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FRAMEWORK FOR DISTRIBUTED REAL-TIME PROJECT MANAGEMENT INFORMATION SYSTEMS

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Abstract: Successful design and implementation of real-time control applications for large project management demands interactions between several different disciplines. Nowadays these activities are to be performed by joint teams, which are collaborating in a specific manner, according to their different background, particular tasks and their "group" or "professional" interests. In this context, the proposed approach is based on new cooperation methods, mediated by the modern communication technology: defining a framework for the modeling of different real-time scheduling policies for distributed real-time project management information systems. *Copyright © 2002 IFAC*

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1. INTRODUCTION

Nowadays, project management is the science and the art of transforming an empirical project management to a rational and creative one. It represents a planning, coordination and control instrument for complex of different activity fields: information technology, research and development, construction, engineering, education, health, commerce etc. This discipline involves managing a project from inception to completion and the successful attainment of the project's objectives.

Project Management is generally divided into two major phases: *planning a project* and *managing and controlling* it. Each Phase contains other activities (Maryssael, 2001):

- *Planning* the project*:* scope and work analysis, Work Breakdown Structure (WBS), planning / scheduling, resource allocation and leveling, budgeting.
- *Managing and controlling* the project: tracking vs. base line, resource leveling, cost control.

These activities have equal importance. To ensure that a project completes on schedule and within budget, it must be first carefully planned and detailed; each task must contain all the resources with their availability (resources can be personnel, materials, equipment etc.). A good and detailed planning will allow a good progress control together with an accurate cost control. During the construction phase, by carefully tracking actual progress versus the base lined planning and use of resources, the project can be completed on time and stay within its initial budget, unless resources have been initially underestimated.

The purpose of project control or tracking is to generate corrective actions to keep the project on schedule even when the inevitable or unexpected occurs. This helps to maintain realistic goals, update the plans and stay on track. Project control is represented by feedback loops in which the outcomes are compared against plan. The impact of any deviations to target dates and costs are assessed, and corrective actions are settled.

The nowadays trends in project groups are towards "*global project teams*", "*outsourcing*", and "*empowerment of employees*" (WST Corporation, 2000).

Project Leader (project manager) is the person who leads the project management process and facilitates the team organization.

The central management group of the project, *project team* is the assembly of people, considered as a group, that shares responsibility for the accomplishment of project goals and who report either part-time or full-time to the project manager.

Project Management Information System (PMIS) represents the system used to chart activities and data. It is also used to track progress and information flow in a project. PMIS means gathering, recording, filtering and dissemination of pertinent information for members of a project team.

Project Management Software is a class of computer applications specifically designed to aid with planning and controlling project costs and schedules. *Project management software distributed collaborating systems* represents the nowadays work technology in the field. But practicing an efficient management means more than using sophisticated software packages. The leader has to use his/her knowledge, experience and intuition in designing a good frame for gradually management planning. There are certain skills to have when conducting project management: making the right decisions, receptivity, good organizing, and efficient financial control. The manager has to know how to listen, how to gather information, how to bear bad news, administer his/her time and run effective meetings.

Complex design problems require more knowledge than any single person possesses because the knowledge relevant to a problem is usually distributed among participants. The individual participants involved in a design process are called *stakeholders*; they can be sponsors, users, customers, creators, technical experts, and others. Bringing different and often controversial points of view together to create a shared understanding among these stakeholders can lead to new insights, new ideas, and new artifacts. New media that allow owners of problems to contribute to framing and resolving complex design problems can extend the power of the individual human mind (Fischer and Ostwald, 2000).

Knowledge management systems integrate existing components at both the infrastructural and content levels, bringing together people and information systems associated with collaborative tasks. Tools that handle explicit, easy-to-code content of project management systems, as well as components that enable sharing and distributing tacit or contextualized content (e.g. digital whiteboards, case/basing rezoning tools and concept-mapping systems) must be temporally and spatially integrated (Tiwana and Ramesh, 2001).

In traditional KM approaches, management collects and structures an organizational memory's contents as a finished product at design time and then disseminates the product. Such approaches are top-down in that they assume that management creates the knowledge and that workers receive it.

The *design perspective* assumes a culture in which management and workers see the workers as *producers and managers of knowledge*, rather than as consumers. KM is a *cyclic process* involving three related activities: *creation*, *integration* and *dissemination* (Fischer and Ostwald, 2001).

2. INFORMATION TECHNOLOGY, KNOWLEDGE MANAGEMENT AND SYSTEMS INTEGRATION

Project management is the ideal *workgroup application*. The teamwork benefits of the complementary member team roles. Web-based collaboration offers the appropriate technical support for cooperation in space and time among persons with different competencies. Software infrastructure offers a full suite of *project collaboration tools* (Interfacility, 2000). Centralization increases the efficiency of the entire team.

Teamwork strategy, using information technology (IT) facilities in the collaborating process, is defined as a paradigm, CSCW (*Computer Supported Cooperative Work*). *Groupware* is a term describing the electronic technologies and software that support person-to-person collaboration. Groupware is based on: *communication* (the exchange of information), *collaboration* (people work together) and *coordination* (integration of individual works for a greater goal). As open systems applications, the groupware software is designed to run on heterogeneous platforms, with different operating systems and distinctive network architectures, including those for mobile users.

Specialized companies are providing (on the Web) collaborative tools for users, such as: electronic

messaging, group calendaring and scheduling, electronic meeting systems, desktop video and synchronous or asynchronous data conferencing, group document handling, workflow, workgroup utilities and development tools, groupware frameworks, groupware services, groupware applications, collaborative - internet-based applications and products. Most of these products are Web based. Nowadays, *groupware* is more than a technology, it is a cultural phenomenon: choosing the right tool is not enough; its successful implementation depends on the cultural, economic and social environment.

Network technologies and models of the distributed collaborative software are evolving to support an efficient *knowledge management* (KM) of virtual organizations. On-line communities may include any group sharing interest on a website. *Communities of practice* are a specific kind of community. They are focused on a *domain of knowledge* and over time *accumulate expertise* in this domain. They develop their shared practice by interacting around problems, solutions and insights, and building a common store of knowledge.

KM involves collecting and assimilating information within informal and formal networks of people and artifacts spread throughout an organization (Tiwana and Ramesh, 2001).

These technologies enable a "behavioral change" of virtual workteams: peer cooperation and collaboration in ways that raise productivity and economic efficiency. Technologies and infrastructures are making people aware of the difference between the transmission of information and the sharing of expertise.

All *project management knowledge* areas are integrated with real issues associated with *information system projects*:

- project management terms and concepts,
- project life cycle (planning, analysis, design, assembly, testing/training, and deployment phases and maintenance),
- project management principles and techniques (integration, scope, time, cost, quality, human resources, communications, risk, and procurement management),
- project management software.

How to solve integrating the functionality of the projects managed in a company? One of the answers can be choosing *standardized systems* (SEPT, 1999) that are designed to be *data-integrable but also designed for different types of users*. That means an easy- to-use graphical user interface system for some users and a more complex high-end system for others.

Each stakeholder comes to the project with a different perspective: different preferences, environments and knowledge. Stakeholders' viewpoints adapt to situations that occur to the design process and can evolve during interactions with each other. A project management information system that accounts for these socio and technical factors would not only manipulate design data, but also facilitate reconciliation of these design perspectives over the Internet (Lu and Cai, 2000).

Groupware and KM maximize human interaction while minimizing technology interference (Coleman, 1997). A layered configuration of the collaboration technologies includes networks infrastructure, network applications, collaborative applications (groupware), and knowledge management. Functioning of each layer relies on the operating of the previous and the latter is improved to assure a suitable interface to the former.

Nowadays, the XML (Extensible Markup Language) technology steps up integrating network collaborative technologies.

3. CONCEPTUAL FRAMEWORK OF SUPPORTING VIRTUAL COLLABORATION FOR KM OF PROJECT MANAGEMENT INFORMATION SYSTEMS

The framework (Fig. 1) represents an integrated collaborative project management system, using collaborative tools, all linked together to provide an almost seamless integration of information, process flow and accountability.

Steps in integrating a PMIS in the framework:

1. *Identify a high-priority project* that the team must plan;
2. *Pull together any rough project notes*, including information related to deliverables, schedule, resources, and so on;
3. *Identify the key project stakeholders* -- sponsors, users, customers, creators, technical experts, and others.

It is prepared a custom-tailored session designed to achieve these objectives*:*

⇒ Introduce the project team members to a set of powerful PM planning tools,

⇒ Build consensus among project team members regarding the exact deliverables, which the project will produce and the work processes to be used to produce them.

⇒ Facilitate a series of activities in which the team members create their own custom-built project plan including:

- clear and concise project scope statement,
- Work Breakdown Structure (WBS),
- list of project activities and tasks,

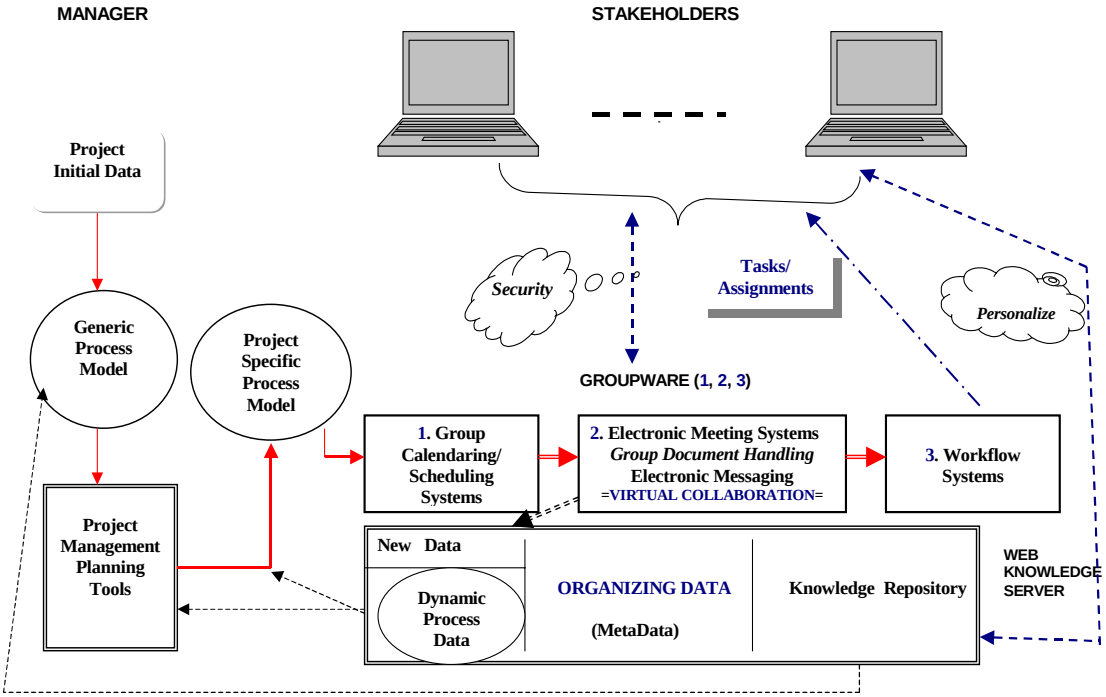

Fig.1. Conceptual framework of supporting virtual collaboration for KM of PMIS

- expressed as a network diagram,
- list of required resources,
- project schedule,
- project cost estimate,
- project communications plan,
- project staffing plan, including roles and responsibility matrix,
- project tracking mechanisms (to track project deliverables, deal with open issues, provide regular status reports, and achieve sign-off of deliverables at key points during their evolution).

A *Web Knowledge Server* (WKS) was chosen to facilitate integration and organization of spatially distributed explicit and tacit knowledge content.

Information and knowledge flows are represented as arrows, in the framework. The initial data of the project is processed by a PM planning tool, according to a *generic process model*. The result is *the project specific process model*, in fact, the plan of the project.

The three components of the groupware system are made accessible to the stakeholders by *secure* Internet access points. Stakeholders are informed participants in the creation of knowledge, not only consumers. Knowledge is information that is made actionable by being *contextualized* and *personalized.* In his or her personal work time, each stakeholder can access "Knowledge Repository", for retrieving useful information.

Calendaring/Scheduling systems enable virtual meetings happening, according to the plan of the project. An electronic meeting system facilitates collaboration to solve a specific item of the project. The meeting notes are exported into a *Notes*-like or *Collabra*-like database, which provides an organized forum for ongoing discussion and decision making for the project. The *new data* of the project is collected by WKS. The outcomes of these kind of virtual meetings are *tasks and assignments* that are to be imported into a *workflow* tool, that will help mapping the project process. This tool may also simulate project phases and choose the most convenient thread to continue the project. The workflow tool would also track and route *tasks* and *assignments* for each member of project team, with time and data stamps. Such a system would finally ensure that when someone in a meeting volunteered or was assigned a task, it could be tracked through to completion and integrated into the project plan and resource management. The phase of the project would be completed, and then the cycle would begin again, for the next stage. If it is necessary, the next phases will be replanned to correspond to the real process data and so, *the project specific process model* will be updated.

The project is completed when all its objectives are fulfilled. *Generic process model* will be enhanced with new features and the next projects will benefit of this.

4. FEATURES OF KNOWLEDGE MANAGEMENT SUPPORT TOOLS

There are some problems faced by the knowledge acquisition process and they require special tools during collaboration between team members:

- *Capture and retrieve tacit knowledge.* A key feature of knowledge management support tool is the ability to capture and retrieve *tacit knowledge*. The solution is to convert a part of tacit design knowledge into explicit, by recording *assumptions* and *beliefs*. Explicit knowledge is formal knowledge that is easy to transmit between individuals and groups.

- *Retain context along with information stored.* The context is to be perceived as:
  - *organizational context*: process (e. g. workflow) and structure (e. g. enterprise ontology),
  - *domain / content based context* (domain ontology and knowledge profiles),
  - *personal context* (knowledge profiles, user profiles / user models and interest profiles),
  - *Physical context* (location and time).

  The system should support the *specification* of a variety of information about the concepts that users specify:
  - w*hat* information is represented,
  - *how* this information is represented (formal or informal means),
  - *who* are the stakeholders,
  - *when* this information was captured, modified and evolved,
  - *where* it is represented (sources), *why* a concept was created or evolved, etc.

- *Capture and reuse of knowledge created during the collaborative process.* Design information from past projects and current projects is accessible to the present team. Store multiple and identifiable versions of content at a single central remotely accessible repository. Shared medium between cross cultural team members provides a common discussion field.

- *Create well indexed knowledge.* Record assumptions made in the design process. Reuse knowledge, processes and design artifacts from past projects. Changing team membership is another problem to face. Each team member's augmentation to the design discussion process has to be captured in the deliberation records. Creating well indexed knowledge of similar problems faced in earlier teams will allow retrieval of informal information (by using meta tags).

The system should provide the ability to define meta models (schemas) in terms of objects representing knowledge components of interest. Associations among these components should also be represented. Characteristics or attributes of concepts have to be specified too.

5. CONCLUSIONS AND FUTURE DIRECTIONS

The article presents the basic concepts in the field of managing large projects, on which the framework relies. Development of such projects is not to be conceived without an interdisciplinary view on the problems. It requires virtual team working, communication, cooperation and coordination of the participants. The manager has to be assisted by new technology facilities and the new ideas and even decisions are emerging from collaboration, by synergy of competences.

The Internet offers the appropriate technical support for cooperation in space and time among persons with different competencies and it also provides opportunities for up-to-date documentation on various subjects. The proposed framework emphasizes the creation of a community of practice with its own domain of knowledge and how it accumulates expertise in this domain.

There are three project models involved in the framework: *generic process model*, *specific process model* and *dynamic process model*. The first is generated from organization's past and present experience and it helps defining the *specific model* of the ongoing project; the *dynamic process data* helps in updating the first two.

The functionalities of XML in integrating network collaborative technologies are two: to increase the degree of control over *how* documents are presented on the Web and to explicate the standards for exchanging information that is structured for further processing.

The Web pages will include XML-based process descriptions and, in this way, people and organizations will be helped in organizing their work, preventing "information overloading". Therefore, *project management systems integration* will be facilitated by the new XML technology standards.

The Project Management schema defines a main document element named 'ProjectManagementSchema' (http://www.oasis-open.org/cover/ProjectManagementSchema-xml.txt). The XML schema is of interest to software applications with a focus on the exchange of *standard project management data* such as cost, schedule, and resource information. The Project

Management document represents the complete set of project information most commonly used by project management software products and most critical to an accurate exchange of project status between two software systems.

The Workflow Management Coalition (http://www.wfmc.org/) attempts to provide a simple protocol that enables interaction between requesters and providers of workflow type services. The specifications of workflow interoperability standard (Wf-XML) are to be enhanced. The Web provides a common platform for document sharing. What is to come in the near future? It is "the next Internet layer for work sharing" and "Internet-mediated workflow will be the single most important technology of the early 21st century" (Petrie and Sarin, 2000).

The Knowledge Management System has to be linked to the organization model. It empowers people within and outside the company to learn as they work. The efficient knowledge work teams represent the key of success in the future.

The KM perspective presented in the article requires a cultural change, in which all stakeholders must learn new relationships between practices and attitudes.

Building a learning organization implies using the five principles of a pedagogical and learning model (Project N Corporation, 2000): learning to recognize patterns, learning to make distinctions, learning to forge relationships, learning to organize systems and learning to get perspectives.

Authors' ongoing work is to develop mechanisms to facilitate knowledge capture, transfer and use it in virtual organizational work, such as collaborative design and collaborative learning.

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