GENERIC REPRESENTATIONS

Typical design without the use of types

HENRI ACHTEN
Eindhoven University of Technology. Faculty of Architecture, Building and Planning. Design Methods Group. P.O. Box 513. 5600 MB Eindhoven, The Netherlands

Abstract
The building type is a (knowledge) structure that is both recognised as a constitutive cognitive element of human thought and as a constitutive computational element in CAAD systems. Questions that seem unresolved up to now about computational approaches to building types are the relationship between the various instances that are generally recognised as belonging to a particular building type, the way a type can deal with varying briefs (or with mixed functional use), and how a type can accommodate different sites. Approaches that aim to model building types as data structures of interrelated variables (so-called ‘prototypes’) face problems clarifying these questions.
It is proposed in this research not to focus on a definition of ‘type,’ but rather to investigate the role of knowledge connected to building types in the design process. The basic proposition is that the graphic representations used to represent the state of the design object throughout the design process can be used as a medium to encode knowledge of the building type. This proposition claims that graphic representations consistently encode the things they represent, that it is possible to derive the knowledge content of graphic representations, and that there is enough diversity within graphic representations to support a design process of a building belonging to a type.
In order to substantiate these claims, it is necessary to analyse graphic representations. In the research work, an approach based on the notion of ‘graphic units’ is developed. The graphic unit is defined and the analysis of graphic representations on the basis of the graphic unit is demonstrated. This analysis brings forward the knowledge content of single graphic representations. Such knowledge content is declarative knowledge. The graphic unit also provides the means to articulate the transition from one graphic representation to another graphic representation. Such transitions encode procedural knowledge. The principles of a sequence of generic representations are discussed and it is demonstrated how a particular type - the office building type - is implemented in the theoretical work. Computational work on implementation part of a sequence of generic representations of the office building type is discussed. The paper ends with a summary and future work.

1. Introduction

Both architectural theory (Argan 1963; Colquhoun 1981; Rossi 1982, p. 40-41; Westfall and van Pelt 1991, p. 140-144) and design methodology (Heath 1984, p. 121, p. 133; Habraken 1985, p. 23-36; Rowe 1987, p. 85-88, p. 190-194; Schön 1988) pose the building type as a constitutive element of architectural thought. Formulated generally, a building type constitutes knowledge of classes of buildings. It plays an important role in architectural design as it aids 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 architectural knowledge. CAAD systems therefore, can profit considerably if such kind of knowledge is implemented in design aid systems. Work on computational approaches towards type-like structures in architectural design (Gero 1990, Coyne *et al.* 1990, Oxman 1990, Rosenman and Gero 1993) faces problems about the relationship between the various instances that are generally recognised as belonging to a particular building type, the way a type can deal with varying briefs (or with mixed functional use), and how a type can accommodate different sites. This is due to the emphasis on the data structure and downplaying the importance of the design process. A more balanced relation between knowledge structure and design process seems required.

1.1. GRAPHIC REPRESENTATIONS

In the design process, graphic representations are a predominant element. They are a generally acknowledged medium through which the architect develops the design. The relationship between graphic representations, design decisions, and knowledge of building types is outlined in Figure 1. A single graphic representation depicts the state of the design in a particular stage of the design process. Through a sequence of graphic representations the design is worked out. Establishing a graphic representation requires taking design decisions (*e.g.* a contour of a building envelope requires decisions upon the shape, relative dimensions, and major building parts).

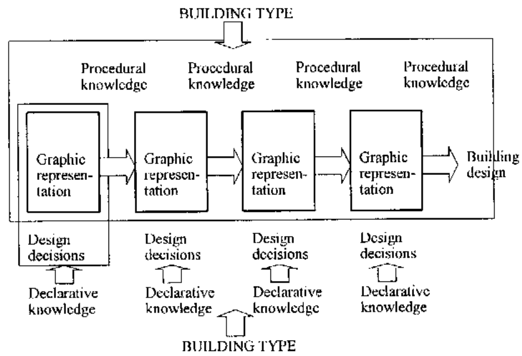


Figure 1. Relations between graphic representations, design decisions, and procedural and declarative knowledge of building types.

Making design decisions requires knowledge of the design task. This knowledge encompasses factual knowledge of the kind of building that is being designed. Such knowledge generally is indicated by the term declarative knowledge. Since in each graphic representation design decisions are involved, declarative knowledge is required in each graphic representation. During the design process, the design evolves through a number of graphic representations. Such a sequence of graphic representations reflects a sequence of design decisions. Knowledge of the order of design decisions is generally termed procedural knowledge.

1.2. GRAPHIC UNITS AND GENERIC REPRESENTATIONS

If it is possible to consistently describe design decisions in graphic representations and transitions between graphic representations (arrows in Figure 1), graphic representations can be the basis for modelling design processes. In this paper, an approach is presented that describes knowledge content and transitions by means of graphic entities present in the graphic representation. Graphic entities such as lines, shapes, and symbols conform to conventions of depiction and conventions of encoding. This means that a certain set of graphic entities (*e.g.* a set of lines) has a particular meaning (*e.g.* a system of axes, a grid, zoning). Such a set is connected to different design decisions (*e.g.* a basic ordering of spaces along axes, a field defining place and measure, and areas with specific properties). Therefore, it is necessary to distinguish between sets of graphic entities that have different meanings. Such a set is termed a "graphic unit": a set of graphic entities with a specific meaning. Description by means of graphic units results in generalised graphic representations. Graphic representations that share the same graphic units deal with the same design decisions. Such generalised graphic representations are termed "generic representations."

2. Identifying Graphic Units in Graphic Representations

By means of analysing graphic representations it is possible to identify graphic units. For this purpose, it is necessary to compare graphic representations and identify similarities and differences. In the research, 220 graphic representations selected from books are analysed. This is demonstrated by the examples in Figure 2.

- Circle, triangle, and square are instances of regular n-sided polygons (n=3, 4, 5,…), including the circle. They are characterised by the term "simple contour." Under the assumption that the graphic representation depicts a building, the "simple contour" represents the building envelope.
- The forms that are part of the layout are closed polygonal shapes. Under the assumption that the graphic representation depicts a building, this drawing represents a differentiated building layout, where the lines of the shapes indicate borders between major spaces.

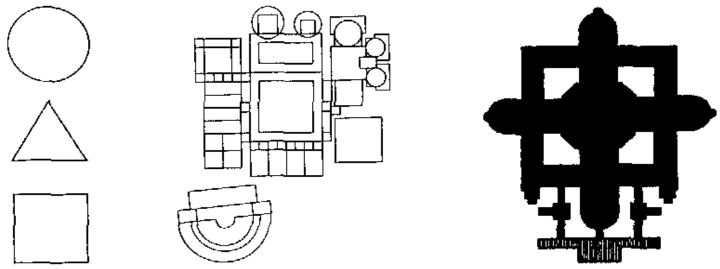


Figure 2. Three graphic representations. Left: three contours (Ching 1979, p. 54). Middle: layout (Mitchell and McCullough 1991, p. 136). Right: figure-ground drawing (Zevi 1974, p. 51).

The shapes of the layout are not always "simple contours," but in all cases they are "contours." The act of drawing a *simple contour* indicates the decision to limit the possible shape to a specific class of shapes (regular n-sided polygons). Drawing a *combination of contours*, as in the layout, indicates the decision to use particular shapes and to establish their relations concerning place and relative scale.

Therefore, two graphic units can be distinguished: *simple contour* and *contour*, which are instances of two generic representations: simple contour (which has one graphic unit, the *simple contour*), and combination of contours (which has one graphic unit, the *contour*).

Although both the layout (Figure 2; middle) and the figure-ground drawing (Figure 2; right) depict combinations of contours, they are different from each other:

In the layout, all shapes are represented by lines only. Under the assumption that the graphic representation depicts a building, the drawing represents a differentiated building layout, where the lines of the shapes indicate borders between major spaces.

In the figure-ground drawing, graphic distinctions are made by colour (black or hatching pattern) in complex shapes. Under the assumption that the graphic representation depicts a building, it represents the mass-space distribution of the building, where the lines and edges indicate borders between space and mass, and the colours (black, white, hatched) identify either mass or space.

In the layout, there is no distinction between mass and space. In the figure-ground drawing there is a distinction between mass and space. Both drawings imply different design decisions. In the figure-ground drawing, the filled-in black and hatched drawing imply the decision how to articulate mass and space and their edges.

Therefore, a new graphic unit can be identified: *complementary contours*, and a new generic representation: complementary contours (which has one graphic unit: *complementary contours*).

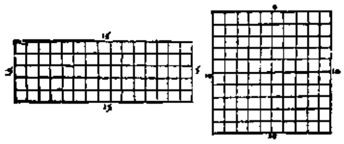
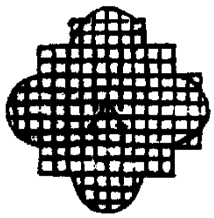
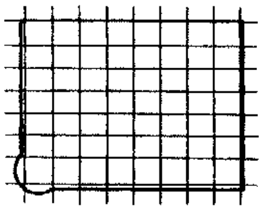
Describing the form aspects of graphic units results in a vocabulary which uses terms such as regular n-sided (n=*3*, *4*, *5*,…) polygonal shapes, closed polygonal shapes, filled-in (black, white, hatched, etc.) polygonal shapes, interlocked surfaces, etc. for shapes; single line, double line, line weight, linetype, etc. for lines; and direction, parallel, module, irregular distance, colour, and hatching, etc. for describing sets of graphic entities. The degree of specification of the vocabulary demonstrates that it is important to carefully distinguish between graphic entities that occur in a drawing.

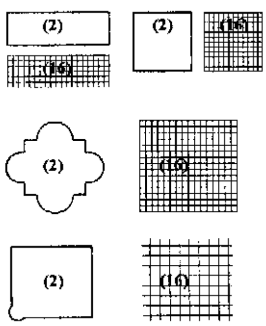
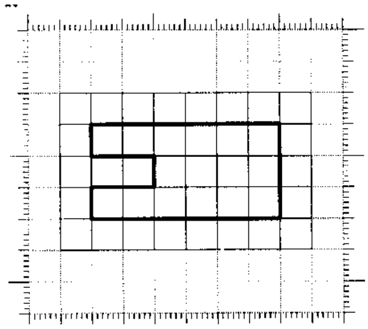
3. Generic representations

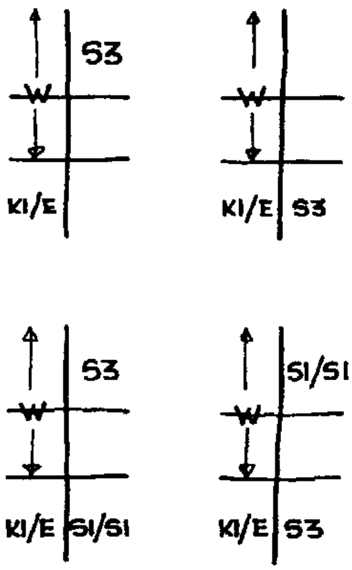
As the examples above show, graphic representations are very diverse in appearance. However, it appears that if a number of graphic representations have the same graphic units, then no matter how different they may seem, it is possible to state that they deal with the same design decisions. Such groups of graphic representations with the same graphic units are generic representations. In the manner outlined above, graphic representations are described in terms of graphic units. In the analysis 220 graphic representations taken from architectural sources are analysed, resulting in 24 graphic units and 50 generic representations.
A generic representation can be described by the following features: (1) *name*, (2) *source*, (3) *graphic representation*, (4) *textual description*, (5) *graphic units*, and (6) *iconic representation* (see Figure 3). The following pages show two cases.

Name of generic representation	
Graphic representations: - picture of case - *Image from the source list on right side of table* - source of picture - *Text identifying the image*	**Sources:** - list of sources and pictures - *Sources of the images, place in the source, and brief description of the image included in the graphic representation section* **Description:** - description of graphic representations - *The use in the design process, related design decisions, and graphic units found. Graphic units are named and numbered.*
Graphic units: - drawings of graphic units - *The graphic units as they occur in the graphic representations section above. It is possible that graphic representations have more than one graphic unit. The numbers correspond to the text in the description section.*	**Icon:** - schematic representation - *The salient features of the graphic representations are shown by a drawing consisting of graphic units. In this way, the properties of the diverse drawings in the graphic representations section are made clear. The icon therefore, shows the generic representation that can be derived from the graphic representations of the case study.*

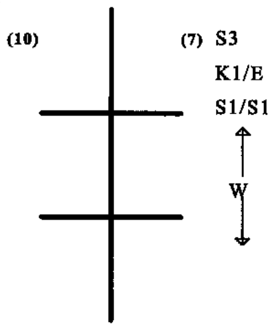
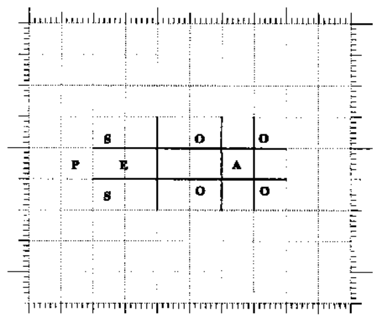
Figure 3: The format of presentation of generic representations.

<table>
<tr><td colspan="2">Contour in grid</td></tr>
<tr><td>Graphic representations:

Serlio (1611), First Book First Chapter, Fol. 7

Cesariano (1521), p. 239

Sullivan in Clark and Pause (1985), p. 117</td>
<td>Sources:
Serlio (1611), First Book, First Chapter Fol. 7. Grid argument for demonstrating different surface areas with the same perimeter.
Cesariano (1521) in Tzonis (1986), p. 21 figure 10 top drawing. ‘Grid pattern.’
Ching (1979), p. 239 figure B, D, H
Sullivan in Clark and Pause (1985), p. 117 figure F. Geometry in Carson Pirie and Scott Store, Chicago, Illinois.

Description:
The grid structures the place of elements, such as the perimeter, or columns. Not every part of the contour has to conform to the grid. When the perimeter follows the grid, this establishes a surface area unit that can be used in the building to co-ordinate rooms and spaces. If the grid is used for a structural system it is sometimes kept distant from the facade in order to resolve conflicts between columns and walls. Decisions concern the relationship between contour and grid, in particular the dimension of the module with which the contour is measured. Graphic units are the grid: orthogonal set of lines (16) and</td></tr>
<tr><td>Graphic units:

</td>
<td>Icon:
</td></tr>
</table>

<table>
<tr><td colspan="2">Schematic subdivision with function symbols</td></tr>
<tr><td>Graphic representations:


Boekholt et al. (1974), p. 82</td><td>Sources:
Boekholt et al. (1974), p. 82 figure 1 bottom figure. Sector analysis of a basic variant in housing.

Description:
Schematic subdivision with function symbols demonstrates a general principle of subdivision in combination with the assignment of functions. The figure shows a SAR-representation of a so-called basic variant: different functional layouts within a particular subdivision. The symbols W, K1/E, S1/S2, and S3 denote functions: W (living), K1/E (cooking, eating), S1/S2 (single person sleeping), and S3 (master bedroom sleeping). The arrow denotes in which area of the subdivision the function is allocated.
Decisions in this graphic representation concern the principle relations of place between functions and their position in a general subdivision.
Graphic units are schematic subdivision: lines (10) and function symbols: letters and numbers indicating functions (7).</td></tr>
<tr><td>Graphic units:

</td><td>Icon:
</td></tr>
</table>

4. Relations Between Generic Representations

The list of graphic units and generic representations is presented in Appendices I and II. At this point it is necessary to identify how in a design process transitions from one generic representation to the next are established. The claim of the hypothesis of the research work is that graphic representations are the medium for supporting design processes. Therefore, the properties of graphic representations identified in this work must be used in order to show how sequences of generic representations are established. It means that the concept of the graphic unit must be used for elaborating the relations between generic representations. Three kinds of relations between generic representations can be distinguished:
1. Addition.
2. Themes.
3. Succession.

4.1. ADDITION

Addition of graphic units identifies all transitions from one generic representation to another by means of addition of graphic units. In each 'step' a graphic unit is added. Therefore, the transition is by definition from simple (one graphic unit) to complex (more graphic units). The new graphic unit has to be matched with the existing graphic units of the previous generic representation. Figure 4 illustrates such relations. Applying the notion of addition to generic representations identifies sequences of generic representations that become more complex.

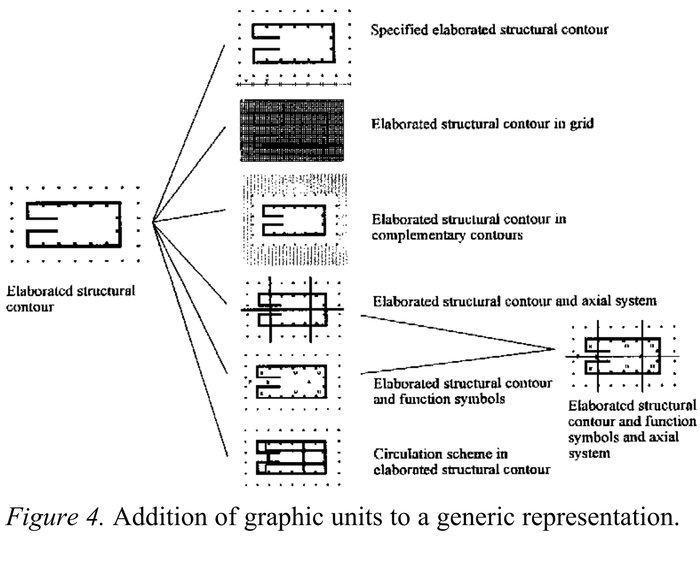


Figure 4. Addition of graphic units to a generic representation.

4.2. THEMES

Similarity between generic representations indicates if they deal with similar design decisions. For example, the generic representations simple contour, combination of contours, and complementary contours are the only generic representations that deal with the shape and place of the building edge exclusively. They constitute a theme, which is called "shape." In the same manner, other themes can be established. The generic representations in a theme develop independent from generic representations in other themes. By combining generic representations from themes (addition of graphic units), it is possible to establish more complex generic representations that deal with more sophisticated design decisions. Themes that are found on the basis of generic representations are: "shape," "system," "structure," and combinations of themes "shape and system," "shape and structure," "structure and system," and "shape and system and structure." Applying the notion of themes to generic representations results in groups of generic representations that deal with the same design issues.

4.3. SUCCESSION

A generic representation provides preconditions for more elaborate generic representations if one or more of its constituent graphic units provides such preconditions. A generic representation implies more schematic or less specific generic representations if one or more of its graphic units implies more schematic or less specific graphic units. For example, before the particular length of a wing is decided upon, the decision has been taken that the shape of the building actually consists of a number of wings. In terms of graphic units this means that the *contour* (a shape with no particular dimensions) is established before the *specified form* (a contour with particular dimensions). By analysing graphic units, it is possible to identify such sequences. These are called "successive graphic units":

1. *Contour* → *specified form* → *combinatorial element vocabulary* → *elaborated structural contour*
2. *Simple contour* → *specified form*
3. *Contour* → *complementary contours*
4. *Function symbols* → *zone* → *functional space* → *element vocabulary*
5. *Modular field* → *grid* → *refinement grid* → *tartan grid* → *structural tartan grid*
6. *Structural tartan grid* → *structural element vocabulary*
7. *Measurement device* → *proportion system*
8. *Schematic subdivision* → *partitioning system*
9. *Schematic axial system* → *axial system*
10. *Circulation scheme* → *circulation*

Applying successive graphic units to generic representations of a theme results in sequences of generic representations that develop a particular issue (shape, system, structure, etc.) from general to specific (less defined to more strict defined).

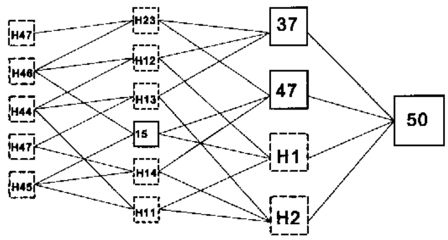


Figure 5. Identifying hypothetical generic representations (H1, H2, etc.) by addition of graphic units ending in found generic representations.

5. Missing Generic Representations

The relations of addition, theme, and succession can be applied to the set of generic representations found in the analysis. A number of generic representations is not related to each other by these relations. For example, the generic representation schematic subdivision in zone in contour with function symbols (number 49 in Appendix II) is not established by addition of either *function symbols*, *contour*, *zone*, or *schematic subdivision* to any generic representation 35 - 47 (see list of Appendix II). Given the number of possible generic representations[1] this leads to the conclusion that there are generic representations missing in the survey.

Given the aim to use generic representations as a medium for encoding knowledge of building types, it does not seem very productive to add all possible generic representations to the set of found generic representations. It is possible to limit this number by adding the constraint that any sequence of addition of graphic units must terminate in a generic representation that is part of the set found in the survey or in a hypothetical generic representation that is required for reaching a generic representation found in the survey (see Figure 5). This strategy yields a total of *106* generic representations of which *50* generic representations are found in the survey and *56* are hypothetical generic representations (see Appendix III). These hypothetical generic representations are embedded in the set of generic representations found in the survey. It is possible to state their properties on the basis of the constituent graphic units. In the remainder of this paper hypothetical generic representations are included. Figure 6 shows how found and hypothetical generic representations are related to each other in the theme “structure.” Five groups of structures are identified. From left to right: grid, proportion, axial system, subdivision, and zone. Each group of generic representations within the theme deals with an increasing level of specification with its structures.

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[1] The analysis results in the identification of 24 graphic units. Generic representations identified in the analysis have no more than four different graphic units. Therefore, all possible generic representations are generated by combining one up to four graphic units. This gives a total of $24! / (4! \cdot 20!) + 24! / (3! \cdot 21!) + 24! / (2! \cdot 22!) + 24 = 12950$ possible generic representations.

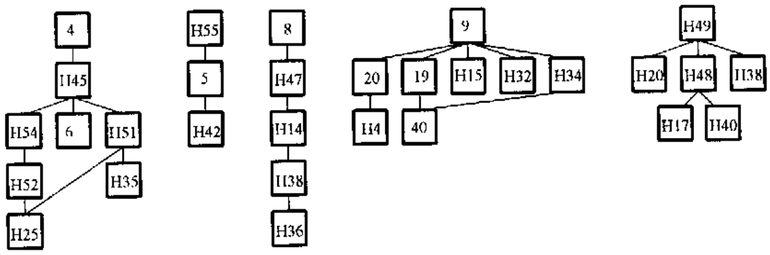


Figure 6. Found and hypothetical generic representations in theme "structure."

6. General Sequences of Generic Representations

With the set of found and hypothetical generic representations it is possible to establish sequences of generic representations. By means of the relations of additional and successive graphic units generic representations have been linked to each other within themes. Therefore, a sequence of generic representations can be based on a sequence of themes. This is illustrated in Figure 7.

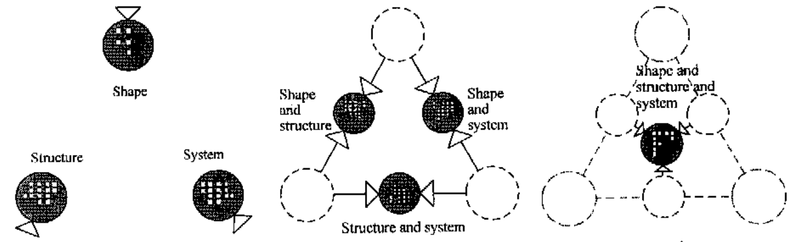


Figure 7. *Three major steps in a sequence of generic representations.*

In the first step (Figure 7; left) for each of the themes "structure," "shape," and "system," the relations between generic representations are established. These provide the starting points for a sequence. It means that any sequence must start either with generic representations dealing with "structure" (grid, zone, axes, subdivision), "shape" (contour), or "system" (circulation, functional, structural). In the second step (Figure 7; middle) for each of the combinations of themes, the relations between generic representations are established. The sequence continues with generic representations that combine "shape and structure" (matching the building layout with its internal organisation), "shape and system" (matches the building layout with the systems), or "structure and system" (matches the systems with the internal organisation). In the third step (Figure 7; right) for the combination of all themes, the relations between generic representations are established. The building layout is matched with its internal organisation and systems. All sequences terminate in this theme. By means of this strategy, it is possible to define six different sequences of themes that establish a sequence of generic representations (see Figure 8).

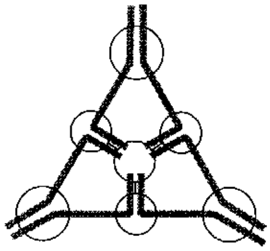


Figure 8. Six possible sequences of successive themes (bold gray lines).

7. A Particular Sequence of Generic Representations

The general sequence of generic representations becomes particular when a design task is given. This makes it possible to test to which extent generic representations can support a design process. As stated in Figure 1, the building type provides declarative knowledge required for making design decisions in each generic representation of the sequence. Procedural knowledge of the building type is encoded in the sequence of generic representations. The building type chosen for the design task is the office building. It is a type which is well covered in publications which simplifies the process to acquire declarative knowledge related to the building type.

The procedure of mapping declarative knowledge of the office building type on the sequence of generic representations is discussed in detail in Achten et al. (1995). For each generic representation, it is possible to identify the pieces of knowledge required from the office building. When put in a sequence, this models a design process of the office building. The work by hand demonstrates that the theory of generic representations aids in knowledge acquisition of a building type. Furthermore, it demonstrates that application of generic representations to the office building type leads to a sequence of different graphic representations (see Figure 9; Achten et al. 1996 shows the complete list).

Implementation issues are presented and discussed in Achten et al. (1995). It shows the computational work and contains also contains source code of the program implemented in a CAD system. To summarise, the computational approach underlying the structure of the system has been the use of frames for generic knowledge. Each slot of the frame refers to one generic representation. The sequence of slots encodes the sequence of generic representations. The particular sequence of generic representations uses seven generic representations of the general sequence. The system is programmed in AutoLISP in an AutoCAD environment. At the end of the sequence the program aids the architect in developing orientation, size, basic layout, and functional organisation via zoning of the office building. Although the implementation uses only a limited set of generic representations, it is large enough to provide additional weight to the conclusion that the theory of generic representations can model procedural and declarative knowledge.

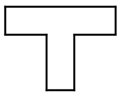
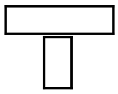
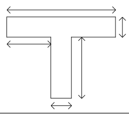
Generic representation	Name and some characteristics
	*Contour* (H46; see Appendix III) Defining the outward form of the building. Establishing the T-shape; triple-winged building. Surface area. Parametrise wing-length.
	Combination of contours (2; see Appendix II) Composing ensemble of simple contours to establish overall shape. Define internal proportions and place of simple contours. Explore emergent forms.
	*Specified form* (H50) Establish tentative dimensions for wing length and depth, and orientation of the building.

Figure 9. Three generic representations of the office building.

8. Discussion

At this point, the following is established in the research work:

- The graphic unit is defined and identified in an analysis of graphic representations.
- The generic representation is defined and identified on the basis of graphic units.
- The knowledge content of generic representation is identified.
- Relations between generic representations are defined and applied.
- Missing generic representations are identified on the basis of graphic units.
- Six general sequences for design processes are identified.
- A particular sequence for the office building is established.

The work demonstrates that it is possible to establish knowledge content of graphic representations by means of the graphic unit. It identifies such issues as building envelope, structuring devices such as grid, zone, subdivision, axial systems, systems such as circulation, function, structural systems, and combinations of these issues. It is demonstrated that generic representations develop these issues from schematic to more specific. These issues are relevant especially in the early stages of design which leads to the concept design of the building.

The fact that generic representations are derived from architectural sources such as books, indicates that the notions of knowledge encoding and knowledge transferring via graphic representations is well-established within the architectural community. The analysis shows that such architectural ways of communicating knowledge can be consistently described and used in computational environments.

Both procedural and declarative knowledge of the building type are encoded in the sequence of generic representations. It is not clear at this point however, how far in the design process generic representations can be supportive. In the work on generic representations, attention is given to the process and the role of knowledge in the process. It is demonstrated that combination of a particular process laid down in the sequence of generic representations and declarative knowledge of a building type leads to designs belonging to that type. This is done without the use of an explicit type-like structure such as a prototype.

The work demonstrates that the strategy of combining process and knowledge has potential for developing typical design with the use of overt types, that is, abstract data structures which have to be sequentially particularised. It may prompt another approach to the role of building type in computational environments.

By showing how generic representations encode design issues that are helpful in the early stage of design, the work points to directions to support architects in a more architectural fashion in design aid systems. A CAAD system that operates via generic representations or that could identify generic representations in a drawing is able to identify the knowledge required at that particular stage in the design process. The implementation of generic representations would result in an extra 'layer' between the architect, the graphic user interface, and the computer (Achten 1996a).

Future work has to address the following questions:

- Can generic representations be applied to other building types.
- Is it possible to consistently interpret sketches by means of graphic units.
- How can generic representations can be implemented in a responsive and interactive manner.
- To which extent do different knowledge bases generate different designs
- Finding cases of graphic representations that belong to hypothetical generic representations proposed in the research work.

Acknowledgements

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Appendix I: Graphic Units Found in the Analysis.

1. *Simple contour*
2. *Contour*
3. *Specified form*
4. *Elaborated structural contour*
5. *Complementary contours*
6. *Functional space*
7. *Function symbols*
8. *Modular field*
9. *Grid*
10. *Refinement grid*
11. *Tartan grid*
12. *Structural tartan grid*
13. *Proportion system*
14. *Measurement device*
15. *Zone*
16. *Schematic subdivision*
17. *Partitioning system*
18. *Schematic axial system*
19. *Axial system*
20. *Element vocabulary*
21. *Structural element vocabulary*
22. *Combinatorial element vocabulary*
23. *Circulation scheme*
24. *Circulation*

Appendix II. Generic Representations Found in the Analysis.

Generic representations with one graphic unit:

1. Simple contour
2. Combination of contours
3. Complementary contours
4. Modular field
5. Proportion system
6. Multiple grids
7. Functional spaces
8. Schematic axial system
9. Schematic subdivision
10. Elaborated structural contour
11. Element vocabulary
12. Combinatorial element vocabulary
13. Circulation scheme

Generic representations with two graphic units:

14. Proportion system in contour
15. Contour in grid
16. Zone in specified form
17. Function symbols in combination of contours
18. Axial system in specified form
19. Schematic subdivision in grid
20. Schematic subdivision with function symbols
21. Schematic subdivision in contour
22. Partitioning system in contour
23. Specified elaborated structural contour
24. Elaborated structural contour in grid
25. Elaborated structural contour in complementary contours
26. Elaborated structural contour and axial system
27. Elaborated structural contour and function symbols
28. Element vocabulary in grid
29. Element vocabulary in multiple grids
30. Combinatorial element vocabulary in grid
31. Combinatorial element vocabulary in specified form
32. Circulation in contour
33. Circulation scheme in elaborated structural contour
34. Structural element vocabulary in structural tartan grid

Generic representations with three graphic units:

35. Proportion system in elaborated structural contour in tartan grid
36. Zone in contour in grid
37. Axial system in contour in grid
38. Axial system in contour in tartan grid
39. Axial system in specified form in structural tartan grid
40. Schematic subdivision in grid and refinement grid
41. Schematic subdivision and schematic axial system in contour
42. Elaborated structural contour and function symbols and axial system
43. Element vocabulary in zone and contour
44. Circulation in contour in grid
45. Structural element vocabulary in contour in modular field
46. Structural element vocabulary in structural tartan grid and refinement grid
47. Structural element vocabulary in axial system in contour

Generic representations with four graphic units:

48. Element vocabulary and function symbols and grid in specified form
49. Schematic subdivision in zone in contour with function symbols
50. Structural element vocabulary in axial system in contour in grid

Appendix III. Hypothetical generic representations

Hypothetical generic representations with one graphic unit:

H44. *Structural element vocabulary*
H45. *Grid*
H46. *Contour*
H47. *Axial system*
H48. *Zone*
H49. *Function symbols*
H50. *Specified form*
H51. *Refinement grid*
H52. *Structural tartan grid*
H53. *Circulation*
H54. *Tartan grid*
H55. *Measurement device*
H56. *Partitioning system*

Hypothetical generic representations with two graphic units:

H11. *Structural element vocabulary* in *grid*
H12. *Structural element vocabulary* in *contour*
H13. *Structural element vocabulary* in *axial system*
H14. *Axial system* in *grid*
H15. *Schematic subdivision* in *zone*
H16. *Zone* in *contour*
H17. *Function symbols* in *zone*
H18. *Function symbols* in *contour*
H19. *Element vocabulary* and *function symbols*
H20. *Function symbols* in *grid*
H21. *Function symbols* in *specified form*
H22. *Specified form* in *grid*
H23. *Axial system* in *contour*
H24. *Structural element vocabulary* in *refinement grid*
H25. *Structural tartan grid* in *refinement grid*
H26. *Structural element vocabulary* in *modular field*
H27. *Contour* in *modular field*
H28. *Circulation* in *grid*
H29. *Element vocabulary* in *zone*
H30. *Element vocabulary* in *contour*
H31. *Function symbols* and *axial system*
H32. *Schematic subdivision* and *schematic axial system*
H33. *Schematic axial system* in *contour*
H34. *Schematic subdivision* in *refinement grid*
H35. *Grid* in *refinement grid*
H36. *Axial system* in *structural tartan grid*
H37. *Specified form* in *structural tartan grid*
H38. *Axial system* in *tartan grid*
H39. *Contour* in *tartan grid*
H40. *Zone* in *grid*
H41. *Proportion system* in *elaborated structural contour*
H42. *Proportion system* in *tartan grid*
H43. *Elaborated structural contour* in *tartan grid*

Hypothetical generic representations with three graphic units:

H1. *Structural element vocabulary* in *contour* in *grid*
H2. *Structural element vocabulary* in *axial system* in *grid*
H3. *Schematic subdivision* in *zone* in *contour*
H4. *Schematic subdivision* in *zone* with *function functions*
H5. *Schematic subdivision* in *contour* with *function symbols*
H6. *Zone* in *contour* with *function symbols*
H7. *Element vocabulary* and *function symbols* in *grid*
H8. *Element vocabulary* and *function symbols* in *specified form*
H9. *Element vocabulary* in *specified form* in *grid*
H10. *Function symbols* in *specified form* in *grid*

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