

Representation and Typological Refinement in a Case-base

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Abstract. *The subject of the paper is the possibilities and limitations of domain knowledge in design computing, as experienced in the development of a case-base of school buildings. In case-based design domain knowledge is used not only in the documentation and analysis of the cases but also in the structure of the case-base. The cases were documented and analysed using a geometric and topological representation. With respect to typological classification the highest abstraction level was occupied by three established types, the corridor, hall and pavilion type, which represent practically all school buildings in our case-base. Progressive abstraction of the geometric and topological representation returned the components of each type at various levels of specificity that correspond to different levels of design thinking and decision taking. The resulting typological / case-base structure provides a transparent description of both parts and global arrangements and has led to the identification of subtypes, variations and hybrids.*

Keywords. *Knowledge modelling; case-based reasoning; design methodology.*

Introduction

For a number of decades Dutch secondary education has been characterized by what conservative educators considered to be stability, while progressive ones thought of it as stagnation. This situation changed radically in 1995 with the introduction of the so-called Second Phase and the Study House, which were the result of general social and technological developments (Stuurgroep Profiel Tweede Fase Voortgezet Onderwijs, 1994). These focused mainly on new teaching models, which resulted into significant changes in the ways of teaching and learning, new programs and different, new facilities. One of the fundamental assump-

tions of the educational renewal is that instead of amassing knowledge the emphasis was now on obtaining skills and developing the learning process. The traditional school with mainly passive, listening students was transformed into a school with actively learning students (Schiel and Gier, 1996, MesoConsult, 1997).

Even more significant was the catalytic influence of these changes. Rather than accepting the Second Phase and the Study House as the minor overall modifications they actually were and returning to the practical everyday problems of teaching and managing a school, Dutch secondary education appears to have become fascinated with the idea of educational innovation. At the moment of

writing there are quite a few secondary schools in The Netherlands known to pursue novel, even radical didactic and pedagogic concepts. Their number is constantly growing, in particular with schools interested in partial innovation, i.e. integrating a few new ideas into their existing approach and curriculum.

This recent educational revolution in The Netherlands was not followed by a similar wave of radical changes in Dutch school buildings. The established types continued to be used with generally minor modifications that reflected the main foci of the new didactic ideas, such as the dispersal of individual work places in circulation areas, libraries or classrooms. The Study House is often physically implemented in the existing buildings like open-space office-like areas. For example, many central halls (originally mainly used for circulation) have been transformed into a centrally located study house, with a variety of working places. These include individual computerized workplaces and group work places, which can be used by teachers with a small group of students or by several students working together on their assignments. Schools also use the opportunity to take care of practical problems like demographic changes.

Summing up the current situation, we observe that the established types are still being reproduced even without analysis of appropriateness to the new demands that go together with the new approach of teaching and learning. New elements are nevertheless introduced in ways that may conflict with existing spatial arrangements and may cause lower performance of the building. There has been no thorough performance analysis of existing types, despite the frequent complaints about e.g. acoustic and thermal aspects of the conventional classrooms. This is of particular importance for reuse of existing forms and buildings (not merely falling back to established solutions) (Dudek, 2000, Horne, 1999).

Cases, types and representation

In order to analyze this problem we developed a case-base of existing buildings to explain and guide the spatial organization of new use patterns at a variety of levels, from global aspects such as circulation to the accommodation of specific learning activities in small groups (Heylighen and Neuckermans, 2001, Leake, 1996, Riesbeck and Schank, 1989). The matching of use requirements to existing school buildings should provide a measure of adaptations necessary for achieving the desired performance. We assumed that these adaptations would relate to the architectural type of the building. This could lead to concrete expectations and constraints concerning the adaptability and transformability of each type.

The three types that now dominate the existing building stock are the corridor type, the hall type and the pavilion type (Boersma et al., 1996). The basic type was the corridor school, which evolved after the implementation of a new law in 1863. The law made it possible for the students to choose subjects. In order to accommodate different subjects in separate classrooms the main space of the old school buildings was divided into separate rooms and connected with a corridor. So emerged the still popular corridor school type. The development of the hall type was a natural consequence in the 1950s, when a central hall for group activities was introduced. It was thought that students needed more space than just classrooms for their development. This made group activities important in education. Further transformation of both the corridor and the hall types has led to the pavilion type, a school which consists of a number of pavilions or wings of different size and character.

Of particular importance to our analyses is the ability to recognize the topological structure of building types (Steadman, 1976;1983). By making it explicit we are able to study relationships between types and identify the type of a building not only in whole but also in part. The latter is crucial

for the study of transformations, as it helps identify typologically hybrid solutions and partial mismatches between accommodation proposals and the spatial articulation of a building.

In addition to the topological representation of a building we use the geometric representation and zoning schemes to analyze and classify the cases. The geometric representation can be described as a simplified, structured floor plan that depicted each relevant spatial and building object as an integral, unambiguous entity. On the basis of the geometric representation we were able to analyze and evaluate issues such as space allocation to the various actors and activities in a school. We believe that the relationship between geometry and topology in a type is more intricate than mere deterministic, directed constraining. In order to study this relationship we employ the concept of zoning by which the building is subdivided into usually fuzzy and frequently overlapping parts. The resulting zones integrate geometric, topological and functional characteristics into subdivisions of a building that frequently play a prominent role in a study of possible transformations (Steijns and Koutamanis, 2004).

The cases described on the basis of structured representations derive from Steadman's dual graph representation and have been applied earlier to prisons (Koutamanis et al., 2001, Leusen and Mitossi, 1998, Mitossi and Koutamanis, 1998). We expected that progressive abstraction of the geometric and topological representation would reveal the components of each type at various levels of specificity that correspond to different levels of design thinking and decision taking. For example, rather than attempting to allocate each activity separately in a particular space of a building we clustered each group of activities into a structure that could be represented topologically and then matched this structure to the topological pattern of a part of a type (e.g. a wing). Analysis of use requirements at the level of individual activities took place on the basis of the geometric representation

only after a satisfactory topological matching had been achieved for the whole school. The process also involved the development of cluster variations using different points of view (e.g. similarity of activities, user groups).

Type recognition

The hypothesis underlying our strategy was that the grouping of spatial and building entities in both representations involved the same abstraction levels and returned the same parts and overall configurations. For example, each wing of a hall-type school building should be unambiguously recognizable in the geometric and topological representation regardless of abstraction and specificity. The hypothesis was initially reinforced by analyses of the topological representations of the cases.

The topological representation of a corridor school makes explicit the sequential spatial structure of this type (Figure 1 and Figure 2). Spaces are positioned on either one or on both sides of the circulation space (the corridor). Exceptions like the entrance or the gym are visible as separate wings shoved into the building. The topology of these special wings can differ from the rest of the school.

The (normalized) topological structure of the hall school shows us that the different wings are actually obvious variations of the corridor type (Figure 3 and Figure 4). These wings are all connected by a central hall which usually houses different functions and therefore has a different topology. The hall school is recognizable by the internal circulation ring which connects the wings. The different pavilions in the pavilion school are easy to recognise and can all have their own structure (Figure 5 and Figure 6). These individual pavilions are variations of either the hall type (with a circulation ring) or the corridor type.

In other words, the hall and pavilion types actually comprise parts that have the structure of

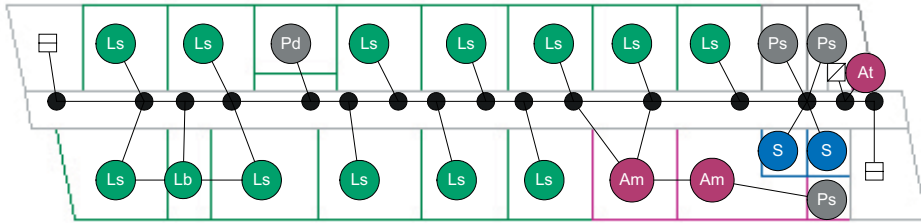


Figure 1. Topological representation of the corridor school PrismaCollege Graaf Engelbrecht

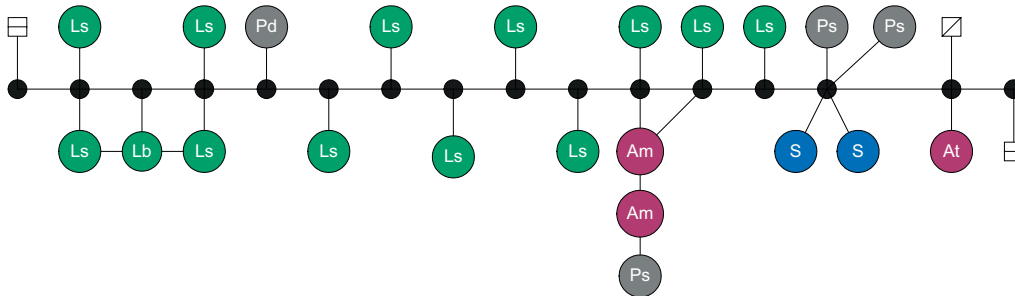


Figure 2. Normalized topological representation of the PrismaCollege Graaf Engelbrecht

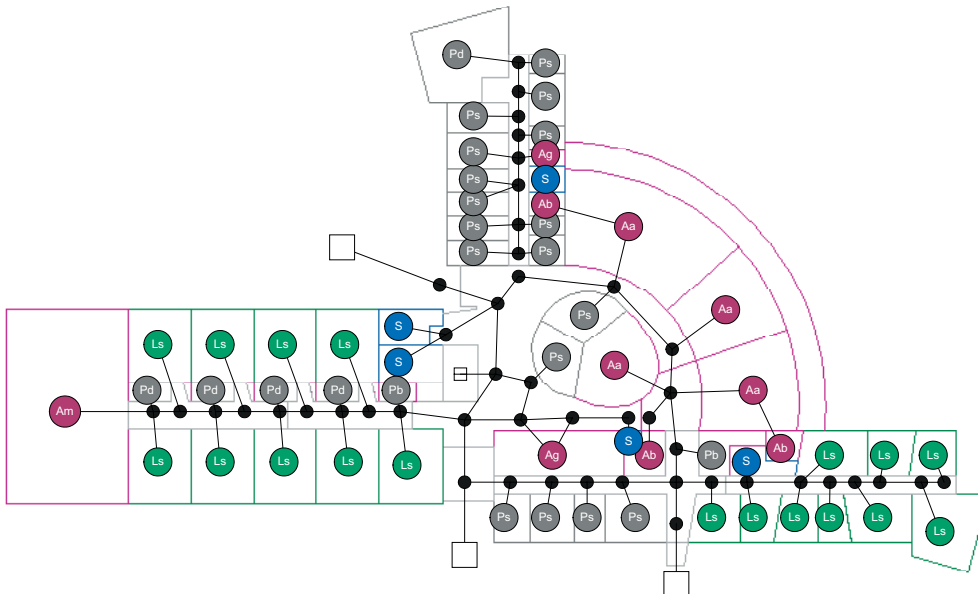


Figure 3. Topological representation of the hall school Dockinga College

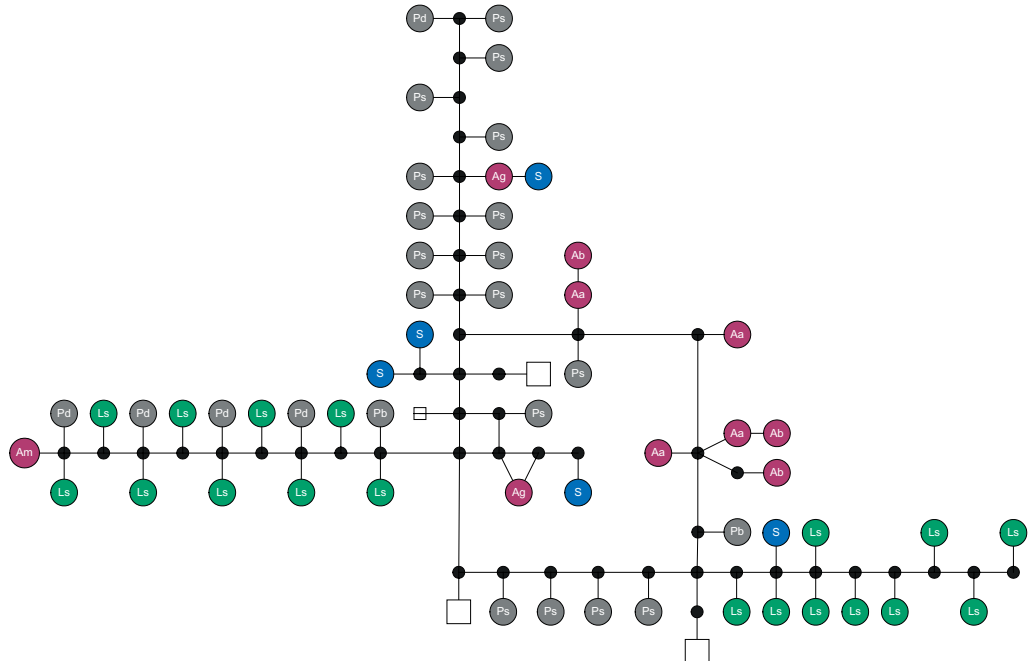


Figure 4. Normalized topological representation of the Dockinga College

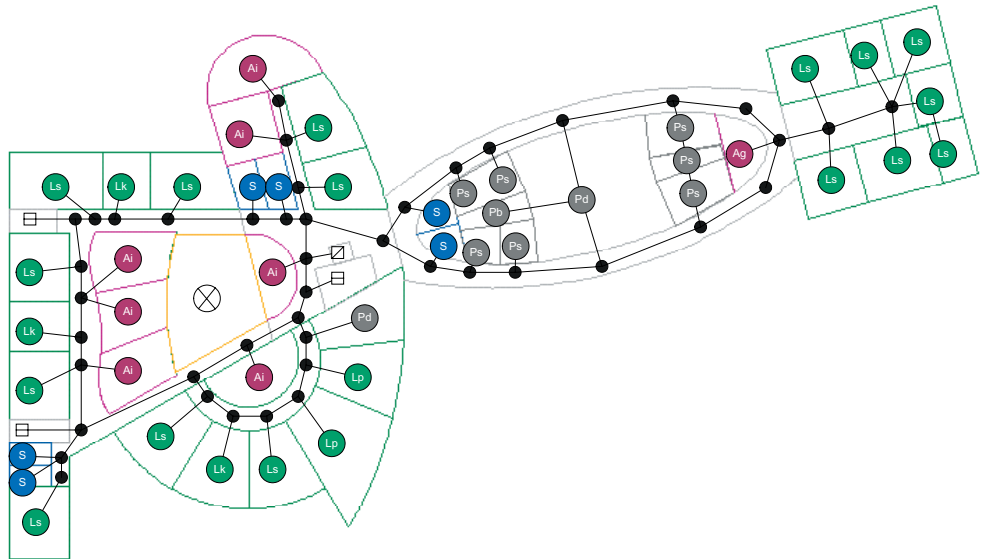


Figure 5. Topological representation of the pavilion school Trevisanum Scholengroep Sittard

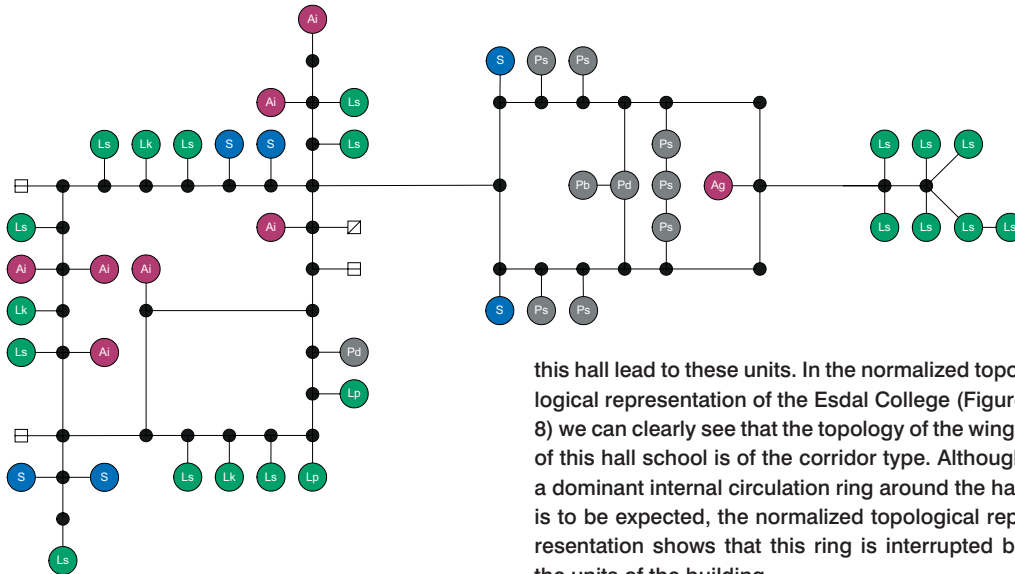


Figure 6. Normalized topological representation of the Trevianum Scholengroep Sittard

the corridor type: clusters of several classrooms and related spaces arranged sequentially on one or both sides of a corridor. These micro-corridor instances are the basis of most wings in a hall type and most pavilions in a pavilion type, the notable exceptions being groups of special-purpose spaces (e.g. gym). The encapsulation of the corridor type in hall and pavilion schools agrees with the historical line of development of the hall and corridor types from the earlier corridor type. The main departure of the new types was that the hall type introduced a central, multi-purpose space that acted as a focal area for a variety of activities (not just circulation), while the pavilion type organizes space clusters into units of a smaller scale in an urban (or more frequently suburban) overall arrangement.

The plasticity of the central hall may also lead to significant changes in the spatial structure. The Esdal College is a hall school comprising seven units. These units are situated around a central hall in the middle of the building. Three staircases in

this hall lead to these units. In the normalized topological representation of the Esdal College (Figure 8) we can clearly see that the topology of the wings of this hall school is of the corridor type. Although a dominant internal circulation ring around the hall is to be expected, the normalized topological representation shows that this ring is interrupted by the units of the building.

From a topological viewpoint the school consists of three corridor instances abruptly connected to each other. The typical functions of the central hall with respect to circulation and group activities are severely undermined by choices made in the spatial articulation of the school. The appearance of the Esdal College contains many of

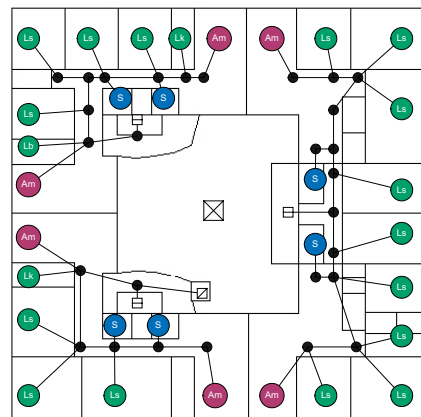


Figure 7. Topological representation of the Esdal College

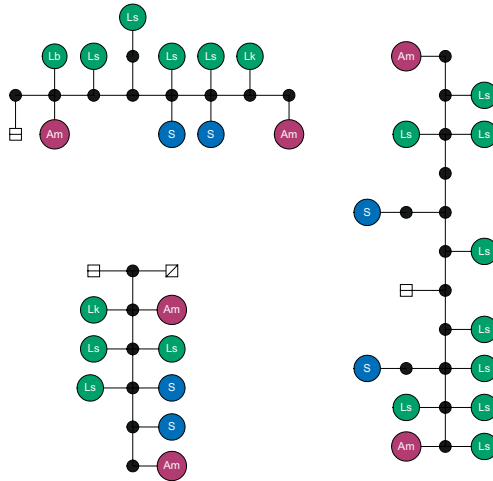


Figure 8. Normalized topological representation of the Esdal College

the features of the hall type but their spatial and functional structures are more akin to the corridor type. As a result, fundamental differences between the two types may lead to deviations from the expected performance of the building and conflicts between the structure of activities and the arrangement of spaces used for their accommodation. The adaptability of the users of the built environment generally obscures such conflicts. Nevertheless, we consider transparency and coherence of design decisions important for design performance.

Conclusions

In the development of the case-base (analysis and classification) the topological representation posed important typological questions. Elements such as central halls could be parsed into sequential arrangements that effectively described a loose collection of corridor schools and had little to do with the geometric character of a hall. Similarly, school buildings of the pavilion type were revealed as instances of the corridor type where the corridor had been stretched in order to create more distance between space clusters and hence

improve environmental quality or accentuate morphological characteristics, including indications of space grouping (common devices in larger corridor schools).

These problems made the identification of a topological cluster with a discrete geometric part of a building tentative and unreliable. In many cases we came to the conclusion that a typological characterization relied more on geometric similarity with an established prototype than compliance with the structure of the type. Consistent with the bottom-up character of most architectural typologies we decided to rely more on the representations used in the case-base. This had obvious advantages for automation but also gave us the opportunity to reconsider and refine the conventional typology. The conventional types were retained as a high abstraction useful for e.g. communication, but intermediate levels were developed independently primarily on the basis of the topological representation that offered links to the brief as well as connections between types.

Our hypothesis concerning the three conventional types is that on a high abstraction level they can be useful as global indications of behavior and performance, e.g. of pedestrian circulation, social contact, certain types of adaptability and transformation. Topological representation and analysis allow for progressive refinement of these expectations. Even geometrically complex cases like the Trevianum Scholengroep Sittard (Figure 5), have a clear topologic structure. This allows the unambiguous recognition of the primary type and typological variation and it tests our underlying assumptions and techniques.

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