Spatial Structure and Use of School Buildings

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This paper is concerned with the spatial structure of the school building and the preconditions it contains for the users. School buildings are designed to support the work of the staff and the education of pupils. The design is based on ideas about pedagogy, learning and instruction as well as on principles of school organization. Also ideas about the relations with parents and about the role of the school in the neighbourhood have an influence on the design. Not all ideas are realised in the building, but once it is built, the design has a powerful influence on both pupils and staff, as well as on their use of the building.

The paper is based on preliminary results of a research project where school buildings are studied with the space syntax analysis. The approach is interpretive and has an educational perspective. Syntactical properties are considered as preconditions for the use of the building. Use of the building is discussed in terms of e.g. movement through the building and occupancy of spaces. Of special interest are spaces for different non-classroom activities, such as the staff room, school library, lunch room. The relation between different syntactical properties and views on children is discussed.

Keywords: children, floor plan layout, organization, school building, space syntax.

EDUCATION IN SWEDEN

Public schooling in Sweden has a history of more than 150 years, and frequent educational reforms have been made during this period. In 1950, the school system was changed completely. Since then, several curriculum changes have been introduced and the latest curriculum for compulsory school dates from 1994.

The great majority of schools are run by the municipal authorities and are free of charge. All children start school the year they turn seven, but from 1997 they can start at the age of 6 if the parents so choose. Compulsory schooling lasts for nine years. After that, a majority of the children continue in upper secondary school.

Education at all levels is dominated by two aims, equality and democracy. Regardless of social background and geographic location, equivalent education is offered to all with a strong emphasis on democratic aims and procedures. The rights of pupils to influence and take responsibility for their own education is written into the curriculum. A commission, appointed by the Ministry of Education and Science in 1995, is studying parents’ and pupils’ influence and participation in school matters and has made proposals as to how it can be strengthened (SOU 1995, 1996).

Against this background, the design of school buildings is important not merely for the individual student’s cognitive achievement, but also for her/his development in a broader sense, through the preconditions for cooperation and participation that exist in the building.

SCHOOL BUILDINGS IN SWEDEN

Already in 1796 a proposal was presented for the design of a small school building for rural areas. From the end of the nineteenth century, the government has given recommendations for the design of school buildings. Great attention was paid to their design, which was expressed in statements about e.g. aesthetic qualities. The influence of the Swedish government on the design was linked to financial support for schools. In 1990, however, the municipalities took over all responsibilities for the staff and the buildings.

Around 1914, almost 14,000 schools existed in Sweden. Since then, the number was reduced to 4,700 in the 1980s (Marklund, 1989). Schools were built in the traditional manner with classrooms connected with corridors, but in the 1970s experiments were made with open-plan schools. Lack of economic resources, poor maintenance, changed standards of performance and changes in the curriculum have led to frequent complaints about school buildings. In a study about the types of problems that headmasters experienced in school buildings, Krupinska (1987) found that the majority of problems were due to the lack of fit between the current curriculum and the layout of
the building. This is no surprise, since the lifetime of a school building is longer than that of a curriculum.

There are a number of new Swedish schools where the design has been adapted to the new curriculum and where leisure time centers have been integrated in the building, but most pupils still go to school in older buildings that were designed for somewhat different aims.

EDUCATIONAL AND ARCHITECTURAL RESEARCH ABOUT SCHOOLS

In educational research about schools, the layout of buildings has very seldom been included in the study. Examples are the studies about teachers’ work environment (G. Berg, 1985) and research about social climate in schools (Grosin, 1991). In the few cases where the physical environment is dealt with at all, it is treated in a very general manner (Löfgren & Tellenback, 1984) relying mostly on subjective judgements of the building or its spaces.

In research based on the so-called frame factor theory (Lundgren, 1972) factors influencing processes in the school are studied and here the building is included. It is described in terms of the age of the building, size, quality of the facilities, maintenance and attitudes toward the building, while the actual layout has not been studied.

A different perspective was taken by Skantze (1989) in her study of pupils’ perceptions of their school building, but the pupils’ descriptions that she reports, were not related to the actual physical layout. In a report about “Ways to the Good School”, Holmberg & Lindell (1993) who worked with the national evaluation of writing and drawing in the compulsory school, note to their surprise that pupils are extremely aware of their buildings and attach great importance to them.

A broader approach can be found in the studies of a number of open plan schools in southern Sweden which participated in an experiment with flexible grouping in the seventies. These schools were designed and constructed according to a new educational model. The studies focussed on relations between activities, layout of spaces, furniture arrangement and pupils’ achievements (Gran & Rudvall, 1981).

Another example is the evaluation of a more recent development project concerning new pupil and teacher roles in the school for the year 2000. Changes had been made both in the organization and the work environment, but it was shown that they did not lead to the intended effects (Forsberg, 1993). The problem seems to be that it is difficult to specify what exactly is needed to be able to work in accordance with a new curriculum and a new organization.

Moore & Lackney (1993) summarize school research especially from the U.S. where the building and the design of the layout has been considered. Based on literature reviews, architects’ experience and teachers’ opinions, proposals are made about design patterns for classrooms and for organizing principles of school buildings.

The use of pattern language as it was developed by Alexander (1977) is an interesting approach. However, my experience is that patterns are not sufficient to describe the structure of a building as a whole and that patterns, which are taken out of context, often disregard differences which may be based on global structural properties.

THE PROBLEM OF FIT BETWEEN ORGANIZATION AND BUILDING

In principle, a building is planned to suit the organization, which implies that individuals and groups with different roles and status occupy different places. The spatial relations between these places constitute the interface for those groups and individuals, who are the inhabitants of the building, and between the inhabitants and visitors (Hillier & Hanson, 1984, p. 4). In a school, the relations between teachers and pupils are specified by differential access to spaces, in hospitals the relations are between doctors and nurses on the one hand, and patients on the other.

Both organization and building may be planned with the same objectives in mind, but there is no direct link between purpose and design. This was shown clearly in my thesis (M. Berg, 1987) where daycare centers were studied with syntactical analysis. In these centers, both organization and layout were based on the same principles, yet, a great variety of spatial patterns and organizational practices could be found.

If the necessary spatial relations are not provided by the building design, the work in the organization will be more difficult. Compensation will be made, for instance by regulating contacts in schedules or by rules.

The problem of fit between organization and building is well-known in architectural literature. Alexander (1964) defines fit as well-adaptedness (p. 16). He argues that the idea of fit stems from the perception of and the reaction to failures. One way of describing the physical environment is with the use of pattern language (Alexander et al., 1977). In my opinion, this is an interesting way to describe problems and to present a possible solution, where the different levels of structures are seen in a hierarchical way. However, when patterns concerning the design of a space for specific activities is discussed, this is done without reference to the global structure. In this way, frequency of use can falsely be regarded as due to
the shape of the design instead of to position in
the global structure, which may range from cen-
tral to isolated. In syntactical terms, a pattern such
as “activity corners” may function well when the
location is in a central (or integrated) place in the
building and not at all when it is in an isolated (or
segregated) location.

Space syntax on the other hand provides a
method for the empirical study of relations be-
tween the organization and the layout (Hillier &
Hanson, op. cit.). The physical properties of
the building are regarded as preconditions for the use
of the building. The method allows a description
and analysis of the building as a whole. Syntac-
tical measures can be compared between buildings
and can be related to other measurements. Of spe-
cial interest is the location of the most integrated
and the most segregated lines, and the location of
different spaces in relation to these. Use of the
building is studied in terms of e.g. movement
through the building and occupancy of spaces.

One point has to be clarified: the syntactical
description of the building does not imply a de-
terministic view of the physical properties of the
building. The spatial properties are important as
facts, and when they entail hindrances for the
aims of staff or pupils, they can be overcome by
organizational means.

VIEWS ON CHILDREN — AN
EDUCATIONAL PERSPECTIVE

The two main groups of people in schools are
teachers and children. The school building has
been designed to facilitate the relations between
them, against the background of child rearing ide-
ologies and ideas about teaching and learning.

The British educational sociologist Basil Bern-
stein, (1977, pp. 5, 61) distinguishes between two
views on children, that are characteristic for strati-
fied and differentiated social structures, where so-
cial control is maintained in different ways.

In stratified structures, pupils are regarded as
having fixed attributes. Ritual in such structures is
differentiation and groups are clearly marked and
bounded. Transmission of knowledge and belief
systems is sharply bounded and consensus is
based on values. Through rituals, values are
changed into elements of social structure. Social
control is positional, i.e. it is based on clearly ex-
pressed authority structures. This means that in
stratified structures children are regarded as indi-
viduals belonging to different groups with differ-
ent properties with e.g. age as a main stratifier.
This leads to different treatment of children ac-
cording to age and to a hierarchy between chil-
dren, with higher age having greater status than
lower age. Teaching aims at providing knowledge
for children to acquire and examination criteria
are explicit.

In differentiated structures, children are re-
garded as possessing variable attributes, which
develop in interaction with their environment.
Cognitive ability is viewed as a process and posi-
tion in groups or sets is related to proficiency in a
subject. Social control is personal, in that it is
psychologised and directed at personal character-
istics. This form of social control is called ther-
apeutic (Bernstein, op. cit., p. 62). It works through
verbal manipulations of motives and dispositions
in an interpersonal context. Consensus is based on
means and skills. Values are transmitted not
through rituals but by individual communication,
which is unpredictable. This means that in differ-
entiated structures, children are regarded as per-
sons in development, with a capacity to learn
starting out from individual preconditions. Chil-
dren are regarded as unique individuals, teaching
is individualised, examination criteria are im-

When different types of social structure appear
in schools, they can be regarded as the product of
a certain organizational or managerial style, in
combination with different views on children and
different socialisation practices. The main dis-
tinction lies in the importance attached to proce-
dures for maintaining boundaries between groups,
and whether boundaries are based on positions
(rank, sex, age) or on personal characteristics
diligent, open, talkative).

Another important relation exists between the
view on children and the way knowledge is de-

In the curriculum the idea of differentiated
praxis in schools is very often in accordance with
stratified structures. Most often, one teacher
works with her/his own group of pupils, inde-
pendent of other teachers.

As Bernstein points out in his description of
invisible pedagogies (op. cit., p. 116), in order for
differentiated organizations to function, there
must be agreement on the main integrating prin-
ciples. The selection of the staff may be one way
to achieve this. Differences in recruitment and
staff attitudes in schools in different socio-economic areas have been observed (Arfwedson & Lundman, 1980), which lead to different types of school codes and staff values. On the whole, a school is such a complex organization, that it is almost impossible to presuppose that one common opinion will exist. Disagreement on certain matters between several staff groups will be the rule and not the exception.

The shape of the building influences the possibilities to share information, to establish agreement, or to live with disagreement. In split buildings, it is easier for groups to isolate themselves in the wings of the building, thus creating correspondence systems where the spatial group also has the same views or interests. In compact buildings, where everyone is closer to information, it may be easier to maintain an integrated group. But the shape of the building is not the only factor. If the aim for the total group is social integration or at least the sharing of information, a non-correspondence system may be chosen so that encounters between individuals with different interests and views are promoted.

In summary, different views on children and the transmission of knowledge are of major importance for how the organization is set up and maintained. These views may have consequences for the design of the building in three main areas:

1. The spatial definition and composition of groups and the conditions for relations between them
2. The definition of knowledge areas (school subjects) and their relations
3. The view on the total group and the management philosophy (e.g. correspondence, non-correspondence)

This paper deals with what is shown in the design of the floor plans of two primary schools with regard to these areas. Another question is whether the social relations that are built into the layout of a school fit to the educational ideas of that particular school. In the following, an attempt is made to answer the first part of this question.

SYNTACTIC DESCRIPTION OF TWO SCHOOLS

The two school buildings are very different from one another, both in building type and in educational idea. School M has corridors, classrooms and 3 storeys that are used as a structuring device. The building has a strong programme which means that all contact is regulated in the layout.

School K has an open plan and little structure in the school part of the building. The corridors are partly in activity spaces. The programme of the school part is weak. Movement is regulated by rules. The children are in the most integrated parts while staff of all kinds are in the more segregated parts. The different parts are well connected, but children do not have access to all parts.

The layout of the buildings at the time they were built, is analysed in several ways by focusing on different aspects:

* The pattern of the most integrated and segregated lines
* The use of the extreme parts of the building (25% most integrated and segregated, and highest control values)
* The location of some important activity spaces for children and staff

In the following, some examples of results from the analysis will be presented and discussed.

School M

The school was built in the 1950s and consists of several buildings. Focus is here on the main building, which is for three classrooms each in grade 1–6 and has 3 floors and a cellar.

The 25% most integrated lines are (in rank order) on floors 1 and 2, the cellar and floor 3. The four main corridors are included on all floors except floor 3 as well as most of the stairs. Furthermore, most spaces on floor 1 which include six classrooms and spaces for staff, staff cloakroom, office, headmaster, janitor, small meetings, copying machine.

The 25% most segregated lines are (in rank order) in the cellar (all three toiletrooms) and classrooms on floor 3, floor 1 and 2. Of the classrooms, two were ordinary rooms while the others were for wood crafts, drawing and textile crafts.

Lines with 25% highest control values, which is a local, not a global measure. They cover the four main corridors on all floors and some activity spaces mainly on floor 1, namely, the corridor outside the rooms for wood crafts, the main entrance, staff cloakroom, office, headmaster, janitor.

In summary, the communication spaces are the most integrated part of the building. The most integrated activity spaces are spaces for staff on the bottom floor and the classrooms for children in the lower grades 1 and 2 also on the bottom floor.
Most segregated are the toilets in the cellar, all the classrooms for aesthetic activities (crafts and drawing) irrespective of on which floor and two more classrooms on floors 2 and 3.

It is interesting to note that while the entrances on the far sides of the building are among the 25% most integrated lines, the main entrances are not. Regarding the control values, it is the opposite, in that the main entrance is among those with the 25% highest control lines whereas the other entrances are not.

This may result from children whose classrooms are closer to these far entrances, mainly entering and leaving the building in this way. The main entrance on the other hand may be used mainly for the headmaster, other staff and visitors, who have closer to their cloakroom and their spaces from there.

Relations between groups: The youngest children and the staff are on the most integrated floor, floor 1. The highest floors are for the oldest children. Staff and children may be separated by the use of different entrances. The corridor system is very clear and separates classroom activities from each other and from visitors. Spontaneous meetings between children may occur in corridors and staircases on their way to and from classrooms. Outside, in the school yard children of all ages can meet.

Relations between knowledge areas: Crafts are placed in the most segregated parts of the building, spread over three floors. Spaces for natural science, the school library and the room for singing are located in the “middle” part of the building on the 2nd floor.

Relations to the neighbourhood: The school is clearly visible in the neighbourhood, the school yard is between the different buildings. The most integrated lines go around the building on the outside, forming a ring, with two lines pointing into the yard. This means that when you are not going to visit the school, you automatically choose to walk around it rather than walk across the yard. The main entrance can be reached from the outside (the side of the neighbourhood). Almost all entrance lines belong to the most segregated part and most of them can only be reached from the side of the school yard. Two of them lead to the toilets in the cellar for boys and girls respectively. The lines with highest control values lead around several sides of the building but do not form a ring. Two of them lead into the main entrance on the school yard side.

Thus, the school is clearly visible, but the entrances are segregated and most of them lead to the yard in between the buildings. Children in the yard are not in contact with the neighbourhood.

School K

The school was built in the 1970s for two classes of children in grades 1 to 6. These are located on one side of the building. The school building also includes a dentist’s practice and an office for the school doctor. The gymnastics hall is in the same building and spaces in the leisure time center are used during school hours for crafts.

The 25% most integrated lines are corridors and lines connecting classrooms. The main, most integrated corridor connects the school part of the building with the leisure time center, the children’s space with lockers, the gymnastics hall, the administration spaces, the dining room, the kitchen and the spaces for dentist and doctor. The integration core contains seven rings, permitting choice of way. There are no core rings in the administration part and in the dentist part. The library and seven classrooms are in the 25% most integrated part, only two classrooms and some rooms for special education are not included.

All but one classroom entrance is included. The staff spaces and the janitor’s office are on the 25% core. So are the headmaster’s corridor and several lines in the leisure center. The building has an integrated structure.

The 25% most segregated lines are almost exclusively not in the school/classroom part (only two lines to toilets are included). They consist of treatment rooms and other spaces in the dentist part, the kitchen staff space, showers near the gymnastics hall, the doctors’ office spaces, the headmaster’s office spaces and the leisure center office. Only one space for children’s activity, namely, for solding in the leisure time center is in the most segregated part. This means, that there are no segregated spaces for children to be somewhat secluded to sit and study.

The lines with 25% highest control values go past all entrances. Only one ring is formed through the gymnastics hall. The school part and
the leisure center have their own control structures, which are not connected to the other parts. The control lines of the dentist, the administration, the doctor and the gymnastics hall are connected. There is less control in the school part than in the other parts. In the activity spaces for children, the lines with highest control values are in the leisure center. This means that the leisure staff can keep an eye on the children by being on the high control lines, while the school staff needs to be present in person since the structure does not support control.

**Relations between groups:** The building has an integrated structure, but several parts are segregated, namely, the dentist, doctor, administration offices and showers. In this way, the children do not easily come into contact with the inhabitants of these spaces. The children have an inside space with lockers, which is connected to the lunch room, which is open for them during lunch time. Otherwise, this way is closed for them.

Several classes have to pass through the library to go out. The youngest children have their classrooms at the side of the building facing the park. Cloakrooms are in the entrances, and in this way children are directed to use the entrance closest to their classroom.

The building is well connected for teachers, who in the staff room are at least six steps away from their classrooms, at most nine (special education). For the headmaster, it is not necessary to walk through the building to get to the office since there is a special entrance, but still the office is four steps away from this entrance. The children’s classrooms are at most three steps away from their respective entrances.
Relations between knowledge areas: The most segregated parts are not for school subject purposes (except the space for solding). The school areas are well connected but there is not much differentiation between different knowledge areas. The classrooms differ in level of integration. Several classrooms have their entrance door towards the library. The spaces for aesthetic activities are mainly in the leisure center, many of them also among the most integrated parts.

Relations to the neighbourhood: The school is not so clearly visible from the neighbourhood because it is a low building and surrounded on all sides by the school yard which has a border of trees and bushes. The most integrated lines go around the building through the yard but they do not form a ring. Only one integrated line points into the yard. Four of the five most segregated lines lead to entrances for the oldest pupils and the kitchen. The lines with high control values also go around the building, and one leads to the headmaster’s entrance.

Thus, the open plan school has an open yard but is not visible from the outside. The entrances are not on integrated lines, but the children on the yard have direct access to the neighbourhood.

INTERPRETATIONS OF PROPERTIES IN THE LAYOUT

Children’s status in the school
The view of children, as being of equal or subordinate status compared to adults is expressed in the design through having a space of their own or not. In both schools, the children have no indoor space of their own to be in, other than the classroom. In school M, they can be in the corridors and the area of the main entrance. But in both schools they are supposed to be outside during recess and only during a snowstorm or heavy rain they may perhaps be permitted to remain inside. Staff of all kinds on the other hand have spaces for coffee breaks, either together (school M) or separate (school K). In the open plan school K, the openness had consequences for the management of the total group and children were given limited access inside the building.

Relations between children of different ages
There is a tendency to separate children of the three lower grades from those of the three higher grades, by giving them access to separate parts of the school building and yard. In school M they are on different floors, but use the same entrances; in school K they are on different sides of the building and use different entrances. This is in accordance with the stratified educational model and with the correspondence model in the layout.

Relations between boys and girls
The only spaces exclusively for boys or girls are the dressing rooms for gymnastics in both schools, and the separate toilets in the cellar of school M.
Relations between children and the headmaster

The position of the headmaster of the school in the building is important, as well as who has access to the corridor leading to her/his door. Of course it is important for the social climate of the school whether the pupils know the headmaster or not, and whether they can have contact with her/him personally.

In case K, the headmaster has a separate entrance and all staff for management is in a segregated part of the building. In this way, there is no natural reason for the headmaster to pass through the school part of the building. The children cannot pass the headmaster’s office, since the interior of the building is not open to them. In case M, the headmaster is in the most integrated part, but the children mainly use corridors that do not lead past the headmaster’s office. Yet they can if they want to. So, the open plan in case K does not simplify contact, while the stratified structure in case M simplifies contact for the children. Of course the headmaster in school K might counteract isolation due to the location of the office, by making a habit of walking around through the building, having personal contact with the pupils and learning their names. In such a case, the secluded space may have an important function to assure a quiet place for other, administrative work. Thus, the location of the headmaster’s room is important and no clear advice can be given about its location. What is best depends on the type of relations the headmaster wants to develop.

Relations between children and other staff

In the research literature, several staff persons are mentioned as important to the children. This may be the janitor, the school hostess, or the school nurse. It is easy to interpret this as a function of the role they perform, or of their personality. Another factor may be the location of their room in relation to transition spaces and its location in the building.

Shared spaces for staff

Spaces for the staff are on the first floor in school M and in both cases close to the headmaster’s office and close to the entrance. That is, it is easy to reach by all the staff on their way out. But due to the shape of the building and the corridors, the staff will meet different teachers on their way to the staff room. Some teachers who have spaces in segregated positions, like crafts teachers in case M, may prefer to stay in their own localities during breaks.

Collaboration between teachers

Teachers who have their classrooms next to each other may see each other during recess on their way to the staff room, and can share each other’s company when having their lunch break. A door between classrooms simplifies collaboration. When two teachers want to work together, and do not have their rooms close to each other, this is much more difficult. The design in school M with separate classrooms is in accordance with the collection code for the curriculum. In school K on the other hand, several classrooms are interconnected and have direct access to the library. This simplifies collaboration between teachers and also the integration of subject areas is easier, which is in accordance with the collection code for the curriculum.

Status differences between subjects or functional differences

Even between teachers there may be differences in status, depending on the subjects they teach. Subjects like maths and Swedish language are among the most important. The importance of natural science is a constant subject of discussion, as well as how to raise interest for the subject especially among girls. In the present schools, most rooms for special subjects had no extreme positions, only the crafts spaces in school M had a special location (segregated) in the building.

In an earlier study of an upper level comprehensive school, I found special spaces for natural science, biology and chemistry in a secluded part of the building. Here, the teachers formed a small group with a lot of common interests. They had a coffee machine in their localities. This might be very suitable for their work, their internal discussion and preparations for teaching. From another point of view, however, their seclusion meant that they did not participate in the life of the school as much as desired. They would not spend their coffee breaks in the staff room, they would not get information in an informal way from other teachers or the headmaster. Instead they would have to rely on the formal and slower way of information spreading through papers.

Visitors to the school

For visitors, it is important to find the right entrance and to find their way in the building. The schools are clearly different in this respect, partly because of the position of the building in the yard, the number of visible and hidden entrances and partly because of their internal structure. The ideology of the open school in case K, was not carried through in the design. The low degree of control in the spatial structure was not solved. Case M on the other hand is more clear to visitors, who cannot disturb the children when walking through corridors.

SUMMARY

These two examples of school buildings show that several educational and spatial models are
mixed in the design. The world of the school is extremely complex. The frequent changes to the curriculum and changes in emphasis on one or the other educational model can be handled with different spatial means. Space syntax analysis can give users a tool to understand consequences of different decisions. I suggest that great care should be taken in decisions about the layout that have consequences for the social life in schools. More research is needed about this.

REFERENCES