VHBUILD: TRANSFERRING PROJECT MANAGEMENT INTO KNOWLEDGE MANAGEMENT

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Introduction

The construction industry is an information rich industry, both in terms of the information generated and exchanged amongst its participants, as well as the information it absorbs from outside sources (Abdelsayed and Navod 1999). The effective management and delivery of information is crucial to the successful completion of a construction project life cycle. Although some IT tools such as email, video-conferencing, electronic networking and multimedia technologies, have been used to enhance communication and data/information transfer, it is usually in a discrete and uncoordinated manner. Integration such tools can improve efficiency and enhance effectiveness. On the other hand, the fragmental, dynamic and one-off nature of the construction project management process implies that without an integrated information system, project-specific information cannot be stored appropriately for generating knowledge for future use. Moreover, it has been discovered that up to 50% of project managers' time is spent searching information (Edwards et al. 1996) which significantly contributes to an inefficienct project management environment.

By way of a solution, internet technology has been harnessed to accelerate and simplify communications as well as to share information amongst the different participants of construction projects. A survey conducted by Veshosky (1998) amongst 14 leading engineering and construction companies discovered that 6 companies out of the 14 used Local Area Network (LAN), and 6 had both LAN and dedicated Wide Area Networks (WAN). Rushdi and Retik (1997) suggested that virtual teams provide new opportunities in the industry for replacing face-to-face meetings which often prove expensive and time-consuming for distant participants.

In this paper, we present ***VHBuild.com*** which not only serves as a repository for project-specific information available to all project participants, but also is able to acquire knowledge from previous cases of critical issues and experiences using data mining techniques. In order to clearly describe this system, it is necessary to identify some of the typical problems that are often encountered in the process of project management. (Then, the computational model of VHBuild.com is presented, which is followed by an example of using the system in project management.)

Information Flow Model

A data flow model is developed for ***VHBuild.com*** in order to define the system components and their interaction within the overall information flow and sharing process. The model is based on a repository, or database, of all project information at different stages which resides on a main server to ensure security and integrity of data. The model is composed of four main components. The daily site report (DSR) component allows collection and storage of information regarding daily site activities and produces schedule data. The schedule control (SC) component enables updating schedule and produces schedule reports. The document management (DM) component provides a convenient tool for management of different project files generated throughout the project. The critical issues (CI) model maintains a track record of all important issues which occur during the project life. The model components and their interaction are illustrated in Figure 1.

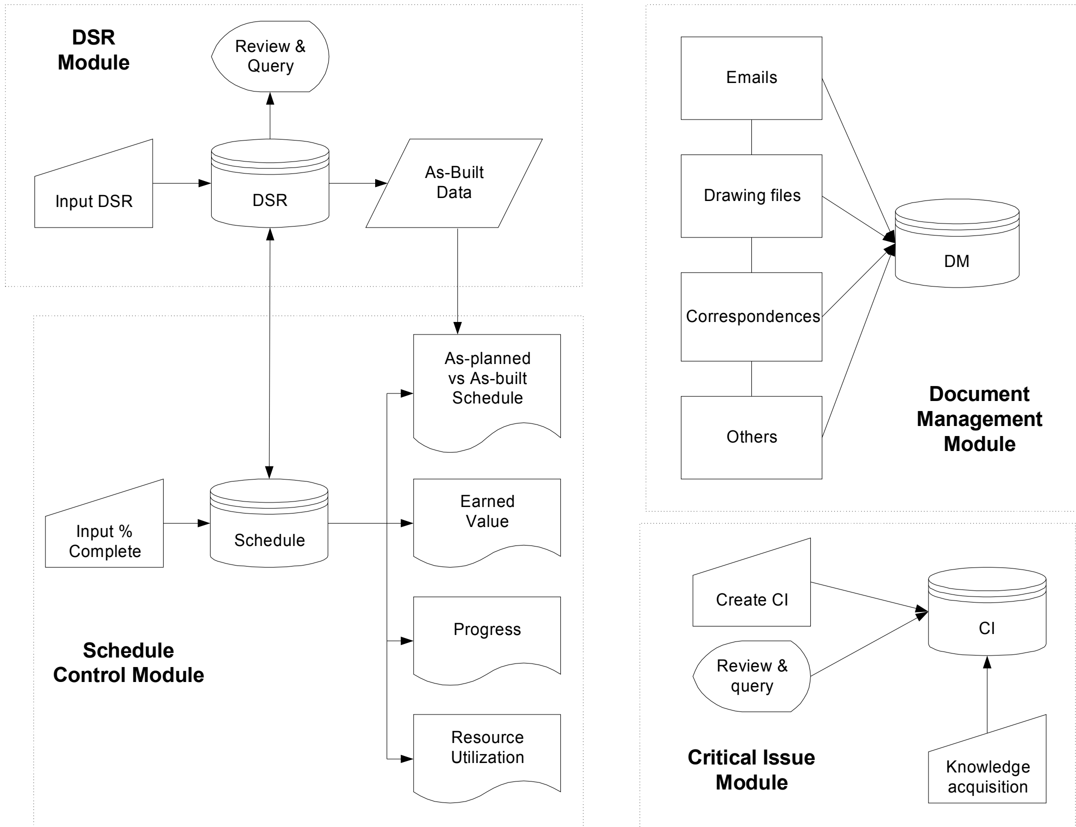

Figure 1: Components of VHBuild.com

Each of the four components are further described in the following sections.

Daily Site Report Module

Daily site reports (DSR) provide project managers with a comprehensive record of site activities. The reports are prepared by generating and completing electronic forms, the format of which are determined by users based on the level of details they required. The DSR allows users to register information regarding the types and descriptions of work done on a daily basis, and problems encountered. It can also keep track of periods of work suspension or inactivity as well as records of types and quantities of resources available and utilised. Figure 2 shows an example of a daily site report.

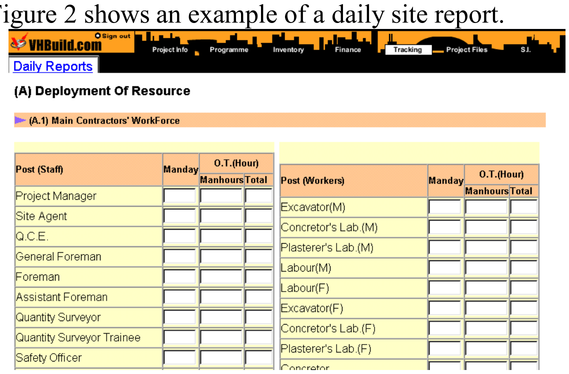

Figure 2: An example of DSR

Information collected from daily site reports can be used to generate as-built factual data. The availability of daily site reports allows project participants to review project information in real time, these site reports being available immediately upon creation rather then at the end of each month.

Schedule Control Module

The schedule control module provides access to "on-line" schedule information. Users have the option to select the level of details of the schedule to view. Typically, the schedule control module can present the percentage of an activity either in an-hours or dollars. The as-built schedule data, which is collected using daily site reports, can be summarized and incorporated into the schedule to form the realistic as-built representation of an activity's progress.

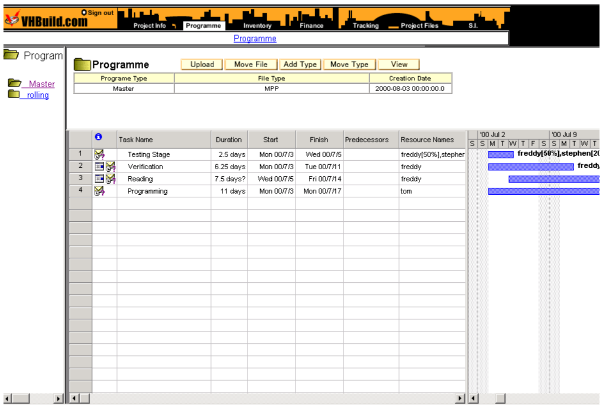

Figure 3: Schedule Control

Figure 3 is a screen dump of the schedule control module. It can be seen that the comparison between the as-built and as-planned is presented graphically.

Document Management Module

A document management system is developed for the management of incoming and outgoing correspondences, drawings, photos and other useful documentation. The system allows users to view documents in various formats including DWG, MSWord/MSExcel, scanned images etc. Documents can be exchanged conveniently and efficiently amongst project participants using the upload/download functions. In addition, a searching mechanism is available for retrieving documents. Figure 4 indicates the interface of the document management module.

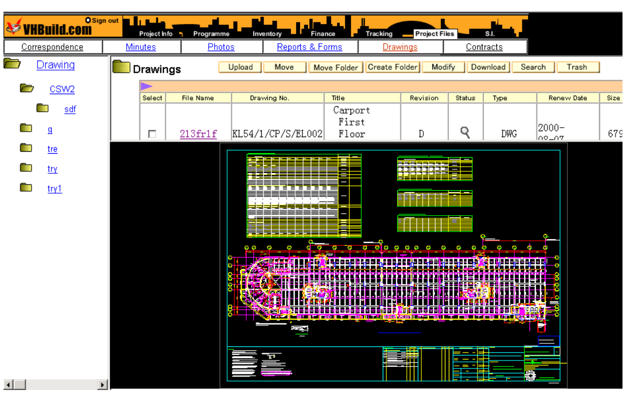

Figure 4: Document Management Module

The availability of the document management module maintains the integrity of project documents.

Critical Issue Module

The critical issue module enables project managers to record critical issues and/or events which occur during the project life. By recording the nature of the critical issues which includes the consequences, reasons and related descriptions and files, the system retains them for further use. These critical issues can range from important site instructions from architects to potential hazards and threats to the project completion. The critical issue module has the following major functions:

- Store and retrieve critical issues
- Advise the project managers on how to handle the critical issues
- Automatically update its knowledge base on the arrival of new critical issues using data mining techniques.

By creating critical issues, the user can maintain a comprehensive history of the development of the project. For example, a design change could be considered as a critical issue and can be recorded and monitored from the reason for redesign all the way through to completion of revised construction and the additional costs incurred. Furthermore, the module provides the common platform for retaining all relevant information such as drawings, photos, progress programmes etc. in a centralised location for quick and easy retrieval and access at a later stage.

When a new critical issue is prepared and entered into the system, it is stored as a case precedent that can be retrieved and reasoned using case-based reasoning techniques (Li 1996).

Knowledge Management: Case-Based Reasoning Approach

Case-based reasoning (CBR) is a problem solving strategy founded upon the re-use of past solutions to address new problems. Instead of representing knowledge as rules in rule-based expert systems, a case-based reasoning system maintains case precedents that retain previously solved issues . Upon encountering a new problem, the system retrieves similar cases from its database, selects the most suitable one, and modifies the old solution for the new problem (Kolodner 1988). This technique is appealing as humans often make decisions in a similar fashion, with several attempts being made to address CBR as a scientific cognitive model (Kolodner 1988).

There are two important operators in a case-based reasoning system: select and adapt. Select is the means of retrieving the most suitable case from the database according to the features of the new problem. A weighted count of matching features provides one method to selecting the best case; however, this does not take into account the fact that the case itself may determine the importance of a feature. Some approaches to finding the best cases are: preference heuristics (Kolodner 1988), dimensional analysis (Rissland and Ashley 1988), and dynamically-changing weighted evaluation function (Stanfill 1987). Once the best case has been chosen, it is necessary to adapt the solution of that case to fit the new problem as closely as possible. In adaptation, decisions have to be made about what remains the same and what changes. The two alternatives for reusing a previous construction situation are to replay the operators that produced the solution and to reuse the construction situation itself. These are identified by Carbonell (1986) as derivational analogies and transformational analogies. The second transfer the solution of an old case directly to that it satisfies the criteria of a new problem; whereas a derivational analogy modifies the problem-solving processes or techniques of an old case to construct paths that result in solutions to the new problem.

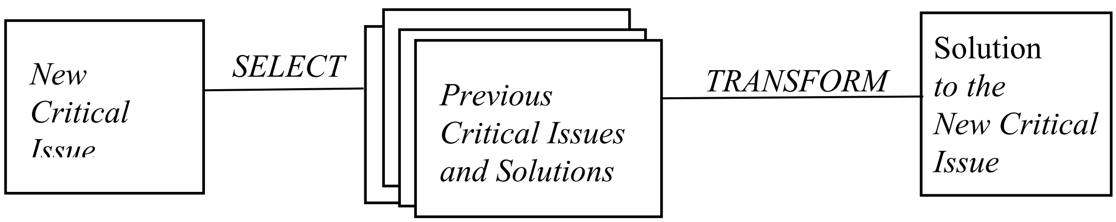

Figure 5: Case Based Reasoning Mechanism

A critical issue case is an abstract of information concerning a previous situation or incident. The content of each case should include information that facilitates its reuse but not necessarily all the details of the critical issue itself. Cases can be developed from a collection of previous critical issues. For our project, a critical issue case contained (1) case number and indexing keywords, (2) situational description addressing the background of the critical issue, (3) parties involved, (4) related documents, files and reasons for invoking the critical issue, (5) expected or actual results. A case has a root node indicating its indexing number and keywords representing important issues involved in the case. The retrieval process is based upon searching for and matching keywords.

The retrieval and selection amongst cases entails the recognition of the relevance of each case to a new critical issue. The case base is indexed by the keywords of each case. When a new critical issue is defined as a set of issues and goals, the system traverses the cases according to the new definition of critical issue, and identifies the similarities between the cases and the new critical issue. The case with the highest similarity is then selected as a basis for generating a solution for the new critical issue. To model this selection process, a weighted count of matching keywords can be applied. User interaction allows the set of matching keywords and their relative importance to be modified.

Case adaptation in ***VHBuild.com*** forms the essence of solution generation. As a CBR model, the system assumes that case selection provides a specific case that is close to an acceptable solution and adapts those aspects of the case that are inconsistent. The selected case should contain most issues and goals that define the problem of a critical issue to be resolved. Knowledge used in case adaptation includes heuristics, common senses and issues, case base, and proportional relations. Modify reservation values, introduce new issues/goals, and select additional cases are three techniques of case adaptation.

Summary and Concluding Remarks

The construction industry is an information rich industry. How to efficiently exchange information among various project participants, as well as to provide a useful tool to facilitate knowledge management has always been a major topic for discussion and research. In this paper, we present ***VHBuild.com***, a user friendly system that allows multiple access to project information from different locations by different project participants. The system incorporates a common work breakdown structure to avoid duplication of data among databases implemented to store various aspects of project information. One unique feature of the system is that it utilizes a case-based reasoning mechanism which enables users to obtain intelligent support when dealing with critical issues. By maintaining and indexing previous cases of critical issues into a case database, the CBR mechanism transfers past problem solving experiences into a process of knowledge management.

The system has been implemented in a web-based environment with a main server containing project databases. With a desktop computer and an internet connection, users can enter the system from different locations. The first phase of development is completed and the system is undergoing a rigorous testing periods using real-life project data. Ongoing development will focus on the integration of different stages of the project life cycle into the system. Specifically, essential functions will be provided to assist designers to collaborate and manage designs and to facilitate facility management. Moreover, we will also consolidate the first stage development by enhancing the data flow integration and to further improve the security of the system.

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