PRODUCT MODEL BASED QUALITY MANAGEMENT SYSTEM

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ABSTRACT: The idea of our research project was to build an integrated computer-aided quality management system of building projects. Making use of expert knowledge, we are building an information system, which will supervise, in each phase of a building project, the fulfillment of the required conditions for undisturbed and quality project continuation. The kernel of the quality control system is based on the expert system technology.

In the basic version of the quality control information system, the user will be guided through control sheets whereby the required control data will be collected. In the case of unfulfilled quality conditions, the system will suggest possible solutions based on experiences stored in the knowledge base. The system will compare the present project to past ones and determine the weak points of the project to assure the total quality. Statistical evaluation of the comparison should show the efficiency of the running project.

At the same time, a link between the expert system and the product model of the building is being designed with the aim of raising the automation of the quality management of building projects.

KEYWORDS: civil engineering, project management, quality control, knowledge-based expert system, case-based reasoning, product model, software integration

1. INTRODUCTION

The biggest mistakes in quality management are made in the very early project period, no matter if they are done by engineers, architects, or others. The reason is that the degree of impact on quality and costs in the early phases of the project is much higher than in the forthcoming project phases (Figure 1).
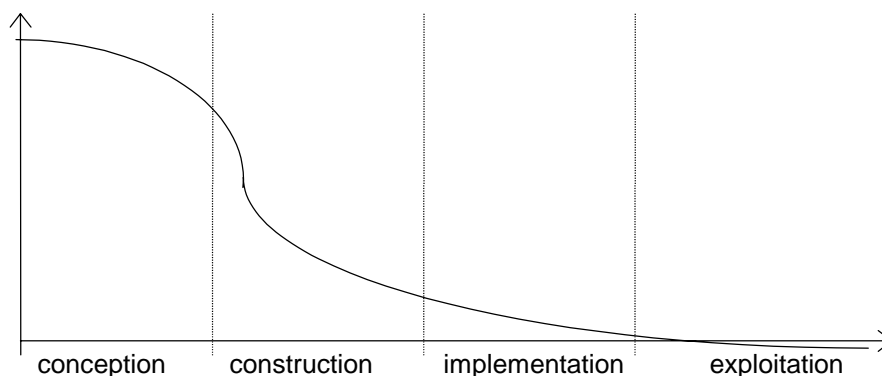
Figure 1 A degree of impact on quality and costs during the phases of the project (Jungwirth, 1996)

To improve the results of the quality management and to gain better costs/quality ratio we need accurate information in all phases of the project. Such information is specially needed in

the construction phase when the quality level is to be defined. It would be ideal to gain the information from the forthcoming phases of the present project, but this is unfortunately impossible. Therefore, we have to simulate the present project information with information from similar projects in the past.

2. THEORETICAL STARTING POINTS FOR THE EXPERT SYSTEM DESIGN

The solution is based on the expert system, which is able to accumulate information from existing projects and apply them (in form of experiences) on the situation of the running, present project. This approach, known as the Case-Based Reasoning (CBR), involves solving problems on past solutions of similar problems (Riesebeck, 1989). For easier understanding of the problem and for a clearer implementation of the system following presumptions and simplifications had to be done:

- a project is a discrete distribution of activities,
- milestones are defined in random time steps,
- failures in similar projects are caused by the same reasons,
- experiences gained in the past projects are valid for the present project.

All information is processed by the expert system. Between the past projects and the expert system the information is transferred only in one way (from the past projects to the expert system), but between the expert system and the present project there is a two-way communication - the expert system tests milestones in the project and provides solutions in case of failure possibilities (see Figure 2).
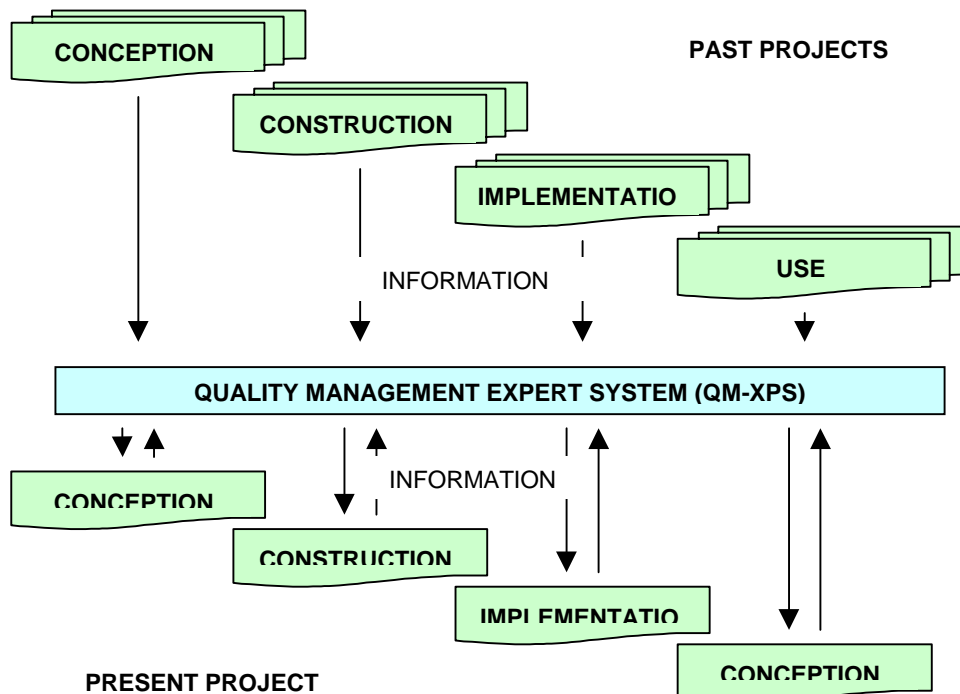

Figure 2 Information (experience) flow from past projects through the quality management expert system to the actual project in progress

The quality management expert system (QM-XPS) runs in two main modes:

- gathering knowledge (solutions to new problems) in form of rules that are connected to recorded milestones (new possible-failure-locations) in the project being analysed (past project), whenever a failure has been detected (new problem),

- checking the running project as it progresses through the planned activities, and detecting possible failures (problems) whenever the running project hits a registered possible-failure-milestone.

The first mode is designed for experts. Information about a failure (new problem) is recorded as a possible-failure-milestone. Possible solutions are given and recorded in form of rules in the knowledge base of the expert system.

The second mode serves the end users of the system. In the simplified version of the system, the project will be controlled manually through checklists provided by the expert system for every registered milestone in a specific activity. The user (a quality manager) will have to find a comparable activity in the knowledge base by himself and assure the intelligent connection between the expert system and the running project.

In the next step, the QM-XPS will be connected to a Project management system. A problem detection agent will supervise the project execution and identify possible problems by milestone comparison (see Figure 3). Then, it will activate the QM-XPS, which will provide solutions to the project manager. No special quality manager will be necessary and the quality assurance will be processed in the background through a Project management system.

In both cases, however, the user will have to gather the needed data manually. This means he will have to search for values of variables contained in the checklist rules in the existing documentation, databases, different computer programs, etc. In case of a failure possibility, the expert system will provide possible solutions to avoid the failure.

3. INTEGRATED QUALITY MANAGEMENT OF BUILDING PROJECTS

To assure automatic data supply we have anticipated to integrate the QM-XPS with the product model of the building. A link to a product model will be established whenever the expert system will need specific data for the specific rule check activated by the QM-XPS.

This task will be executed by a special agent, which will form a query based on the expert system demands for specific construction data. The query will be executed by the product model database system and the data forwarded by the agent (see Figure 3).

The goal of the final integrated quality management system is to simplify the process, to improve the efficiency of the quality control and quality assurance of building projects, and to gather expert knowledge in a systematic and consistent way. The early recognition of the failure possibilities will be done automatically during all phases of building projects. Therefore, the optimal costs in relation to the optimal quality could be planned.
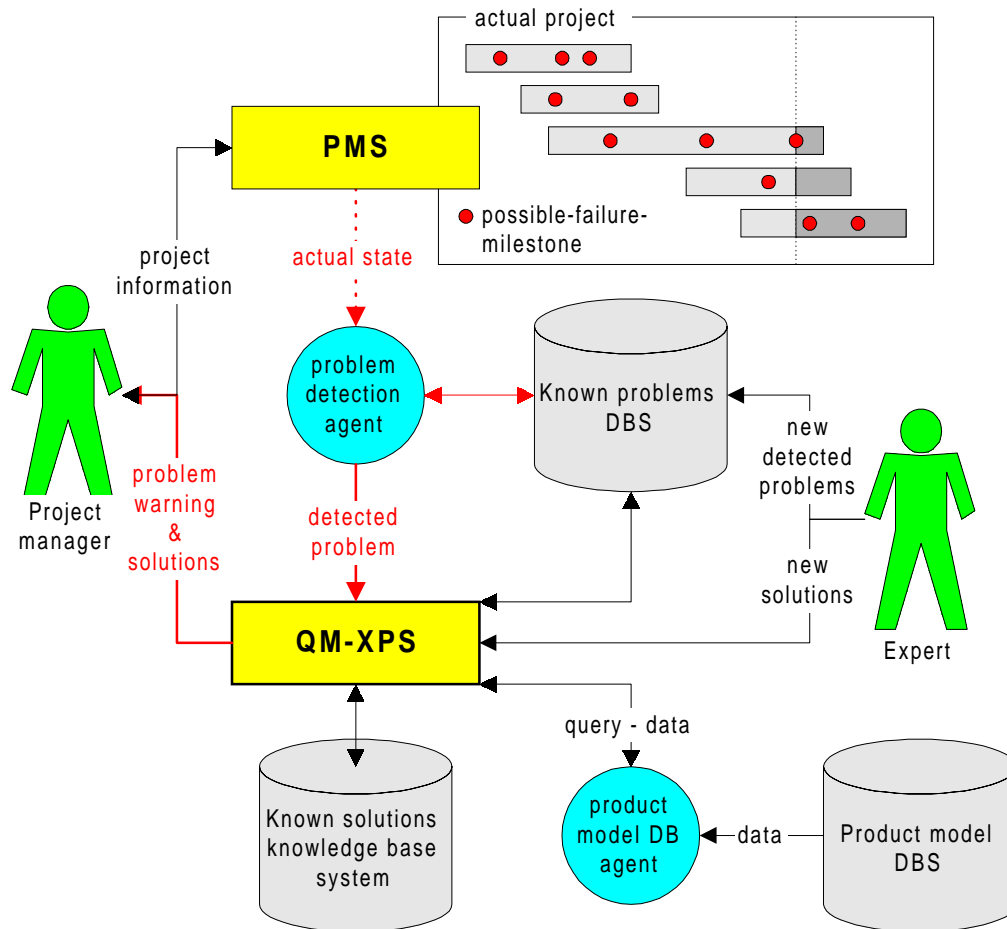
Figure 3 The concept of the final quality management supported by the expert system, the (conventional) project management system and the product model.

4. SYSTEM IMPLEMENTATION STARTING POINTS

In the conception, designing and prototyping of the QM-XPS system following presumptions were considered:

- a component oriented RAD environment for implementation of the QM-XPS
- generally applicable software for common tasks (like conventional project management), whereby
- software already equipped with standard communication interfaces (like OLE) is preferred
- the product model has to be in accordance with the STEP standard (ISO, 1994)
- available software components are used whenever possible
- agents (active components) are used to identify relevant events (like project progress in the activity scheme of the PMS) and to seek for the relevant data in the product model database
- registered possible-failure-milestones are manually entered and stored in a RDBS
- solutions to registered problems are stored in form of rules and analysed by an XPS

For the first prototype implementation we have used the following tools:

- Visual Basic RAD for implementing the user interface, the system shell, and the agents,
- M.4 knowledge base system
- MS Project (especially because of the compatibility with Visual Basic)
- MCT product model of a road for the first product-model-based prototype (see Rebolj, 1998)

5. CONCLUSION

Integrated quality management of building projects is an information system, which permanently supervises a building project and performs quality management during all phases of the project from the idea to the removal of the building object. The gain of this investigation will be a sophisticated quality management system, which will control the building project and recognise the failure possibilities. The results will be seen in a better quality and an optimal cost/quality ratio of building projects.

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