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APPROACH FOR METHOD TRANSFER TO CIVIL ENGINEERING

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Abstract

In Civil engineering a lot of quality faults happens due to a lack of methodical practice in the planning and design. Methods in engineering design have enhanced the development process and reduced the number of quality faults. Hence transferring methods from engineering design to civil engineering design can improve the design of buildings. Therefore an approach was established and is presented in this paper. The application in an example and experiences are described.

1 Introduction

In Civil engineering a lot of quality faults happens due to a lack of methodical practice in the planning and design. Methods in engineering design have enhanced the development process and reduced the number of quality faults. Hence transferring methods from engineering design to civil engineering design can improve the design of buildings. Therefore an approach of different was established and will be presented in this paper.

2 Quality faults in Civil Engineering

The third report over damages at buildings of the Federal Government of Germany (BMBAU 1996) numbers the avoidable building damages at new civil works (Building construction) for the year 1992 of 1,74 billion €. Here damages through mistakes during the planning, carrying out and material production are registered. With reference to the building construction volume at new buildings from the same year in height of 76,13 billion € (BMBAU 1996) a loss ratio of approximately 2,3 % results from that. The costs for avoidable building damages are for a building approximately on the average 9.700 € with reference to the buildings finished in the year 1992 (179.151 buildings) (BMBAU 1996). The part of which planning faults are at least a part problem of the damages becomes in this report only for the damages with deficient repair and modernization measures (Volumes approximately 1,69 billion € for the year 1992;

BMBAU 1996) indicated. Accordingly the part of the planning errors conducts approximately 57 %. The numbers show that there is considerable potential for saving expenses in the field of the avoidable building damages. A reduction of the building damages means a reduction of the pending waste. With the implementation of quality enhancing methods in the planning process planning errors can be reduced. At the moment methods are only implemented for project management (KOSKELA et al. 2001].

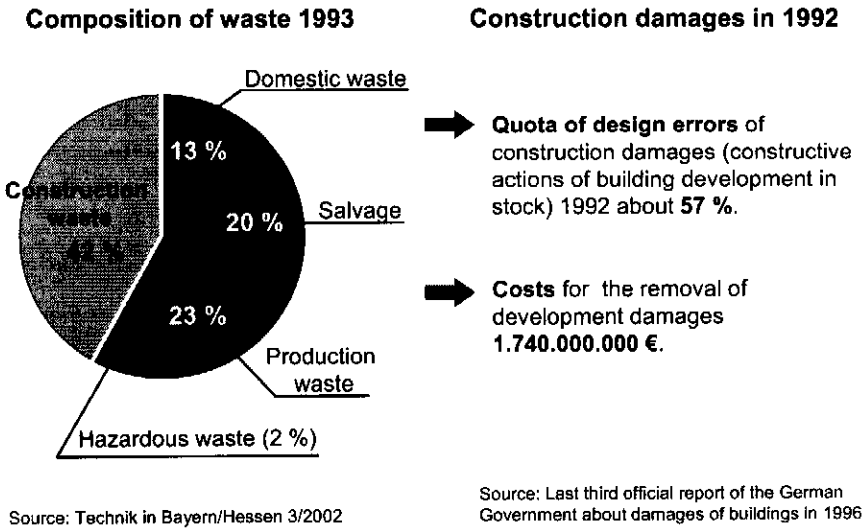

Figure 1. Composition of waste in civil engineering and reasons

3 Approach For Method Transfer to Civil Engineering

For the selection, adaptation and application of methods Lindemann (2003) defined the following model (see Figure 2). He also described the usual way for using this model for methods in engineering design. When transferring methods from engineering design to civil engineering several further points have to be taken into account. They will be described according to the several steps of the model and displayed in an example.

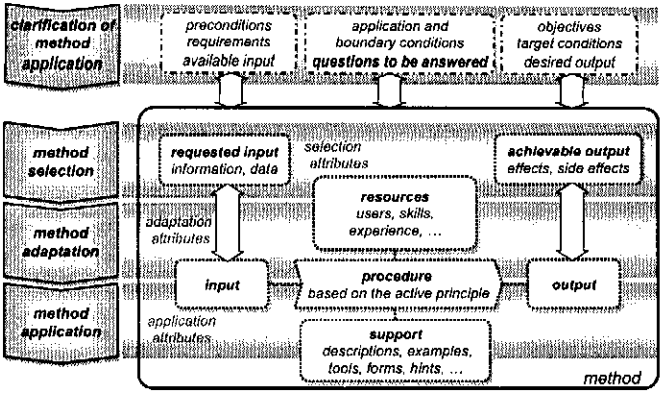

Figure 2. Munich Model of Methods – MMM (LINDEMANN 2003)

3.1 Method selection

For selecting the right method the problem which should be solved or the situation which should be improved must be described in an abstract way. Processes, terms, definitions, problems, and descriptions are different in different disciplines. Hence the formulation of the problem or situation happens on an abstract discipline-independent level. There are several ways for describing the situation/problem for which the method should be used. Some are displayed in Figure 3. Methods can be classified and hence selected by different attributes. These selection attributes correspond to the abstract formulation of the situation/problem.

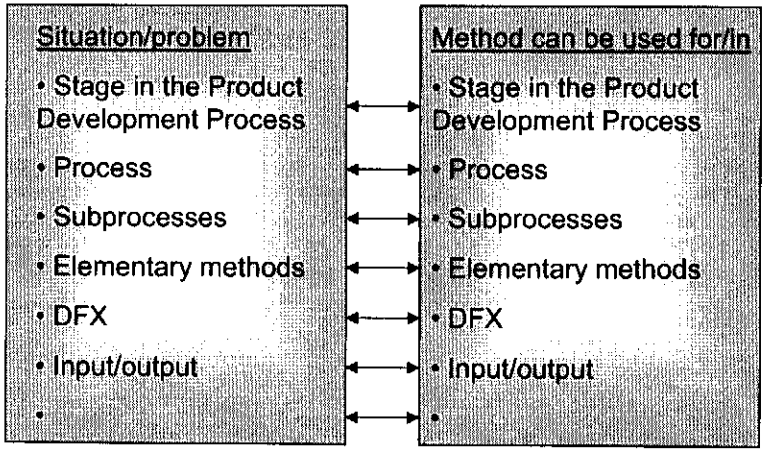

Figure 3. Abstract formulation of situations/problems for selecting methods

Several of these attributes are known from method applications in engineering design (ZANKER 1999, STETTER 2000, VIERTLBÖCK 2000). Some, like elementary methods or DFX, are independent of disciplines, as they describe general attributes of methods. Other attributes must be described for the specific discipline. As the product development processes in civil engineering and engineering design differ they will be contemplated.

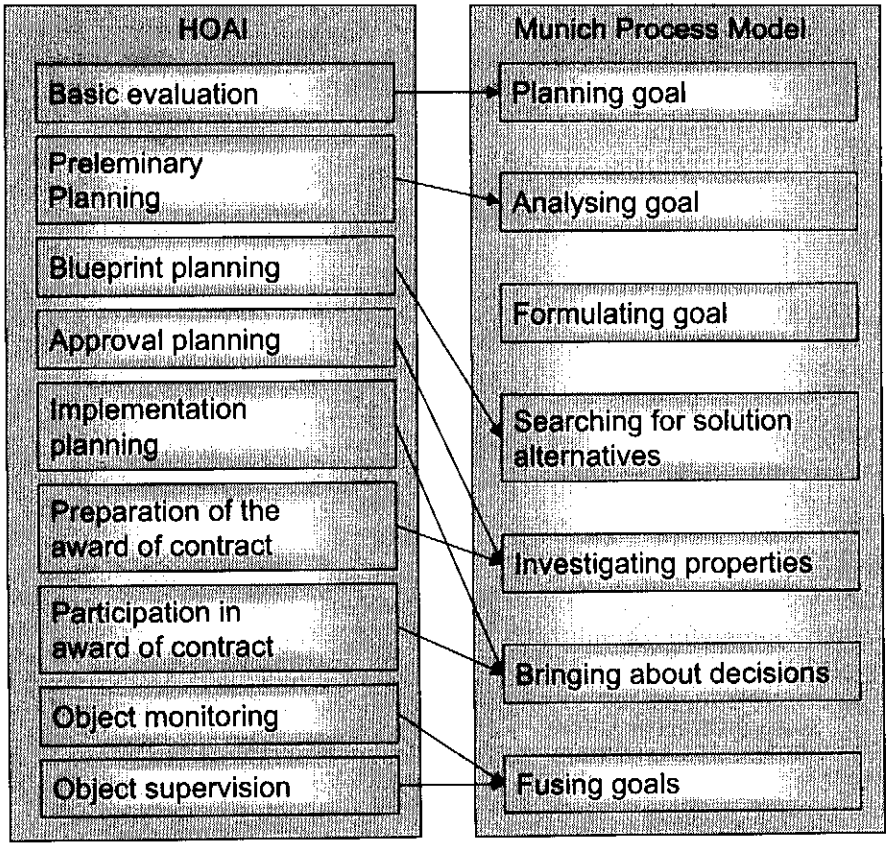

Figure 4. Comparison of the different development process (Lindemann 2003)

For the description of development processes several approaches can be found in the relevant literature. Here following models will be compared: the HOAI for civil engineering and the Munich Process Model for engineering design (LINDEMANN 2003). In the HOAI the basic phases during the development of a building are described. Here it must be noted that different disciplines (civil engineers, architects) should work together. Whereas in mechanical engineering there is only one discipline participated. As it can be seen in Figure 4 some steps are clear attributable (analysing goal, searching for solution alternatives), others intersect (investigating properties, bringing about decisions, fusing goals) and some are only in one discipline (formulating goal). The processes are only models which can differ in practice. Hence this is only a model for selecting the right model for the right situation/problem. Templates have to be prepared and adapted to the new applications. Especially here terms have to be checked and implemented.

3.2 Method adaptation

For the method adaptation the usual boundary conditions (time, number of persons, distribution of persons, tools) have to be considered. In multidisciplinary method application specific terms have to be changed. Some terms may have different meanings in different disciplines or different terms are used for the same circumstance. Also different disciplines link different problems with one term for example medicines need a special blood-non-disturbing steel when they want a steel for their applications. Also special elements which exist only in one discipline have to be added. Here an intensive literature research within the other discipline might be helpful to avoid forgetting special issues.

3.3 Method application

At the beginning an extensive introduction is helpful to point up the sense and the aim of the method. The civil engineer will only accept the methods if they are convinced about the sense and the benefit of it. Examples can be helpful to demonstrate the benefit of the method. The procedure of the method and the several steps should be explained. Hints which could enhance the result or problem that could happen should be mentioned and discussed. Templates for the support of the method application need to be introduced and explained. During the application it is necessary to consider the terminologies. Many problems result from different understandings of terms. To avoid misunderstandings it is senseful to clarify difficult circumstances.

3.4 Examples

In an exemplary product the application of this approach will be shown. A mid-size company which develops and builds up one- and multi family-houses, business houses and octaeders wants to implement methods. In a new product development methods should be selected and implemented. The basic evaluation was finished and the preliminary planning should start. For selecting methods here for the situation was formulated. As the stage of the development process was the "preliminary planning" methods from "analyzing goal" could be helpful. As this development problem was new, not comparable to other projects, complex, and with a high number of ordered buildings it was necessary to avoid planning faults. For collecting and documenting all requirements a list of requirements was chosen. First of all a list of requirements was filled out. The headings and terms could be taken over without change or completion.

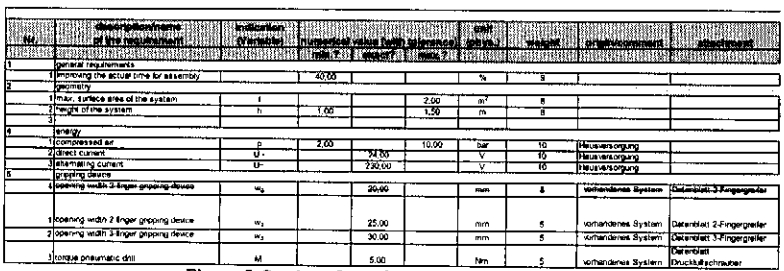

Figure 5. Section of an adapted list of requirements

For filling out the list of requirements a checklist was used to inhibit a lost of requirements. Here it was necessary to add or rename some points like building lease, wind load, snow load, or underground to the checklist as there are different requirements in civil engineering. Nevertheless the sense of the methods and especially the benefit became clear very fast. The civil engineers could systematically collect the requirements, it became clear that without this

method requirements would have gone lost. The corresponding faults and costs for refit the faults were not checked or numbered. The checklist will support the civil engineers in further projects to make the list of requirements.

Characteristic feature	Examples
geometry	Dimension, height, length, diameter, required space, number, arrangement, connection, upgrading, doors, intern-/ overall dimensions, glass faces
building lease	Public building law, Flying Buildings, Roof Constructions, place of work guidelines (for example anti-slip, toilets, temperatures (Heating in the summer), glass faces), public Fire protection rules, EnEV, road safety, clarifying of all guidelines (in comparison with personnel-free pavilions),
kinematics	Transaction type, direction, speed, acceleration
security	Direct security technique, safety system, operating safety, safe working, environmental safety, CE-label
material	Physical, chemical, biological features of the incoming and outgoing products, adjuvant materials, prescribed materials (aliment laws etc.), material flow and transport, logistics
signal	Incoming and outgoing signals, display mode, operating equipment, control equipment, signal mode

Figure 6. Section of an adapted checklist

4 Conclusion

In this paper an approach for transferring methods from engineering design to civil engineering according to the Munich Model of Methods is described. Beginning with an overview about quality faults in civil engineering the necessity for the transfer is shown. The requirements which have to be considered when using the methods are described according to the steps of the model. First results of the transfer in a company are presented. Methods can be transferred to civil engineering but they have to be adapted to the other discipline. For example terms have to be changed and special items have to be added. The selection of the methods works with an abstract formulation of the situation or problem.

Acknowledgement

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