R. S., 1995)

School building spaces should have natural ventilation channels besides the mechanical air-conditioning. Air-conditioning systems are advantageous when the temperature and relative humidity are not adequate for the specific learning activity.

*** Flexibility in structure systems**

Flexibility of structure systems enables repair, additions and subtractions of building parts.

3.4.2.2. Implementation of technology in spaces

Turkish National Education primary schools generally do not have computer rooms available for all students. The new educational program aims at providing students and teachers with computer literacy.

In Western schools computers are available in libraries, classrooms, laboratories and multipurpose spaces in forms of desk-tops and lap-tops (Fig.3.55.).

(a) *(b)*

Fig.3.56. *(a) Montessori College Oost, Architect: Herman Hertzberger. (Source: Fritzenwallner, 2003, p.162)*

(b) Classroom designed with computers, South Lawrence East School, Lawrence, Massachusetts (Source: Perkins, 2001, p.145)

Television set, tape recorder, film projector and overhead projector are no longer the materials of the new era of technology. The computer and the internet, on the other hand, have a significant affect on western educational theories.

Spatial effects of computers on school design:

* Computer laboratories

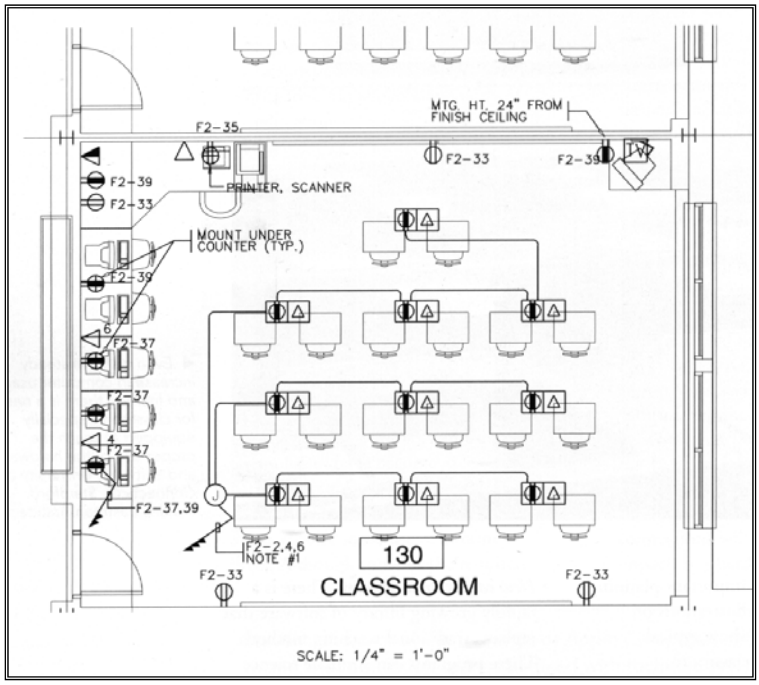


Fig.3.57. *Organization of power cables in a typical classroom under the raised floor.*
South Lawrence East School, Massachusetts. (Source: Perkins, 2001, p.144)

* Classrooms and furniture accommodating computers

"In wealthier districts and private schools, new classrooms are being planned on the assumption that every student will eventually have a laptop, plus access to classroom computers linked to school wide and the Internet." (Perkins, 2001, p.142) Internet connections such as local area network (LAN), wide area network (WAN) are considered in school design and renovations (Fig.3.57.).

In the future it is expected that wireless systems will bring about other changes in the classroom configuration.

* Power cables designed with the furniture

* Library as media center

In developed countries, books are no longer the only educational tools in libraries. New media including Internet connections, videotapes, CD-ROMs, CDs, audiotapes, and the like have caused several modifications in the design. Book shelves are replaced by these information technology tools.

* Radio and television center

* Audio-visual equipment

Although the computer has largely replaced them, overhead projectors, and slide projectors remain common audio-visual equipments in classrooms

* Number and future number of users of these technologies

* Location and type of wiring (less costly copper as opposed to more expensive and flexible optical fiber or a combination thereof)

* Location of laboratories and servers

CHAPTER 4

4. CONCLUSION

Schools should be ideal places for the education and socialization of young members of a society. Spatial qualities and organization should bring comfort; have an appropriate scaling and carry aesthetic attractiveness. In that, the influence of school conditions on student performance and achievement is a generally shared idea by researchers of the western world.

Flexibility of plan can be maintained by open ended circulation paths or by a modular design in a way that grouped function spaces can be repetitive. Appropriateness of spaces for future additions and modifications are important features for a school building, not only for the functional organization but also for the interior design of different spaces: Developments in the technological areas and detoriation of building parts and materials require flexibility of architectural elements for implementation of technology and renovation.

Each site has its own physical environmental conditions. The aim should be maintaining the best school building layout and indoor/outdoor spatial comfort for students and instructors in order to create an environment inductive for the learning and teaching processes as well.

Topography, vegetation and man-made structures should be utilized as filters, barriers and modifiers of sun, wind, rain, snow and similar effects appropriate to different climate zones (cold, temperate, hot humid and hot arid regions). These elements should have the role of creating transitional spaces between indoors and outdoors such as sun shades bearing the role of solar heat and light control.

As an element of urban fabric, the school building site should provide the conditions of accessibility and security. In addition noise and air pollution control should be maintained by the most appropriate layout of the building according to site limitations.

Children between the ages of seven to fifteen (which span corresponds to the eight-year primary school education in the Turkish educational system) need more secure spaces than adults due to the fact that their physical development is not yet completed within the said age span. Security preventions against crime and injuries in the indoors and outdoors are extremely important in a defensible school space. Such environment may be created by increasing visibility and surveillance by means of transparent

separators, walls and windows, locating functionally the administration premises and entrance to specific areas. Circulation zones should be designed with minimum obstacles. Location of fire exits should be designed with minimum length of circulation paths. Circulation paths should be well lit for the prevention of crime and injuries.

Illumination of functional spaces helps the performance of students. Natural light arranges body rhythms of children. The minimum and maximum lighting limits are important for eye-health. Researches show that fluorescent lighting prevents glare and is appropriate for artificial lighting. Color is a helping and strengthening factor of lighting.

Thermal comfort and acoustical quality of spaces are other factors influencing functional effectiveness of school spaces. External sounds (which should be minimized by the building envelope), layout of the building (teaching spaces should be remote from activity zones inside and outside of the site), the use of sound absorbent materials, form and dimensions of spaces (maximum sound path lengths should be calculated), background noises (of noisy light fixtures, HVAC, etc.) and reverberance limits for lecture rooms should be taken into consideration.

Sustainability as a design concept will influence the functional structure of the school building: Sustainability requires flexible spaces and extra spaces for recycling and incorporation of vegetation into the building.

Design of play sets and areas should have properties such as accessibility, diversity and clarity flexibility. Play sets should offer a space both secure and challenging with difficulty spaces. The outdoor space should be open to multisensory stimulation in other words the greatest range of colors, smells, textures, shapes, sizes, sounds, objects, materials, interactions, people, climate, time, space, movement and change. Vegetation also should be used in the learning process: children should contemplate and learn the life cycle through plants.

Compared with western countries, Turkish schools have maximum student number per classroom and thus minimum classroom area per student. Furthermore, playground area per student and lot area per student are at the lowest range among ratios in western countries. The Turkish Ministry of National Education models pursue western educational systems and programs. However the increasing number of students and classroom need after the eight-year primary education system are the obstacles behind the solution of this problem.

School space should be ergonomically suitable for different age groups. Tables, desks, chairs, computer furniture, computers, blackboard, doors, windows, handrails

and ‘panic barres’ suitable for normal and disabled children’s size as well as indoor climatic conditions of comfort such as humidity, heat, cold and light, air quality, noise control are among conditions which a school should provide students as ergonomic qualities. However, Ergonomy does not mean that everything should be at the child’s size. School space should also incorporate a certain kind of challenge and thereby play a preparative role to the real world in a balanced way.

A school’s organization may be designed in different configurations. The sole solution is not simply to align classrooms along a corridor. Early and contemporary western examples prove that variety and three-dimensionality should be properties of school spaces. Legibility, flexibility, variation, attractiveness and originality of the design should be the other concepts of school design.

From topological relations clusters and groups (proximity relation), rows (continuity relation) and their combinations can be formed. Their organization according different school design concepts create different school typologies. Linear, central, combined linear, central linear, additive organization types and compact, open plan and city-like design concepts create a great variety of school types. Legibility can be obtained by hierarchical differentiation of building parts or material (texture, color) and color differentiation which also serve orientation and identification of spaces. Formal flexibility implies use of forms that have abilities to join with each other. The principle of variation requires the repetition of a main form with deviations. Colors, materials, three-dimensionality creating different paths to various activities, natural elements and playful environment can bring attractiveness to the school environment. The course of action of the particular designer and regional influences are other influencing factors of the school design.

The building structure should be chosen according to the building life expectancy, fire safety codes, seismic considerations, the potential of flexibility of the structure system, the cost-effectiveness of the system, capacity to pass over long-span spaces such as cafeterias, gymnasiums, auditoriums, swimming pools, etc. (often steel beams or laminated wood structures are used in western examples). Prefabricated and pre-engineered structures will diminish the construction phase and bring modularity to the system, which increases the flexibility of the school building.

A well-designed mechanical system can be cost-effective in the long run. Lighting, heating, ventilation, domestic hot water, other pieces of mechanical and electrical equipment (pumps, elevators, computers, kitchen equipment, audiovisual equipment

etc.) should be designed according to energy efficiency issues. Active and passive solar heat technologies can be used to energy gain. The building envelope may function as a thermal valve, radiant filter, an air infiltration filter, an energy collector or distributor and a thermal or chemical store between architectural and terrestrial environments.

Technology implementation techniques in educational spaces should be one of the major problems of the Turkish Ministry of National Education, in that, one of the aims of the national education program is to make students and teachers computer literate. Classrooms and furniture should accommodate computers: organization of electrical outlets, elevated floor design, furniture designed for cable connections, etc.

Primary school design can be evaluated according the qualities cited above. An evaluation list should be created regardless of a certain quality is included in the design phase.

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