POTENTIAL PROBLEMS AND CHALLENGES IN DEFINING INTERNATIONAL DESIGN PRINCIPLES FOR SCHOOLS

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Abstract. *The paper is concerned with the spatial condition of school buildings and the preconditions it contains for encouraging and facilitating learning through a social, cultural and informational interface. The paper is organised into three parts. The first part identifies key factors that must be considered when addressing design quality in educational facilities. Major international current trends in school design are reviewed, based on a range of research studies, from the reflective practice of educators and design professionals to the empirical work of architects, social scientists and educational researchers. The second part explores criteria and methodologies for assessing and evaluating school building conditions and educational adequacy. Post-occupation Evaluation (POE) methodologies are analysed and recent models in practice are outlined. The third part discusses the implications of defining international design principles for planning and assessing school buildings in such a way that they take account of the leading educational innovations of the day.*

Introduction

When talking about public/institutional buildings, such as schools, both the relationship between physical/spatial forms and the bodily/social function consists in key aspects. Buildings are planned to suit a particular social organisation, which implies that individuals and groups with different roles and status occupy different places. Buildings are thus the final result of an often extended and complex decision-making process, which involves the conversion of socio-cultural objectives into a spatial (architectural) form, attending for constraints such as time, costs, and legislation (Lawson, 1997). It is according to how both forms and spaces are elaborated into patterns – spatial layout - that the socio-cultural function may occur. The spatial layout embodies the social nature of the building through which it localises people and modulates their interaction as well their experience of the place[1]. Hence, the spatial 'component' must not be disregarded but considered as a significant factor of how the socio-functional processes are (or not) generated (Hillier, 1996: 24). Thus, it is how the spatial layout is defined – structured and organised - and, consequently, how it relates to some kind of social expression.

School buildings are a particularly specialised type of public/institutional buildings. They are designed to make use of space as an educational tool regarding both the transmission of (socio-cultural-scientific-technical) knowledge and the promotion of the learning capacity. They represent the physical place where to meet, search for information, and study. A place where children and youth can get together with other age groups, associate with each other, and take part in things together — a place of vital importance for their social growth. Besides, empirical studies developed on the scope of educational research, show that school building conditions, such as spatial configurations, acoustics, heat, light and air quality have an impact on learning since they affect students and teachers performance and attitudes[2].

The purpose of today's schools is no longer to simply provide knowledge and skills, as well to promote understanding on how to learn, about attitudes, behaviour, and communication (OECD, 2001: 103). Pedagogic thinking and educational philosophy have changed. There has been a shift from teacher-centred instruction to student-centred learning (Lackney, 2003). An investigative, experimenting and self-motivated approach to schoolwork is now favoured in education (Fisher, 2004). Instead of classes of standardised duration with breaks in between, schoolwork now tends to a

more collaborative approach. The rhythm of schoolwork is also shifting: the whole day is for learning, not only during classes. The innovation on ICT transformed the methods of acquiring and producing information. It has made possible information search from networks outside school, collaborative networks between schools, and contacts with the community (Kennedy, 2001: 214). Learning is no longer bound to time and place. It is now understood as a decentralised process that takes place everywhere. The concept of discipline has also evolved from a controlling form of surveillance (*e.g.* CCTVs) to a combination of factors that involve the working of the school as a society.

The traditional school design following a (functional) zoning strategy where teachers, students and classrooms were standing apart given the separation between classrooms and other specialised spaces such as laboratories and libraries, the circulation system, the teachers' premises and the places for assembly and recreation, is no more suitable. Hence, school design should be reconfigured to support changes in the societal context of education and 're-engage students with learning' (Fisher, 2004).

The paper is focused on how the spatial properties of school buildings can embody the contemporary educational curriculum and may operate as a social, cultural and informational interface, *i.e.* how can space be effectively used as a pedagogic tool. The purpose is to investigate spatial quality criteria in educational facilities and to explore how can they be combined into a single common framework for formulating and evaluating school physical conditions worldwide in order to bring school facilities up to higher standards including more flexibility for future change.

The work considers the review of a sample of 21 (new or refurbished) school designs for students of 10 to 18 years (2nd and 3rd grade elementary and secondary) developed over the last 5 years worldwide (table 1). Schools were chosen by reference to the contemporary educational curriculum and their recognised innovative design approach together with the reflective practice of design professionals and educators involved in the building process.

Information was obtained by means of a checklist concerning the planning and design strategy. Programmatic concepts and guiding design principles were identified and the correspondent design solution was analysed through the site design, the building layout and appearance, the construction processes and the environmental design features. From the analysis of this sample of best practices in school design together with the review of research studies - based on the empirical work of social scientists, educational researchers and architects[3] - an approach for thinking about the design of the contemporary school settings and the definition of international design criteria was built.

The paper is organised into three parts. Firstly the underlying principles that apply to school building design process are introduced. Secondly key factors – programmatic concepts and design principles - that must be considered when addressing design quality in educational facilities are outlined. Finally the implications of defining international design principles for school buildings in such a way that they take account of the leading educational innovations of the day are discussed.

School building design process: from 'functional ideas' to design solutions

A well-designed school building involves a two phase-process:

1. The planning or schematic design.

2. The design development.

Recent experiences show that the success of this complex process implies a careful preparation phase involving all those concerned with the project (Sanoff, 1994; Wright, 2004). To reflect educational strategies and curricula as well the targets and priorities of school users, top-downs and bottom-up strategies are needed (DfEs, 2004).

The initial phase – the schematic design – anticipates the definition of the design brief. It is based on 'functional ideas' about how a variety of activities should be executed differently by everyday users - students, teachers, learning assistants - and visitors - parents and other guests - in the school space pattern as a whole. Hence, 'functional ideas' are 'programmatic' (abstract) concepts defined according to educational goals.

Functional ideas are then translated into guiding design principles intended mainly as practical solutions or strategies to solve school's (functional, organisational and operational) problems without regard to the physical response. Basically, design principles are 'reference terms', which describe what a design "must be" or "should do" rather than what it "should look" or "be made of"[4]. They are concerned with school building performance in functional, formal and economical terms *i.e.* how the school physical space (design product) should work to support educational goals (task) and at same time ensuring long term and optimal use of the facility. School activities, the schedule of spaces and fittings required, relationships of spaces and people the physical and psychological environment, the quality of space and construction as well operating and life cycle cost considerations are addressed in this stage. Such briefing can assume both the form of an outline design for the layout of assemblage of the different parts of the school or a form of checklist.

Reference terms are used along the school building project to assist both the delineation and the evaluation of the architectural answer by checking preliminary designs. Hence they should be designed with flexibility in mind to facilitate the quick modelling of projections and scenarios taking into account the inevitability of changes from the present and projections into the future (Brand, 1995).

Afterward reference terms are realised in space through design concepts, i.e. concrete ideas intended as physical solutions to the architectural problems[5]. Once they are shaped, they have implications on school functioning as well on the way in which users experience the building.

Along the planning/schematic design phase emphasis is given to concepts, *i.e.* to both abstract and practical ideas while design concepts are avoided. Abstract ideas decode 'targets' whereas practical ideas are the 'means' to achieve them. Design concepts correspond to the 'physical tangible response': the architectural imprint.
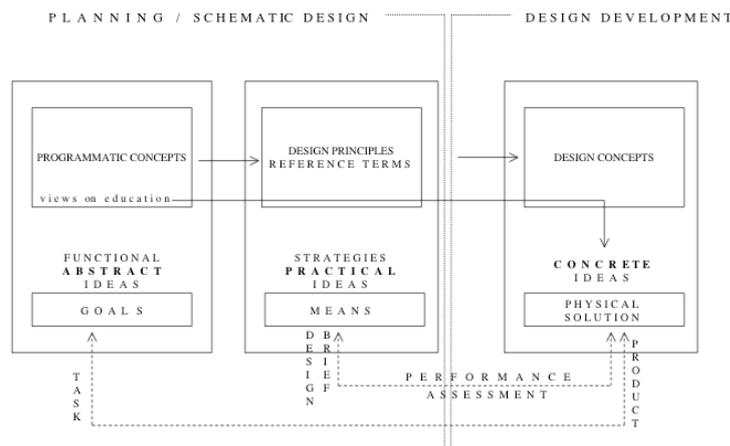

Figure1. School building design process

School building inputs: programmatic concepts and design principles

The chosen sample includes 21 school buildings with different curricula and educational approaches as well different site locations, *i.e.* integrated in 'campus' or into the urban fabric. Comparative analysis of these schools shows a number of interesting similarities such as a participative approach to planning and designs as well a move towards a more collaborative and inter-disciplinary learning.

The school site as a whole is understood as part of the educational project: outdoor spaces are not considered as secondary areas but integrated to become part of the learning process, thus they denote a specific landscape treatment (*e.g.* in Victoria School, Singapore, Tajimi Junior High School, Japan, Haute Vallee School, UK). Moreover, the school building is used as a mean to enrol students with environmental issues (*e.g.* Heinvaara School, Finland, Shitara Middle School, Japan, West Point Junior School, USA).

In general a greater commitment to improve the quality and adequacy of the learning space to the current pedagogic practices and individual learning styles was observed. School design not only focuses on the provision of a diversity of spaces allowing different forms of learning (*e.g.* co-operative, independent, digital, experimental, instrumental) and subjects (*e.g.* humanistic, scientific, artistic, technological) but also on highly accessible communal spaces - internal and external - as a way to foster social interaction among school users. The social and intellectual development of the student is emphasised by means of flexible spaces (classrooms and studios) permitting different layouts (*e.g.* Kvernhuset Junior High School, Norway, Alpha High School, USA, Australian Mathematics and Science School). The rejection of the traditional 'institutional character' of the school building and the adoption of an architectural party appealing to the aesthetics preferences of the young people was also observed in order to foster empathy with the school (*e.g.* Kingsdale High School, UK).

The observed design layouts follow a spatial configuration based on a central core, *i.e.* in a 'gravity centre' from which the different parts of the school are connected. Such space may assume different forms from the internal 'street or gallery' (*e.g.* TwoRivers Middle School, USA, High Tech Middle, USA), 'atrium' (*e.g.* Euro-College, Holland, Heinavara School, Finland) or 'covered patio' (*e.g.* Kingsdale High School, UK) to an open courtyard (*e.g.* South Canden Community School). In The West Point Junior High School (US) the central element of the layout is a "glass box": a two-story space located at the heart of the school where students can gather to learn, perform, eat and socialise. Placing the resources centre sometime reinforces this strategy and other facilities such as the dinning hall in centralised positions (*e.g.* Clacton County High School, UK, Kapolei High School, USA), closed to the core area. To avoid extended circulation spaces as well the tendency to focus movement and activity on certain parts of the building, specialised spaces (*e.g.* learning studios) as well teacher's workspaces are often placed in between (*e.g.* Inderkum High School, USA). The layout of the learning areas follows two main strategies:

1. Grouping of the classrooms around a communal central area (cluster type).

2. Placing the rooms along short linear spaces sharing visual access (*e.g.* Kingsdale High School, UK).

In Crosswinds Arts and Science Middle School (USA) and in High Tech Middle School (USA) the adopted approach includes the arrangement of the classrooms into separate areas (learning centres) connected through a central space sharing high levels of cross-visibility. Each centre contains a conference room, teachers' workspaces and student lockers. In some cases individual classrooms were totally abolished and substituted by 'learning studios' structured around shared spaces, digital work areas and resources (*e.g.* Harbour City International School, USA and Australian Mathematics and Science School).

The incorporation of durability and low cost maintenance and the use of environmental and flexibility strategies by structural means was also identified.

The chosen sample shows some common spatial features, namely:

∞   Building layout organised with reference to a 'central atrium', which is accessed by the main entrance and works simultaneously as a meeting area, a space of transition between school activities areas and of circulation.

∞ Presence of a 'focal point' for the gathering of the school community (communal space).

∞ Multi-purpose nature of the communal space.

∞ Versatile nature of learning spaces.

∞ Relationship between recreational areas and communal spaces.

∞ Relationship between the interior space and the exterior of the building.

In face of the current trends in educational curricula, and following Lackney's "framework of educational design principles" (Lackney, 2003) nine programmatic concepts are identified as the prime requirements that should inform contemporary school building design:

1. Decentralised **learner-centered** supporting formal and informal learning as well the recent developments in ICT in a way to facilitate the social appropriation of those facilities.

2. **Developmentally and age appropriate** taking into account the level of physical, social, emotional, and intellectual development of students as individuals, in small groups or in large groups.

3. **Safe** by means of an underlying system of passive surveillance.

4. **Comfortable** providing users with healthy conditions.

5. **Inclusive** for those with special education needs and disabilities.

6. **Flexible** to accommodate a variety of purposes allowing day-to-day changes as well adaptability to future change.

7. Open to **community use** outside the school timetable.

8. **Sustainable** design operated and maintained efficiently according to high performance building concepts in order to optimise investments and ensure long term and optimal use of the facility.

9. **Inspirational** minimising the institutional character, creating interesting and engaging spaces to present users with stimulation that learning requires.

The set of programmatic concepts are interconnected and related with decisions concerning (1) the site design; (2) the overall building layout; (3) the movement strategies inside and outside the building; (4) the individual space features; (5) building internal and external appearance; (6) construction processes; (7) building materials and finishing; (8) environmental features; (9) equipment and furniture, as summarised in Figure 2.

	site design	overall building layout	movement strategies	individual spaces features	building appearance	construction processes	building materials and features	environmental features	equipment and furniture
learner centered	•	•	•	•	•				•
developmentally and age appropriate		•	•	•	•				•
safe	•	•	•	•					
comfortable							•	•	•
open to community	•	•	•						•
flexible	•	•		•		•	•		
inclusive	•		•	•					•
sustainable	•		•				•	•	•
inspirational	•	•		•	•				•

Figure 2. Relation between programmatic concepts and decisions concerning the design development stage

As referred before the current societal context of education relies on a social-cultural and informational interaction. This process is achieved through spatial (face to face) and transpatial (ICT) forms of interaction, which involves student-student, student to teachers/learning assistants and teachers/learning assistants -teachers/learning assistants[6]. Besides creating opportunities for formal (spatial and transpatial) interactions, school space should promote conditions for informal contacts (random encounter) between the students, teachers and learning assistants. Random encounters are a form of informal interaction between the students and the teachers but also a form of non-confrontational passive surveillance, thus contributing for achieving a safer environment. This can be realised if the circulation system will act as the place of random encounter and co-presence between students, teachers and learning assistants. This strategy is often applied by means of:

1. Integrating different school activity spaces in the main circulation system while avoiding deep dead end corridors with (physical and visual) secluded learning spaces;

2. Providing an easily reached communal space (internal or external courtyard) that serves for the meeting of the school community (school assemblies) and informal extracurricular activities and also as circulation for both staff and students. Increase the opportunity to see and be seen within this space, through improved visual lines will act as a passive surveillance device.

3. Placing teachers' workspaces in between learning spaces or in their immediate vicinity avoiding isolated areas. While participating in learning situations, teachers themselves also learn, experiment, observe and supervise.

4. Making clear the meaning of the 'learning resources centre – library - mediatheque' as the information core of the school by placing it in a strong integrated place, visually and physical accessible, recognised as a flexible and variable space where students can independently search and produce information, work individually or in groups.

5. Spreading out administrative/executive spaces throughout the building in physical and visual accessible places, avoiding deep and remote spaces within the spatial system. Promoting students-executive team interface may contribute to maximise spatial supervision and to create an effective sense of leadership.

Since teaching and learning methods, interface protocols and circumstances are many and varied, a mix of spaces with different spatial conditions should be considered: learning, discussion, and collaborative workspaces for groups of different sizes, from lecture halls to small collaborative work spots. Workshops are needed for learning by doing, and special spaces and laboratories for learning by experimenting and by carrying out various work tasks. These spaces must allow flexibility, in terms of extensibility, convertibility and versatility of use: instead of bearing walls that impede flexibility, the structural solutions should favour pillars, light partition walls, and wide spans. It must be possible to connect rooms with each other by movable wall and door elements that can be moved throughout the day to accommodate a variety of projects and student groups. Also, the technical systems—installations for heating, plumbing, ventilation, electricity, and information networks—need to be flexible.

In order to help students to achieve their potential, it is critical these spaces:

1. Support different developmental needs and abilities.

2. Provide good indoor air quality, ventilation, thermal and acoustic comfort, through a competent design, construction and maintenance;

3. Be furnished with comfortable and pleasant furniture that also enables a versatile use[7]. The whole of the building technology—lighting, air conditioning and waste management—must create a positive example of an environment based on sustainable development.

Conclusion

By comparing a wide range of innovative school buildings in various countries it was possible to obtain a comprehensive understanding of the ways in which current educational goals and values are translated into programmatic concepts and further expressed in spatial terms. An idea of what has been achieved was given and the basic design reference terms applied were outlined.

When separately analysed, each school design is a reflection of the specific educational curricula, local building performance requirements and users needs as interpreted by the project team, taking into account the points of view of the school community. The design process was approached in a holistic and systematic way comprising the physical setting as well the specific social, organisational, pedagogical and emotional framework which characterises each situation. Each design solution reveals its own individuality: it is exclusive and presents a response to different conditions and constraints, namely the educational curricula, site conditions, construction processes and budgets.

In face of the question concerned the use of international design principles for school building it can be concluded that they can only be defined on a basis of comprehensive 'design brief' concerned with the shaping of 'functional ideas', *i.e.* about the view of education taken: pedagogy, learning and teaching methods as well on principles of school organisation.
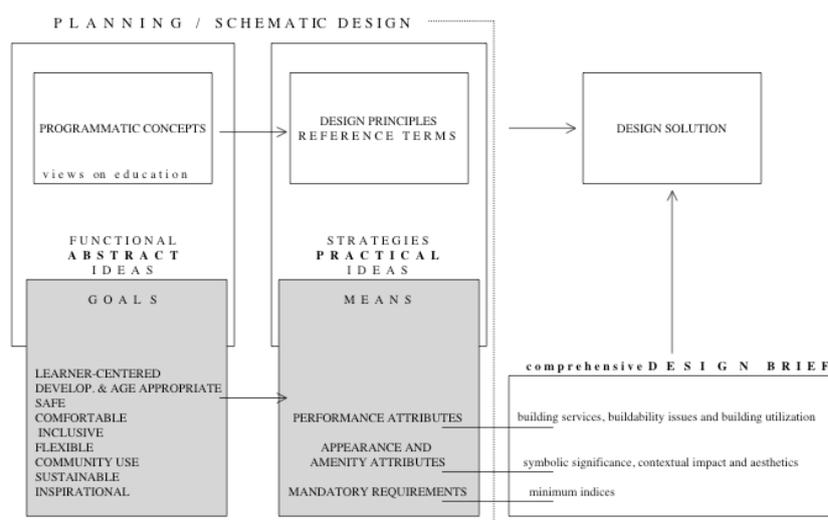
Figure 3. The comprehensive design brief process as a tool to inform school building design worldwide

As Giddings and Holness (1996) refer to achieve a degree of comprehensiveness in the school building design brief three main categories of design attributes can be used:

1. The performance attributes which affect the operational efficiency of the building, and are therefore of paramount concern to the school administration board: These are concerned with building services, buildability issues and building utilisation.

2. The appearance and amenity attributes which are largely related to the view taken on education. These refer to the symbolic significance, contextual impact and aesthetics and are highly cultural and strongly influenced by previously acquired design knowledge.

3. The mandatory requirements, which establish minimum levels of performance and acceptability.

Nevertheless, schools' long lives require buildings that meet the demands of the future. To bring school facilities up to higher standards, while making efficient use of the resources invested in building, renovating and running schools, architectural answers besides being consistent with the educational framework they should be innovative. Being innovative in school design is risky but it is important in order to anticipate changes and rapidly respond to users needs.

Notes

1. Buildings as organisers of space can set in place conditions for either the generation or the conservation of social relations among users. Hillier and Penn (1991) distinguish between two types of building programme: the long model and the short model. The first are those, which have many rules that determine spatial relations (the activities, type of people, visual connections, etc) and the second, where a minimum of rules is specified. Long model buildings tend to produce reflections or projections of the social rules. In the short model, patterns of space use and movement are not highly structured by the building programme, thus space functions to facilitate and extend opportunities for encounter.

2. The literature in the field of environment-behaviour studies shows increase awareness on the understanding of school space and in particular, in exploring spatial factors that affect school functioning (Fisher, 2000; Lackney, 2003; McGregor, 2004). These studies demonstrate that the built environment may contribute for developing a more effective learning environment and that well designed school buildings benefit both students and teachers on many levels, helping them to achieve their potential, including greater motivation. Research especially from the USA identifies key design

variables as having an impact on student behaviour such as lighting levels, indoor air quality, temperature, acoustics, or to school size, furniture and classroom configuration, aesthetic factors, building age and maintenance condition (Fisher 2003). Research on the relation between educational curricula and the school building layout is still reduced and in general is treated in a very general manner. Schneider (2002) provides a broad review in this subject.

3. Recent efforts in re-contextualising the understanding of school space as a whole have implicated many interrelations between research disciplines such as educational psychology, environmental psychology, spatial analysis and environmental design. This is patent in the emergent body of post-occupancy evaluation studies (POE). The findings result from the systematic assessment of school building performance - based on observation methods, interviews and standardised surveys - aiming at check the fit between school users and the built environment and contribute to the improvement of the situation.

4. School building improvement cannot be reached by new construction alone. Rather, it is needed to upgrade existing buildings by restoring and recovering inadequate spaces, removing poor quality space and adding supplementary space in a comprehensive and economical way. Such approach implies the previous evaluation of the school conditions for assessing its performance and capacity to support changes. Evaluation during the post occupancy phase can reveal how the building is being use, what works and does not work. Besides it can lead to a theoretical framework for drawing up reference terms, designing "with people in mind" (Zeizel, 1989).

5. Functional/abstract ideas can be realised by social and spatial means In a school the patterns of space use and movement – the interface between users - for instance, may be guided by means of the spatial configuration (separation or connection), but also by social rules *(e.g.* agreements to knock before entering, or by indications such as 'staff only').

6. This process is well illustrated in the literature on space syntax. Closely related activities would indicate integration to promote interaction, while the need for some kinds and degrees of privacy would indicate compartmentalisation.

7. Traditional furniture for schools - a combination of a desk and bench - is poorly suited for the current way of working at school. They cannot be combined and varied in many ways and do nor allow a workstation to be placed on it, it must be possible to write, draw, and do arts and crafts on it— various requirements that sometimes exclude each other are set on the furniture.

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Acknowledgements

School/Country	site location	Communal area				Learning areas				environmntal. strategies	planning process
		external patio/quad	gallery	atrium	covered patio	flexible use	cluster	side-by-side	learning sudios		
Kvernhuset Junior High School / Norway (Honor Award designshare 2003)	C		•			•	•			•	•
Timberline Middle School / USA (Citation Award designshare 2003)	C		•			•	•				
Two Rivers Middle School / USA (Recognised Value Award designshare 2003)	C		•							•	
Australian Maths andScience School / Australia Merit Award designshare 2003	C			•		•			•	•	•
High Tech High-Los Angeles / USA (Recognised Value Award designshare 2003)	C	•				•			•	•	
Kapolei High School / USA (Honor Award designshare 2003)	C			•			•			•	
Haute Vallee School / UK (Recognised Value Award designshare 2003)	C	•				•	•	•			•
Tajimi Junior High School / Japan (Honor Award designshare 2004)	UF	•	•			•	•			•	
High Tech Middle / USA (Honor Award designshare 2004)	UF						•			•	
Harbor City International School / USA (Honor Award designshare 2002)	UF		•	•		•			•	•	•
Victoria School / Singapore (Merit Award designshare 2004)	UF		•					•		•	•
West Point Junior High School / USA (Merit Award designshare 2004)	UF					•	•				
Heinavaara School / Finland (Honor Award designshare 2002)	UF		•			•	•			•	•
Croswinds Arts and Science Middle School / USA /2004 AIA design Awards)	C	•				•	•				
Hosteter Center for the Arts at the Pingry School / (2004 AIA Citation Award)	C										
Kingsdale Secondary School / UK Schools for Future DfES,	UF				•	•		•		•	•
Inderkum High School /USA (Citation Award designshare 2003)	C	•		•				•			
Venterschool / Holand (Honor Award designshare 2002)	C		•	•				•			
Shitara Middle School / Japan (Honor Award designshare 2002)	UF		•	•			•			•	
Euro College / Holland (Citation Award Designshare 2002)	UF			•				•		•	

South Candem Community School / UK (Schools for Future DfES)	UF	•				•			•	•	•

Legend: Site Location (C: campus; UF: urban fabric)

Table1: List of school buildings