Generic Representations and the Generic Grid: Knowledge Interface, Organisation and Support of the (early) Design Process

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ABSTRACT

Computer Aided Design requires the implementation of architectural issues in order to support the architectural design process. These issues consist of elements, knowledge structures, and design processes that are typical for architectural design. The paper introduces two concepts that aim to define and model some of such architectural issues: building types and design processes. The first concept, the Generic grid, will be shown to structure the description of designs, provide a form-based hierarchical decomposition of design elements, and to provide conditions to accommodate concurrent design processes. The second concept, the Generic representation, models generic and typological knowledge of building types through the use of graphic representations with specific knowledge contents. The paper discusses both concepts and will show the potential of implementing Generic representations on the basis of the Generic grid in CAAD systems.

1 INTRODUCTION

At the lowest level of description, current Computer Aided Design (CAD) systems encode designs as a list of vertices, on the basis of which they define the lines, planes, and volumes which describe the design. The most basic operations provided for act on these entities or aggregates of entities. Although the vocabulary of vertices, lines, planes, volumes, and operations is adequate to describe designs geometrically (see Mitchell and McCullough 1991 for a survey based on the distinction between vertices, lines, planes, and volumes), it does not successfully support design. Furthermore, it does not seem to relate very much to the way architects design and perceive design problems.

Most CAD systems to date are productive when the design is more or less completed. Support in the early phase of design is not yet well developed nor understood. Therefore, it is necessary for CAD systems to become 'architecturally literate,' that is, to acquire structures, elements, and processes that are related to architectural design. Recent advances in the development of Computer Aided Architectural Design (CAAD) systems aim to introduce more complex structures and entities such as shape grammars, element libraries, parametrized objects, and

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constraint modelling (Schmitt 1993). This paper introduces and discusses two approaches that aim to address some of the architectural issues called for.

The concept of the Generic grid (Bax 1976) is related to design elements. We will briefly describe it, discuss its properties and comment on some drawbacks.

The concept of the Generic representation results from current research. It is related to knowledge structures and processes in design. We will describe it and discuss its potential relative to the issues introduced above. We will show how both notions can support the early phase of design and how these notions can accommodate it in a designerly way.

2 GENERIC GRID: DESCRIBING ELEMENTS AND STRUCTURING DESIGN

A Generic grid is a hierarchically ordered set of grids whose modules are whole multiples of each other. The grids are co-ordinated such that their lines overlap. Thus, a set of grids with modules such as, for example, 30 cm, 120 cm, 600 cm, and 2400 cm (notation: 30-120-600-2400) can be defined. In the theory of the Generic grid, each grid defines a level of scale. Its module then is the unit of measurement of the elements defined on that particular level. By assigning elements to specific levels, various design disciplines such as urban designers, architects, interior designers, and detail designers (see figure 1) can be identified as dealing with these grids, since they operate on particular elements and levels of scale. The grids are not independent of each other. Design decisions made on a particular level influence other levels. Between grids, tartan grids can be defined that moderate design decisions between

Figure 1: A schematic representation of a Generic grid.
various levels. In principle this is not direction-specific, that is, design decisions can be accommodated from a grid with a small module (low level) to a grid with a larger module (higher level) and vice versa. Design participants operating on various levels may thus establish agreements on designing, which enable them to operate in a variety of manners, ranging from highly involved into each other’s work (architects discussing urban and detail issues) to autonomous (implying a hierarchical top-down view of influences of design decisions).

2.1 Some issues related to the Generic grid

This particular approach and definition of the Generic grid has a number of properties that relate to CAD systems.

- Different design participants perceive design elements in different ways. For example, structural engineers conceive of a wall as a load-bearing structure with particular properties such as strength. Lighting specialists and interior designers perceive the wall as a particularly shaped surface with specific reflective and chromatic qualities. The contractor views the wall as accommodating electrical wiring and connectors, etc. To complement these rather static views, the contractor perceives the wall as part of the building process. Facilitating these specialised views in CAD systems usually results in specialised approaches because of demands of computational economy. Bringing together this complexity of views calls for a general approach that allows a “loose fit”2 between these views and which concentrates on a common property shared by all views. We propose that this property is form or to be more precise, geometry and place. (De Vries 1996), developing an information exchange model to accommodate communication in the building industry notes that geometric description of objects is an important aspect present in all elements (de Vries 1996, p. 52). Geometry and place are aspects readily definable in a Generic grid.

- Elements are assigned to one grid only. However, they can be defined more precisely on a lower level, but only through elements that are assigned to that level. In turn, elements can be conceived of as constituent elements on a higher level. In this way, elements can be aggregated to form larger sets of design elements which the designer can manipulate. For a similar approach and application to modelling flexibility and costs, see (Prins 1992). The Generic grid offers a principle to decompose design elements in a way attainable for CAD systems.

- Assigning elements to levels and forming aggregates over various levels also implies that elements have different appearances on varying levels. This is usually referred to as “logical zoom,” (Schmitt 1993, p. 76-79) that is, that the level of detail of representing design elements is relative to the scale one is working on. Designing on the urban level does not require a small unit such as 30 cm, or 150 cm, but rather 600 cm or 3000 cm. Therefore, levels of the Generic grid accommodating these units can be used while those with the smaller modules may be discarded. The appearance of elements from different levels may change
according to their notation in tartan grids or otherwise, so that the designer knows these do not 'belong' to the current level he is working on.

- Assigning elements to levels and design participants does not encumber the flow of design acts that take place between levels (a designer may switch through levels at will). It is a notation and way of ordering design elements that makes sense for a CAD system. However, in the case of concurrent engineering (Bax and Trum 1995), and co-ordinating numerous design participants or facilitating prolonged design and management processes (Bax 1985; 1989) the Generic grid, by imposing a top-down hierarchy, may provide the structure to co-ordinate these processes.

2.2 The Generic grid as a general notation of building designs

The Generic grid provides a highly abstract structure for describing designs which can be used for analytical and design purposes. By describing a site in terms of a sequence of modules, one has some very general guidelines to follow (or to contradict) in design (Bax 1992, p. 231 demonstrates a Generic grid analysis of the Centre Beaubourg, Paris). A particular Generic grid (e.g. 30-150-600-3000') defines a class of buildings that share some general geometric properties. These buildings can all be designed according to the set of co-ordinated grids of modules 30, 150, 600, and 3000 cm. Furthermore, it is possible to assign design participants and mandates to specific levels in order to achieve co-ordination between design participants.

2.3 The need for typological knowledge in CAAD systems

Although the Generic grid may be used as a design aid which can be used throughout the whole design process, it does not provide much structure to describe and support the design process of a building design. The qualities defined in a Generic grid - measure, rhythm, and scale - do not support the knowledge intensive design process. An architect uses information of the site, the program of demands, and has knowledge of previous (partial) design solutions and strategies. This information is not incorporated in the Generic grid.

Support of design then, requires knowledge structures and processes that are related to knowledge structures (declarative knowledge) and processes (procedural knowledge) that are used by architects. One particular knowledge structure which seems quite powerful is the building type. Efforts to understand and model the use of building types may aid further development of CAAD systems. If we want to support the design of buildings belonging to a type, so-called "instances," then it is necessary to acquire typological and generic knowledge of building types and design processes.
3 GENERIC REPRESENTATIONS: DESCRIBING KNOWLEDGE STRUCTURES AND PROCESSES

The theory of Generic representations aims to explain and model generic and typological knowledge. The basic approach has been developed on the basis of a survey of architectural theory, design methodology, cognitive psychology, and computer science. The following characterisation briefly summarises the results of the survey work, and gives the essential line of reasoning in the research.

3.1 Type in architecture

Both architectural theory and design methodology pose the building type as a constitutive element of architectural thought. Formulated generally, types constitute knowledge of classes of buildings. They play an important role in architectural design as they aid architects in both generating designs that belong to a specific class of buildings and to recognise buildings as belonging to a specific type. Types constitute a major source of general architectural knowledge. However, since both architectural theory and design methodology are engaged predominantly in theory-building work, they do not provide decisive material on the nature of building types in architectural design. Additional material from research disciplines that study the nature and application of human reasoning mechanisms and structures is required. These disciplines are cognitive psychology and computer science, notably the field of Artificial Intelligence (AI).

3.2 Type in cognitive psychology and AI

Cognitive psychology proposes a form of knowledge organisation through the concept of the "schema" (Hamel 1990, p. 11). The schema is a versatile and complex form of knowledge which seems to have many common characteristics associated with types in architectural theory and design methodology. Schemas and types both hold general knowledge which can become more specific, they are about general classes of knowledge, they explain class-membership, and they can hold procedural and declarative knowledge (Hamel 1990, p. 11, 34; Coyne et al. 1990, p. 34). The discipline of AI aims to implement human or rational thought processes in computers. It has identified the need of complex knowledge structures (Coyne et al. 1990, p. 48-70), proposing for instance 'constellations,' 'frames,' and 'scripts.'

3.3 The prototype approach in AI

An important approach in AI on establishing a type-like computational structure in architectural design, is the concept of the 'prototype' (Coyne et al. 1990, Gero 1990, Oxman 1990, Rosenman and Gero 1993). The basic assumption of this approach is that type is considered to be an abstract data structure that can be sequentially particularised by establishing values for its variables. When based on the explicit use
of building types, it may be considered the equivalent of 'routine design' (Rosenman and Gero 1993). In this view of the prototype, the relation between building design and type is considered to be one of mapping between instance and type. Although this relationship is logically sound, the idea that there is an abstract data structure representing all instances of a type, is problematic. This is mainly due to the shift of emphasis to the knowledge structure and downplaying the importance of the design process. The prototype is defined site- and program independent, but in order to become operational, it has to incorporate knowledge how to deal with site and program. A more balanced relation between knowledge structure and design process seems required.

3.4 Graphic representations as a medium for knowledge encoding

The prototype-approach discards the role of graphic representations such as sketches and drawings (Coyne et al. 1990, p. 66). However, architectural design occurs predominantly through drawings as a medium. These both represent the state of the solution to the design task and the understanding of the design task. Furthermore, the architect uses them as 'external memory' to aid in preserving an overview of the design task and design object. Graphic representations, therefore, provide a sensible way of dealing with design. (Akin 1986) provides a framework of terminology to discuss the way graphic representation consistently encode knowledge of the things they represent. According to Akin, graphic representations display properties of 'multiplicity' (multiple representations of the same reality are possible), 'consistency' (interpretation of the parts of the representation is constant), 'functionality' (a representation conveys a specific purpose), 'abstraction' (representations focus on specific aspects of reality), and 'organisation' (representations have structural properties in order to be able to represent). (Achten 1996) uses the framework to demonstrate this framework and to argue for using drawings as a medium of knowledge encoding.

3.5 Generic representations

In the theory of Generic representations therefore, we propose to encode the process of designing an instance of a building type through specified graphic representations. This set of specific graphic representations has been found in a survey in literature on architecture. The analysis of graphic representations used by architectural theorists yielded a set of twenty-six highly specific graphic representations with specific knowledge contents. We refer to these representations as "Generic representations."

The term 'generic' refers both to the meaning of 'to generate' as 'general property.' It refers to 'to generate' because a sequence of generic representations encodes generating a building design. It refers to 'general property' as a single generic representation denotes general properties present in a specific graphic representation.

A concise definition of a Generic representation then is, "a graphic representation with specific knowledge content, consisting of a set of well-defined graphic elements,
identified by a name and an iconic representation.” The name describes in short the kind of knowledge encoded by the Generic representation. The icon describes in a graphic manner the characteristics of the representation. It also is an instance of the graphic representation found in the survey that we have identified as a Generic representation. Each single Generic representation represents the state of the design object and the knowledge and decisions required in the design process.

4 APPLICATION OF GENERIC REPRESENTATIONS

The theory of Generic representations described up to this point is held to apply to building types. In order to substantiate this claim, it has to be implemented in a CAD system. This implementation, although it is meant for testing the theory, also points to the potential of a CAAD system based on Generic representations. In order to establish the implementation, a particular building type and a design strategy have to be chosen.

4.1 Implementation of the theory of Generic representations in a CAAD system

Before we will present a sequence of Generic representation applied to a building type, we will briefly discuss some implementation issues. These matters have been presented and discussed in (Achten et al. 1995a). We will not pursue them in any great length here as (Achten et al. 1995b) presents an expanded version which also contains source code of the program implemented in a CAAD system.

To summarise, the implementation of Generic representations has been applied to the office building type. From existing literature on office buildings, we extracted knowledge concerning office buildings (e.g. the length of egress, norms of room sizes, organisational features, etc.). This knowledge base formed the basis on which to make decisions during a design process.

The computational approach underlying the structure of the design system has been the use of frames for generic knowledge. Each slot of the frame refers to one Generic representation. The sequence of slots therefore, encodes the sequence of Generic representations. We have defined a particular sequence of seven Generic representations which encodes a design process, applying the architectural design strategy of ‘refinement’ (Oxman and Oxman 1992). The system has been programmed in AutoLISP in an AutoCAD environment.

4.2 Implementation of the theory of Generic representations for an office building

The sequence of Generic representations presented here on the next three pages has been worked out for one particular subtype of the office building. The sequence contains twenty-four of the twenty-six identified Generic representations. The subtype
used is the T-shaped office building. The Generic representations are ordered in a
table consisting of twenty-four rows and four columns.

Each row in the table describes one Generic representation, such as “Simple
contour,” “Combination of simple contours,” or “Specified form.”

The left column shows the icon of the Generic representation. The icon, as stated
before, indicates graphically what the Generic representation is about.

The second column, “Building,” shows how the Generic representation may look
like when applied to the building design. Because a Generic representation is very
specific, the drawing may not always display a complete building.

The third column, “Representation,” shows how the office building type looks
according to the specification of the Generic representation.

The fourth column, “Name and some characteristics,” gives a brief description of
the characteristics of the Generic representation. It provides a brief statement on
the knowledge aspects encoded in the Generic representation.

The next three pages show the development of the sequence of Generic
representation for the T-shaped office building. The sequence of Generic
representations (starting with “Simple contour,” “Combination of simple contours,”
“Specified form,” “Complementary contours,” “Zone,” etc.) of the T-shaped office
building demonstrates how each step decomposes the complex series of design
decisions made. It also shows how this can be made tangible through graphic
representations, which is very much related to the way architects design.

‘Typological knowledge,’ which was referred to above, can now be defined in the
theory of Generic representations as that part of declarative knowledge that is related
to a building type. It can be encoded in single Generic representations, each
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procedural knowledge that is related to a building type.

The theory of Generic representations proposes a knowledge structure - the
Generic representation - which can accommodate typological and generic knowledge.
By ordering Generic representations in a sequence, design processes are instantiated.
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knowledge.
<table>
<thead>
<tr>
<th><strong>Simple contour</strong></th>
<th>Defining the outward form of the building. Establishing the T-shape; triple-winged building. Surface area. Parametrize wing-length.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Combination of simple contours</strong></td>
<td>Composing ensemble of simple contours to establish overall shape. Define internal proportions and place of simple contours. Explore emergent forms.</td>
</tr>
<tr>
<td><strong>Specified form</strong></td>
<td>Establish tentative dimensions for wing length and depth, and orientation of the building.</td>
</tr>
<tr>
<td><strong>Complementary contours</strong></td>
<td>Establish place of building mass in site. First tentative estimate of grid active at the urban level. Relate to demands of distance from site, and other buildings.</td>
</tr>
<tr>
<td><strong>Zone</strong></td>
<td>Zoning structure establishes a principle of ordering the building. Establish a zoning principle for the wings, e.g. single, double, or triple zone with central circulation.</td>
</tr>
<tr>
<td><strong>Schematically subdivided zone</strong></td>
<td>Along a zone, establish areas that have specific qualities such as lighting, circulation, accessibility, etc. This results in an inventory of possibilities.</td>
</tr>
<tr>
<td><strong>Function symbols in schematically subdivided zone</strong></td>
<td>Allocate tentative functions in specific areas along a zone, relative to its qualities. This action is like an inventory of possibilities.</td>
</tr>
<tr>
<td><strong>Zone in specified form</strong></td>
<td>Establish the zoning system in the building form. Establish the dimensions of the zones, identify special places such as intersections, end of wing, internal/external corners, etc.</td>
</tr>
<tr>
<td>Schematic subdivision</td>
<td>Divide the building into sections that can be considered quite independently from each other. For each section, establish a principle division into parts.</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Schematic subdivision within contour</td>
<td>Subdivide the contour of the building according to the schematic subdivision. Identify tentative surface areas to parts of the subdivision.</td>
</tr>
<tr>
<td>Schematic axial system superimposed on specified form</td>
<td>Place system of axes that define organisation of spaces in the specified form. Define general dimensions of spaces.</td>
</tr>
<tr>
<td>Schematic subdivision as modular zones in archetypes</td>
<td>Co-ordinate the schematic subdivision in the specific form along a grid or set of grids. Define major spaces within the subdivision.</td>
</tr>
<tr>
<td>Subdivision of specified form</td>
<td>Subdivision of the specified form according to the grid underlying this level. General organisation of the building layout of major spaces.</td>
</tr>
<tr>
<td>Partitioning system in simple contour</td>
<td>Principle of partitioning along which future divisions may be placed. Establish module for rooms.</td>
</tr>
<tr>
<td>Modular field</td>
<td>Establish grid of building according to modules and dimensions already available.</td>
</tr>
<tr>
<td>Contour and subdivided field</td>
<td>Establish place of rooms and spaces according to underlying grid.</td>
</tr>
<tr>
<td>Contour and modular field</td>
<td>Superimpose the modular field (grid) on the specified form. Establish the module of the grid.</td>
</tr>
<tr>
<td>Zone in contour and modular field</td>
<td>Co-ordinate the zone structure according to the module of the grid.</td>
</tr>
<tr>
<td>Element vocabulary and combinatorical rules</td>
<td>Establish sets of furnishing for parts of the building according to functional requirements, program of demands, and suppliers.</td>
</tr>
<tr>
<td>Contour and element vocabulary</td>
<td>For parts defined according to subdivision of specified form, determine usability and functionality by interior elements (furnishing).</td>
</tr>
<tr>
<td>Element vocabulary in zone, contour and modular field</td>
<td>Determine general layout, furnishing, and zoning of the building design adhering to the Generic grid.</td>
</tr>
<tr>
<td>Circulation scheme</td>
<td>Establish circulation principle according to zoning and schematic axial principle.</td>
</tr>
<tr>
<td>Contour with circulation</td>
<td>Dimension circulation in building design according to requirements and program of demands.</td>
</tr>
</tbody>
</table>
5 GENERIC REPRESENTATIONS AND THE GENERIC GRID: ORGANISATION AND SUPPORT OF THE DESIGN PROCESS

Before the theory of Generic representations can be implemented in a CAD system, it has to become more specific on those issues that have been identified in Section 2.1: geometry and place. Generic representations up to this point are not restrained to any particular formal vocabulary. However, this characteristic also restrains them from being implemented in a CAD system. It is necessary to constrain and define Generic representations in terms of geometry and place.

Viewed from the theory of Generic representations, the Generic grid may be considered as a Generic representation. Its elements are the set of grids, encoding a system of measurements and co-ordination. Since it is highly abstract, the Generic grid offers conditions for implementing Generic representations. It provides the precision of geometry and place called for when implementing Generic representations, while allowing all shapes and forms that can be put in a grid. In this manner the strengths of both approaches can be combined. Implementing Generic representations on the basis of the Generic grid results in reduction of geometric complexity and provides constraints on geometry and place as required for CAD systems. Moreover, it expands the concept of the Generic grid into a more versatile and supportive design aid tool.

By combining the notions of Generic representations and the Generic grid, the Generic grid, which offers a hierarchical form-based decomposition of elements, co-ordination of design participants, and accommodation of concurrent engineering, is expanded with generic and typological knowledge of building types. In this manner, organisation through the Generic grid and support through Generic representations is established. When we summarise the theoretical findings of Sections 2, 3, 4, and their elaboration in Section 4.1, implementation of the work described can result in a CAAD system which features grid-based description of designs, description of design processes, support of knowledge application through a knowledge interface, accommodation of multiple design participants, and support particularly of the early design process through establishing general layout, organisation, partitioning, and use of the plan (the features in italics are implemented in the system described in (Achten et al. 1995a; 1995b) which contains the first seven Generic representations of the sequence).

6 A DESIGNERLY APPROACH FOR CAD SYSTEMS

In order to assess the implications of implementing Generic representations in CAD systems, we will introduce the term "intermediate structure" (Achten 1996), and show how this term can point to some general characteristics of a particular class of approaches to CAAD systems, including Generic representations and the VR-DIS
platform approach developed by the Building Information Technology group of the Eindhoven University of Technology.

6.1 Intermediate structures in CAAD systems

An intermediate structure is a manipulable graphic representation of a building design in a computer. The representation is structured, that is, it has specific regularities which define particular properties. It constraints and supports design actions by designers. Intermediate structures necessarily are implemented in CAD systems because these can accommodate computational characteristics. However, intermediate structures are not graphic user interfaces as understood in the general sense. Graphic user interfaces allow users to manipulate the course of computer actions through interaction with visual entities such as menus and buttons (for example, dialogue boxes in AutoCAD for fixing colors of layers), and to work on the computer by painting and changing visual representations of a computer model (for example, clicking and stretching a shape by handles in AutoCAD). A graphic user interface does not concern what it displays in those actions; it could be anything. An intermediate structure attaches specific interpretations and actions to what is displayed, such as preserving knowledge encoded in a sequence of design decisions through Generic representations, displaying and reasoning with constraints graphically defined (Gross et al. 1988; Gross 1990), or working with parametrized objects (Schmitt 1993, p. 70-71).

The intermediate structure is represented in the computer by a computational structure. The designer also has a representation of the intermediate structure. Both the designer and computer interact on the intermediate structure. The separation into three representations makes it possible to avoid the trap of trying to model the designer in order to make CAAD systems. Each representation accommodates differences in the computer and designer representations of the intermediate structure.

Figure B: Intermediate structure

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Computer   Intermediate structure   Designer
          model, data, etc.              theory, intention, etc.
                                        DESIGN PROCESS
                                        A                 C
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[Source: Achten 1996]
The representation of the designer may reflect quite another set of properties, intentions, reflections, etc. than the computer representation of the intermediate structure. The medium of discourse however, ‘where both worlds meet’ so to speak, is the intermediate structure (see figure 2).

Intermediate structures describe a designally approach to CAAD systems. They allow the architect to act on representations that in part ‘behave,’ ‘model,’ or ‘encode’ architecture-like knowledge structures or processes. Work on intermediate structures furthers understanding of these forms of knowledge and processes by researching them and modelling intermediate structures. In this manner, they generate explicit knowledge of how architects design and how they can be supported. At the same time, the use of intermediate structures in CAAD systems also addresses the architects implicit competence of evaluation and design strategies.

6.2 The VR-DIS Platform

An innovative computational and developmental approach in CAD systems is being developed currently at the Building Information Technology group and Calibre Institute at the Eindhoven University of Technology through the concept of the “Virtual Reality Distributed Interactive Simulations” (VR-DIS) platform (for general introduction, see van Zutphen and Munters 1996). The designer-support strategy of VR-DIS can be discussed in terms of intermediate structures. VR-DIS aims to address (multiple) professional and non-professional designers and design participants in a (partially) immersive design environment on design problems. The strategy is particularly informed by the goal to increase effectiveness of design media by offering three-dimensional models of buildings that can be manipulated real-time with multimedia support (Smeltzer et al. 1994). Therefore, the intermediate structure active in VR-DIS is the manipulable three-dimensional projection of the building design. The computer representation of the intermediate structure falls down into a number of computer models because of the complexity of the visualisation, support, and modelling aspects involved. The architect’s representation is addressed through the immersive projections, and allows the architect to design and evaluate in a natural manner.

6.3 Partial immersive environments

In Eindhoven, some research has been done on “partial immersion” (Smeltzer et al. 1994, p. 14) in VR-DIS like environments. (Coomans 1996) developed and explored a representation mix in the VIDE system (Virtual Interactive Design Environment) which involved the use of plan-based development and simultaneous three-dimensional interactive presentation and manipulation. The work both in plan representation and spatial representation was grid-based, and may be considered in the theory of Generic grids as the elaboration of one level of scale. The use of a grid proves useful in an immersive environment since distance and dimensions are harder to control precisely. From the work of Coomans, one may conclude that issues identified in the section discussing Generic grids, such as logical zoom, and hierarchical form-based
decomposition would enhance the system developed. Considering the other component introduced in this paper, Generic representations are essentially plan-based. Implementing them in VR-DIS would call for a similar kind of representation mix as demonstrated by Coomans. Through the foundation of the Generic grid they can play a role in design support in the immersive representation as well, by supporting the decision making process relative to a specific building type.

7 DISCUSSION

From the above, we may conclude the following.

- Generic representations implemented on a Generic grid offer a basis for developing CAAD systems in the early phase of design.
- Generic representations add typological and generic knowledge to CAAD systems.
- Generic representations offer a knowledge interface for the design of instances of building types.
- The VR-DIS system and Generic representations both are instances of intermediate structures; therefore, it makes sense to implement Generic representations in the VR-DIS platform.
- Because of the immersive properties of VR-DIS, a representation mix as outlined by (Coomans 1996) is desirable for Generic representations-based VR-DIS.
- The notion of logical zoom is helpful in immersive environments, and can be implemented on the basis of the Generic grid.
- The Generic grid offers hierarchical co-ordination of design participants.
- The Generic grid accommodates multiple design participants in concurrent processes.

This paper has discussed ongoing research work on Generic representations. It has indicated the potential of establishing a knowledge interface for early design using building types. It has pointed to general characteristics of the work through the notion of intermediate structures. The paper has shown the common properties underlying Generic representations and the VR-DIS platform research, discussing the potential of implementing Generic representations based on Generic grids in the VR-DIS platform.

8 ACKNOWLEDGEMENTS

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Many studies of architectural design products and processes provide material on the nature of architectural design. (Ronner et al. 1977) provide an overview of design sketches by Louis Kahn showing how his designs evolved throughout the use of the sketch, (Shoshkes 1989) and (Lawson 1994) provide surveys and analyses of design processes by architectural firms. (Rowe 1987) and (Lawson 1980) provide a descriptive and theoretical approach to design. (Heath 1984) gives a knowledge-oriented description of design, and (Akin 1986; Hamel 1990) study design from the cognitive psychology perspective. These studies identify high-level and complex entities that play a role in design, such as sketches, design strategies, types, design generators, information processing in design, schemas, etc.

Comprehensive top-down approaches to establish a general model for the description of buildings have not been very successful. From 1994 onward, many approaches therefore concentrate on the bottom-up strategy. One particular reason previous approaches were not successful, seems to lie in the aim to present a model that describes the building in one big stroke. They do not take into account the many conflicts and problems that the design team solves when designing. Cognitive study of architectural design processes indicate that architects tackle design problems by first solving a number of subproblems and then trying to integrate these solutions in an architectural manner (Hamel 1990, p. 224, 226). The term “loose fit,” therefore, suggests to leave open the possibilities for conflicts between partial design solutions during the design process and to have the design team deal with them in time. An alternative approach, which also aims for flexibility, is discussed in (van Leeuwen et al. 1996) concerning a Feature-based approach to information modelling. One has to note however, that in van Leeuwen’s approach, the so-called form-features are one of many other features, and not the predominant ones.

Modular coordination and industrialised production suggest the 10 cm and the 30 cm module as the smallest module to design with (except for details). However, this is a convention that is not required for the definition of Generic grids. Flexible production systems and large building projects may generate quite independent series of modules, such as 25-125-500-2000, or in the case of Centre Beaubourg, 40-160-1280-5120.

Note that the competence of the contemporary architect has been acquired through training via conventional representations such as the plan, section, perspective drawing, models, photo’s, and personal experience. The VR-DIS design medium is quite different from these media and may even be considered at this moment to be unnatural for an architect. Therefore, dealing with VR-DIS also involves a learning process for the architect. This particular aspect of investigating the effects of this kind of new media, is also part of VR-DIS research.

(Smelzer et al. 1994, p. 11) note that the concept of “level of detail” can considerably aid designing in immersive environments. However, it is important not to confuse the model underlying the representation with the representation that has a specific level of
detail. The architect works with the representation and therefore makes decisions on the basis of the information available in that level of detail. The theory of Generic grids can elaborate the notion of level of detail - or logical zoom - by showing how decisions made on one particular level of detail (i.e. level of scale) influence other levels.

9 REFERENCES


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