INFORMATION MANAGEMENT AS A BASIS FOR CALM – COMPUTER AIDED LIFECYCLE MANAGEMENT IN CIVIL AND BUILDING ENGINEERING

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ABSTRACT

A combination of technical, functional, esthetical, economical and legal aspects influences the construction of buildings. In each discipline, methods and techniques have been developed independently. As a consequence, mapping rules and interdependencies between disciplines have not yet been developed to a satisfactory and comparable extent. This results in disadvantages, specifically if it is necessary to assign interdependencies between different disciplines to different phases in the lifecycle of a building. Preparing the different phases of a building is a complex task in management. Management in this context covers planning and controlling tasks as well as the leadership of teams of specialists. The specific tasks depend on the specific organizational structure as well as the people involved. Projects need to be executed in teams that are set up individually for each project, whereas the success depends on the ability to consider new or modified influences in an efficient way.

The approach of CALM – Computer Aided Lifecycle Management – is to organize the information required in such a way that they need to be captured once, and that they can be processed during the lifecycle of a building in a consistent way. The design of CALM integrates checklists for each team member to support information capturing. These checklists are generated from a database where characteristics of the project and the building are considered.

KEY WORDS

computational management, lifecycle management, process modelling, planning processes, construction processes.

INTRODUCTION

Construction processes and their tasks are characterised by the influence of participants or different phases of the lifecycle. A lot of the tasks of the construction processes are executed in similar ways in different projects. The knowledge of executing these tasks can be

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transferred from project to project whereas the context and the interaction between the tasks may differ. These processes respectively cause a high level of complexity. Therefore, the construction process has to be enlarged by these influences.

The physical lifecycle of a construction or real estate project can be subdivided into different phases. It starts with the idea of the project and results in the deconstruction or demolition. Especially development, execution and utilization are phases containing various principle tasks in the areas of project development, project management and facility management (Kochendörfer et al. 2004). Proceeding in these various phases does not differ eminently according to varying industrial sectors. However, the existence of diverse formalities such as HOAI (the German law on calculating fees for architects and engineers) or DVP (German Organisation of Project Management) leads to diverse variants of how to classify the phases.

The management of interfaces between the process phases in particular causes difficulties. The complexity of construction processes additionally increases by the high number of participants and the interdependence of the process phases. That makes the demonstration of all details within a lifecycle-based process model exceedingly difficult.

Beside the owner and the architect, many other participants take part in construction projects. The bigger the project the higher the number of people involved. The management is responsible for the coordination. A main task is to find the right organizational structure in order to define the contract management. The most common constellations are individual enterprises, master planers, general contractors or main contractors and total contractors. The contract interfaces, the effort of coordination and the risk often decrease from high in individual enterprises to low in total contractors.

The approach presented in this paper reflects the situation in dealing with construction processes and discusses CALM – computer aided lifecycle management – as a suitable way to support these processes. The idea is to organize the information required to support construction projects based on an information system. CALM considers the requirements of civil engineering projects. These requirements result from the specific peculiarities of construction processes. As an example, tasks in the area of managing defects are chosen to illustrate the use of the concept presented.

METHODOLOGICAL APPROACH

In the present example the necessary steps and the accompanying sources of information are exemplarily shown for the design of a preliminary draft. In particular the processes in the building design and execution phase require internal and external communication processes between the different involved parties (Jungwirth 1996, Sonnentag 2000, Korn 2004). In this manner figure 1 makes clear, that the structure of the involved authorities as well as the planning activities linked up with the calculation activities are extremely complex.

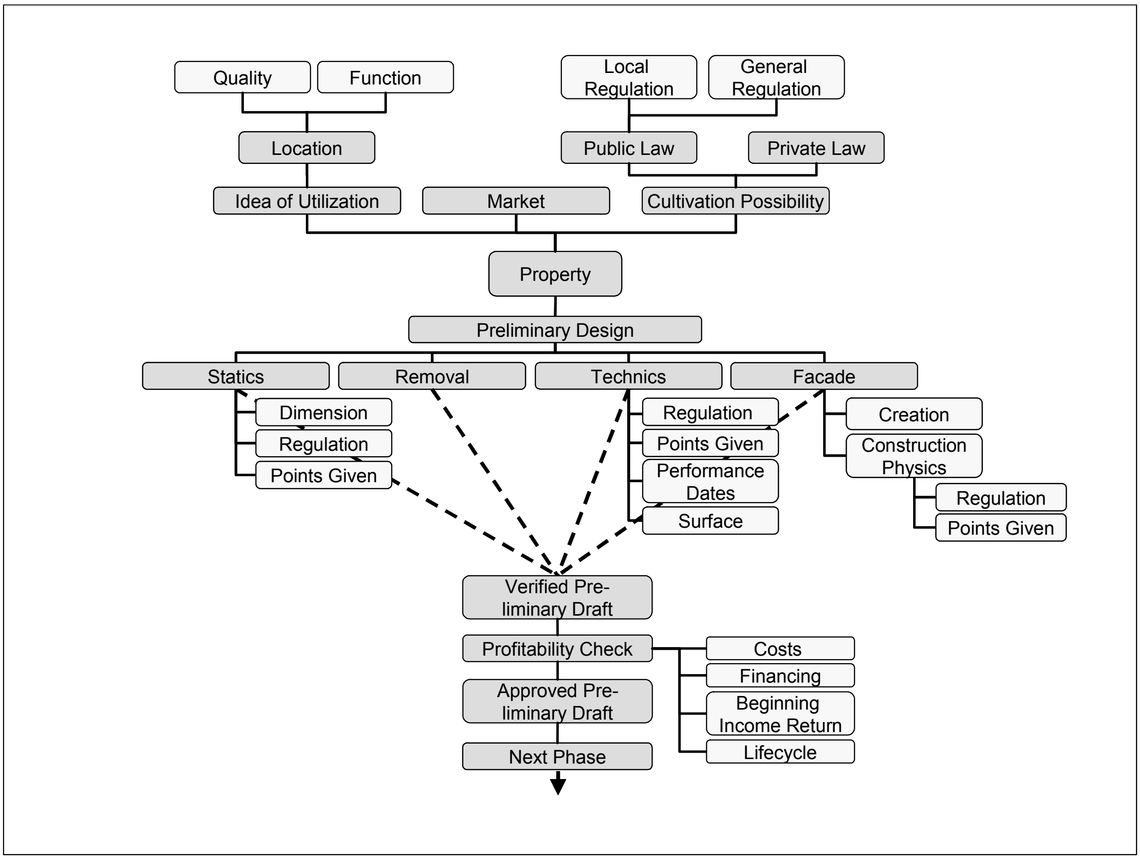

Figure 1: Exemplary Extract of the Net Structure for the Development of the Preliminary Draft

Repetition steps, like functional or economic optimization of the preliminary draft are not shown. Likewise the single steps of other phases, like

- design planning
- approval
- execution planning
- invitation to tender
- awarding
- construction
- acceptance, commissioning
- operating phase etc.

are not shown either because the focus of the paper is the explanation of the methodical approach but not the description of the detailed system components. In addition, the explanations are to be understood as the definition of the problem from the point of view of an engineer, for the purposes of an assignment description for the informatics.

Based on the in general formulated purpose to make necessary knowledge faster and more perfectly available for planning processes, construction processes and company processes, the identification and analysis of the necessary steps is required. In the following five steps are described to analyze the needs for a successful CALM.

STEP 1

In the first step CALM requires the complete listing of all activities in the lifecycle of a building (see figure 2). The single phases of the activities as well as the interfaces between the phases have to be defined. Besides, an activity is defined as a working step which is carried out by a single actor or a team of actors (for instance by a planning team in an architecture office). The change of the actor or the team of actors in the crossing to the next activity is the interface between the action areas of the actors at the same time. The planning on the principle of the division of labour needs a coordination continuously to be adapted on the working assignments, reflecting on the current level of information (Hummel and Malorny 2002, Brauer 2002, Pfeifer 2001).

Usually the building planner or architect for example is commissioned to create the preliminary draft, based on the first version of ground plans, cuts and sectional views. If the building planner hands over these plans to the structural engineer for the first estimated dimensioning of the structure, the activity of the building planner is finished. At the same time the interface to the next activity of the structural engineer is clearly assigned.

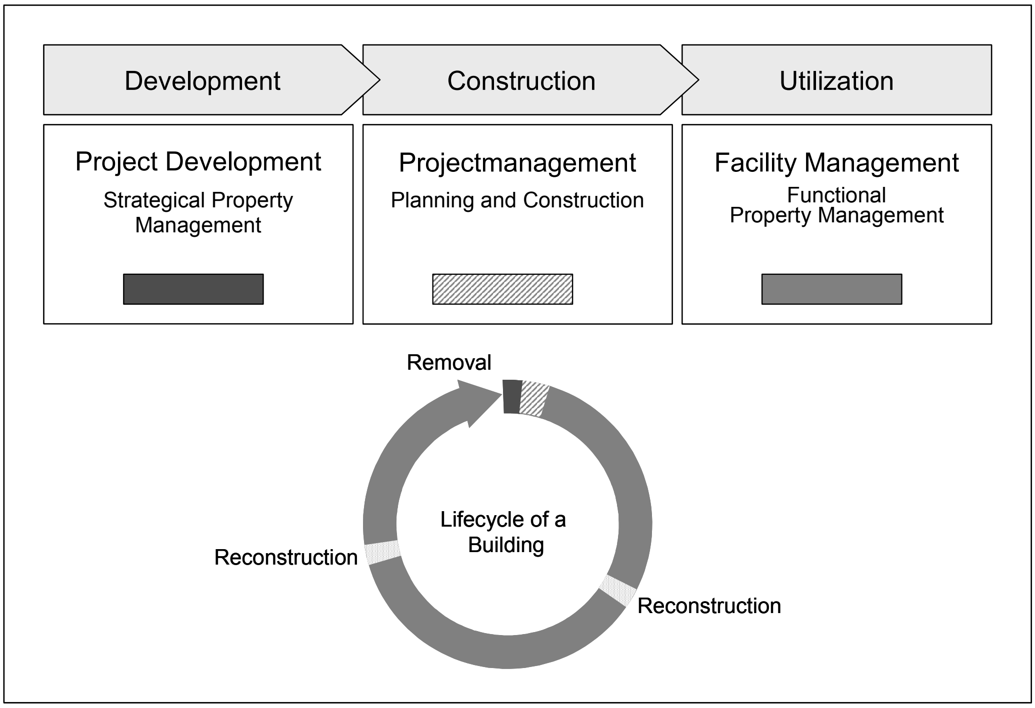

Figure 2: Lifecycle of a Building (Figure in Kochendörfer et al. 2004)

For the purposes of the information technological treatment in this case it has to be unambiguously defined which kind of results (output) the first version of the planner's or architect's preliminary draft has to include. For instance the definition of the requirement to create "ground plans, cuts and sectional views in the scale 1:200" has to be completed with information concerning size and manner of use for the different single spaces. Based on this additional information a space allocation plan as well as a function program can be prepared. The necessary demand of information in the interface between two actors (output-input) has to be defined completely and understandably. For this especially drawings for the non-verbal information as well as checklists could provide a basis.

Thus for several types of buildings standardized lists can be developed, because certain sequences of single activities show qualities specific for property. These checklists need a dynamic structure, so that they are continuously extendable in the following process steps on the one hand. On the other hand, the information flowed into the process can also become post-pursuable for the purposes of a quality management system – and can also be analyzed backwards.

STEP 2

The second step encloses the definition of the dependences between the single activities. A process structure arises only from the unequivocal and entire regulation inputs and outputs of the single activities and the definition of the dependence of the forerunner and the follower. The completeness of the process structure causes that it is determined unquestionably which information the editor needs in the respective process step and by which information he extends the treatment object. The outcome of this is the output which is the input for the next process step at the same time.

For Example: The production of the first version of the preliminary draft by the building planner is based on countless information (input). These reach from the space allocation plan and the function program by size and utilization (abrasion) of the single rooms as well as their spatial assignment up to the information specific for property. These concern the property boundaries (plan of site), the height development and the position and dimension of elements of development (street, water, effluent, electricity, gas, telecommunication). Moreover the building development potential and other regulations as a part of the public law, as well as possible arrangements of the private law (public easement registrations) are to be noticed (see also figure 1). Only with the processing of this information the building planner is able to deliver the entire input for the next activity (if so: for the structural engineer).

The next process step is the change of the activities of the structural engineer to the action area of the planner for the building-technical equipment. On the one hand he needs the plans with the dimensions of the main girders, however, he also needs specifications to the size and to the functional requirements of the single rooms, so that the building services engineering can be dimensioned adequately. Simultaneously he has to choose the right position and size of the supply lines and their centres.

Attention should be paid to the interconnection to construction physics. Because of this particularly the requirements of the indoor climate for instance are to be determined. This means that a process step "production of the preliminary draft for the building-technical equipment" needs other subordinated share-process steps, as for example "coordination building technology with construction physics". Share-process steps like these are not shown in figure 1.

If the planning uses product-related information of single manufacturers or suppliers, it also has to make sure that a web-based access to this information, for instance, to product dates or detailed specifications of the installation, for the servicing etc., is possible.

STEP 3

With the structuring of the single activities which are carried out by an actor in each case or a team of actors identical in acting, the unequivocal assignment of processes and actors arises at the same time. If this information is still connected with the claimed resources of time, material and equipment, then the preconditions to create and calculate a time schedule and network plan – i.e. for the temporally structuring – are given. Indeed, for this the calculation models still exist in form of the different methods of the critical path planning (network planning). However, as a result of the not entire or not consistent information up to now, their application is necessarily risk-afflicted or faulty. In this respect CALM should deliver the entire and reproducible methodically attempt for the calculation of the expiry-models.

If the transition from two-dimensional in the planning is carried out now to the three-dimensional representation (3D), the spatial representation is enabled. This allows beside visualisation oriented to marketing – including the virtual walk through a building – in particular the examination whether the spatial assignment of construction elements is possible without conflict, taking into account the dimension and the position of the elements. Nevertheless, the necessary CAD programs a not part of the CALM project.

STEP 4

If the single processes are defined concerning the linking to forerunner and follower and the other external sources of information required for the treatment (web-based development), the consequences can be determined by changes in the planning and further conditions methodically secured, if necessary and can be analyzed unquestionably concerning their consequences. With it an unequivocal and understandable basis for the action and decision makers is created.

STEP 5

Provided that all steps and contents of the planning processes, decision processes and realization processes are documented unquestionably and understandably. Then the simple handing over to the actors of the next phase, the facility management is guaranteed.

EXAMPLE OF USE

The motivation for a systematic prevention of defects is the high cost of defects in construction processes. It is considered as a typical construction process where usually 4%-12% of the overall construction costs are spend on rectifying faults and defects (Jungwirth 1996). There is a high capability of cost reduction by using information technology. The management of defects fulfils the theoretical requirements: Different processes are necessary to be supported by an information system depending on the point of time when a defect is detected.

Defect prevention in particular is very important concerning the lifecycle of structural works. Most frequently defects appear during execution. In this manner it is to be emphasized that about 30% defects result from earlier planning and design phases (Jungwirth 1996). However, defect prevention is a process attending the whole lifecycle of buildings from development to utilisation. The context and the interdependencies of tasks differ depending on the fact if a defect is detected before or after the final acceptance of a specific work (Riediger et al. 2005). Although the tasks required are almost identical in different processes. To avoid and prevent defects in the construction process it is necessary to keep and make the information of former phases of the lifecycle available. The other important approach in the meaning of prevention of defects is the ability to consider new or modified influences in an efficient way. CALM has the possibility by organizing information systematically during the lifecycle.

MANAGING DEFECTS

As described above, the process of defect prevention is suited for exemplified realisation. Same tasks are assembled to different processes. In the following the process of defect management (Riediger et al. 2005) is shortly described.

In the process of defect management the legal claim of the client or the owner respectively changes at this moment of time when the client accepts the asset under construction or after completion (acceptance). The VOB part B (German Construction Contract Procedures, similar to British Fidic) strictly distinguishes the legal rights of the client regarding construction defects before and after acceptance. Before acceptance the legal rights of the client results from § 4 no. 6 and § 7 VOB/B. After acceptance § 13 VOB/B with a changed burden of proof to the disadvantage of the client is relevant.

Allocation of the burden of proof (before acceptance burden of proof is with the contractor, after acceptance shifting of the burden of proof to the principal), the possibility of substitutive execution and the beginning of limitation are depending on the basis for claim.

CHARACTERISTICS OF THE MANAGEMENT SYSTEM

The chosen example covers recommendations to support activities in the area of defect management. Based on a process model the sequence of events, the central functions and tasks of defect management are shown. Furthermore the process model contains various additional rules and organisational units like persons involved and needed information tools. Figure 3 shows an extraction of the process model. The direction of the arrows indicates the direction of the input or output of data.

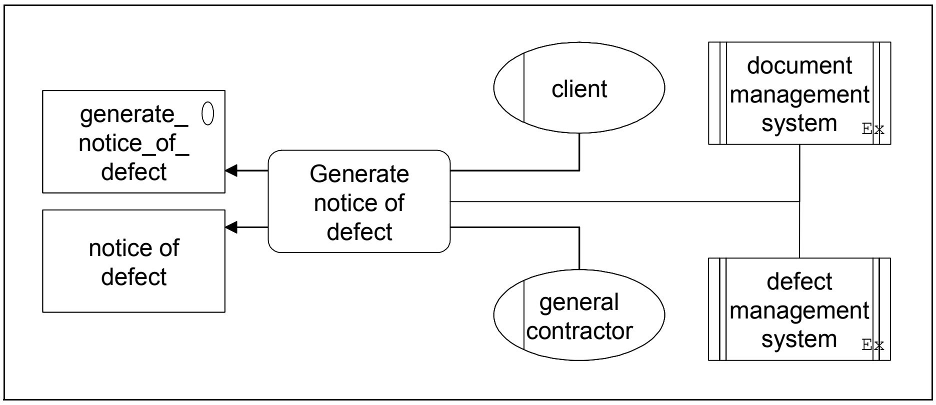

Figure 3: Extraction from a process model (Figure 8 in Riediger et al. 2005)

The basis for the established process model is the definition of the dependences between the different activities in different phases of the lifecycle as well as their influence on former and later phases. The results of modelling the construction process by defining the main interdependencies allow to develop checklists for the team member to support information capturing. The checklists are generated from the database of the process model where characteristics of the project and the building are considered. Collected this way, the information can be processed and made available during the lifecycle of the building in a consistent way.

CONCLUSIONS

CALM supports a process-oriented approach. Based on a process model links can be specified between activities, project members, and information. This allows mapping different levels of detail and transferring information to facility management systems. Information can be detailed and summarized. Extensions can provide risk management and event-oriented asset management with relevant information.

Although construction projects need to be prepared and setup individually for each project, a lot of activities and tasks are executed in similar ways. That means the knowledge of executing these tasks can be transferred from project to project. In addition different activities and tasks of the construction process influences various phases of the lifecycle of the building. Using information technology to manage information during the lifecycle supports to provide the needed information in time and in the necessary quality. At the same time the totally structured capturing of information can help to prevent information-problems in the construction process.

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