ENGINEERING AND PRODUCT DESIGN EDUCATION CONFERENCE
7-8 SEPTEMBER 2006, SALZBURG UNIVERSITY OF APPLIED SCIENCES, SALZBURG, AUSTRIA

PROJECT MEMORIES: DOCUMENTATION AND MUCH MORE FOR GLOBAL TEAM DESIGN

Hilary Grierson, William Ion, Neal Juster

ABSTRACT

The practice of design is increasingly being carried out collaboratively, by geographically and temporally distributed design teams. Designers are no longer merely exchanging geometric design data and information but more general (and contextual) knowledge relating to the design development process. Consequently there is a move from information-intensive to knowledge-based practice. Borrowing from the concepts of organisational and corporate memories of Walsh & Ungson [1] and Conklin [2], and on previous studies in the area of project memories by Perry & Fruchter [3] an initial framework is being developed for a digital 'project memory' (shared workspace and repository) to support global team-based student design projects which records and shares both process-related and product-related resources. This paper examines two studies, one collocated and one distributed; reporting on the type of information and knowledge being kept and shared by students within a digital 'project memory'; what is stored and where; what is re-visited; and what is useful and valued by the students.

Keywords: design information, design knowledge, project documentation, corporate memory, organizational memory, project memory, global design, team projects, reuse

1 BACKGROUND

Organisational and corporate memories capture the information and knowledge an organisation needs to share and preserve and is an attempt to capture its processes and rationale. They are 'stores of knowledge in context; in other words they contain past project information and attempt to emulate the characteristics of an internal memory, i.e. rich, detailed and contextual.' [4] These systems have often been ignored in industry in the past as a resource for a number of reasons. Western culture has come to value results above process; many organisations collect too much information which is difficult to revisit and often fails to capture the emerging design knowledge, the history and the context behind the formal documents which are kept. There are also issues of the additional overhead needed to document process; the tools are often complex and cumbersome and inhibit the natural flow of the design process. With a shift towards the globalisation of design and increasing collaborative design practice there is now a need to record more contextual and (informal) information to support decision making.

Studies at the University of Twente [5] into WWW supported project work in higher education have been positive but highlight the requirement for further support in terms of workflow management; storing and sharing of information and resources; recording of process (decision making) and progress, and the failure of students to plan and reflect. A project memory is a potential tool to support all of the above. This work

defines a project memory for student teams as 'a collection of formal and informal information and knowledge, useful both to team members working actively on a project and thereafter as a project definition, a record of activities, project history, and results'. It provides a central repository and access point for documents, collaboration and communication. Formal information is declarative, the stuff of facts, books, manuals, patents, drawings, reports, etc. Informal information and knowledge consists of ideas, rationale, assumptions, guesses, decisions, experiences, stories and points of view; the more procedural and organisational aspects. The latter are very seldom recorded during student design projects but have high value in terms of student learning.

2 PROJECT MEMORIES IN THE CLASSROOM

Lack of recording of informal information and knowledge on student design projects creates an incomplete picture of the design project. This reflects current practice in design education - more product-focused than process-focused. Past studies at the Design Manufacture & Engineering Management Department (DMEM) over the past eight years, have found shared workspaces to effectively support collaborative learning and distributed team working in design engineering [6] [7]. The following two studies further this work by examining project information and knowledge recorded online in two design projects using a shared workspace. Teams used LauLima (developed from the open-sourced groupware product Tikiwiki), as a 'project memory', to share project information and knowledge; manage workflow; support reflection and documentation and plan project progress. LauLima has document management facilities including hierarchical file galleries (file storage); wiki pages (web pages that can be edited by multiple users); and internal communication tools. Note that only the project memory was examined for content. Students could also record design information, knowledge and discussion elsewhere, e.g. sketchbooks, notebooks, mobile phones, email.

2.1 Study 1: Product Design Partnership Class description and evaluation

Study 1 examined the project information & knowledge stored in LauLima by one 5th year team in the industry-based Product Design Partnership (PDP) class at DMEM, over a period of 7 months. In this class teams of 4 to 5 students are encouraged to take ownership and management of all parts of a project, solving real life open-ended problems with academic and industry partners' support. They are required to keep a log of project events, minute meetings and store project information and resources online. Evaluation was conducted through analysis of the team's file galleries, wiki pages, internal email and observation in class. The team was collocated but varying timetables and pressures of external work meant meeting up f2f was often not possible.

2.2 Study 1: Findings

The team gathered resources and created information and knowledge during the project, using the hierarchical file galleries as a store from which to structure and organise their project information & knowledge through linked wiki pages. Their file galleries contained 182 resources organised hierarchically at 3 levels in a variety of formats (jpg, mpg, ppt, doc, pdf, rtf, xls, html, sldworks). The majority of files were formal in nature, e.g. product and market research information, their outputs, reports, detailed drawings. Little informal information, save a few scanned in hand drawn sketches and ideas were stored there. However, the wiki pages contained more informal information & knowledge. It was about tasks, decisions, agreements, actions, the team and progress. In addition, the students had linked actions and decisions in the wiki pages to

documents that lay in the file galleries. From a tutor's perspective this begins to give more context to the formal documents produced by a team and decision making processes become more transparent. The team met f2f, used mobile phones and the internal email system within LauLima. The content of the internal email system was predominantly informal, about arranging of meetings, decisions and agreements, tasks and procedures. These are all aspects which often don't get captured during student design projects. Feedback (via an end of class questionnaire) was sought from the whole year group of 76. 19 students responded noting that using a central shared workspace and digital repository as a project memory improved project outcomes (74% yes, 5% neutral, 21% no). They reported that it brought structure & organization to project documentation; improved team working by allowing them to work anywhere, anytime; it helped them keep track of progress, plan and focus on project goals. They were less convinced that it improved their learning (42% yes, 32% neutral, 26% no). They did however, report that having a pool of critical information and knowledge supported reflection and decision making and therefore as a result improved learning. They noted that there were drawbacks to using such a system. It created additional workload, was often time consuming and constantly needed to be updated to be most effective. Varying skills in the use of technologies and student attitudes to adopting technologies was problematic, often leaving upkeep to one 'expert'. Asked whether they would use such a system again to support project work, 84.5% said yes, 5% were neutral, 10.5% said no.

3 PROJECT MEMORIES FOR GLOBAL TEAM DESIGN

Project memories seem better suited to global, distributed design since there are fewer opportunities for direct communication and greater instances for misunderstanding. This places more importance on the information implicit with a piece of design information, and how and where it is stored.

3.1 Study 2: Global Team Design Experiment description and evaluation

Figure 1. Paper Bike Global Team Design Experiment

Study 2 examined the project information & knowledge in LauLima stored by a distributed team of 4 students at Stanford University and 3 students at Strathclyde University. Over a period of two weeks the team undertook a design experiment to design, prototype and race paper-bikes at Stanford and Glasgow (*Fig.1*). Like Study 1 the team had to record project information and knowledge and keep team and individual logs (recording activities) which would support project management, reflection and

planning. They communicated via the internal email system in LauLima and their own hotmail accounts. In addition to the 'project memory' the team had access to repositories of past paper bike material and used video conferencing extensively. Evaluation was conducted through analysis of information and knowledge content in the team wiki site and the file galleries; an end of experiment focus group and responses within a questionnaire.

3.2 Study 2: Findings

The team's file galleries contained 92 files hierarchically stored at 2 levels. In contrast to the PDP team 'project memory' most of the information and knowledge stored was informal, procedural - about brainstorming, concepts, prototyping, testing and racing; and organizational - about the team, project set up and planning. The most common resource formats were image (jpg) and video files (mpg, avi). Less than 10% of the information in the file galleries could be classified as formal (mainly past reports). Information in the logs on the team wiki site was brief, mainly noting the activities that had taken place. Instances of this were about the team, project planning or task related, brainstorming, concepts, decisions, prototyping and testing. The paper bike team's use of video conferencing as their main means of communication and the short project time both affected the amount of use of the asynchronous LauLima messaging system. However, analysis showed that, where used, this contained greater instances of informal information, e.g. relating to the team, project planning and progress, tasks, decisions, requests for help and feedback. The questionnaire showed that both sides of the team found digital cameras and video recorders were the best methods for capturing and sharing project information and knowledge with the 'project memory' helping to promote sharing. Students reported they still used sketchbooks and notebooks to record ideas and project development and often kept information on their own computers. All members of the team revisited the material stored in their 'project memory'. Brainstorming and concept information were revisited most often, with two team members revisiting frequently and others less so. The focus session highlighted the value both sides of the global team placed on information contained in images and video. It made for more explicit understanding and engaged more focused discussion at video conferences. However, faster uploading to the 'project memory' was needed. High use of the video conferencing system whilst great for communication reduced the need for the 'project memory'. The time difference impacted on collaborative working patterns making working a little more complicated and there were times when the team members relied on the project memory for updates and the sharing of ideas via uploaded images and video clips. Students reported that on such a short project there wasn't much time to manage the project using software systems. Limited time also meant little opportunity to discuss the design process itself which the students found disappointing. They had to focus on task all the time with little chance for reflection and benefit from the cultural differences beginning to surface. The Stanford coaches (design project facilitators) wished to be able to see more of the remote team's work; more reflection on process; more asynchronous communication; more sharing of ideas at an early stage; all of which can be achieved by giving the 'project memory' greater emphasis.

4 DISCUSSION

A 'project memory' can provide a central repository for student teams to store and share work which can be accessed anytime from anywhere, thus reducing the reliance on f2f contact. It is not merely an information warehouse but a place which allows them to

share, to reflect, to make more informed decisions and to integrate information and knowledge to form new ideas & knowledge. In virtual space the positive effects of tacit knowledge transfer are severely reduced. Information with context becomes increasingly more desirable. Both studies demonstrated different ways in which context could be added to information. Study 1 used hyperlinking. Strength lay in linking between the formal and informal project information and knowledge. Groupware allowed an organisational and procedural record to be built in the course of everyday communication and coordination, through minutes, recorded actions and decisions. Hyperlinking provided the ability to organise and display a rich informational web of project processes and outputs between the informal information in the wiki pages, project logs and the internal email system and the more formal information stored in the file galleries. Clear navigation in such 'project memories' becomes crucial. Students on Study 2 found a short project time resulted in little time to manage the project using software systems but found other methods of adding context. Video clips and images were key to the success of project development on the paper bike project. They added contextual value and made for a more explicit understanding of the problem and solutions. They encouraged more focused discussion at video conferencing sessions. Metadata (keywords or descriptions added to digitally stored resources) was another method of adding more context to the formal documents in the file galleries. Several excellent descriptions were found in some of the paper bike resources which described how things were done. Unfortunately this is not the norm as students tended to upload resources with poor or insufficient metadata.

Time difference impacts on global working patterns making working a little more complex. One solution is the adoption of a 'project memory' keeping an ongoing record of development and decisions. Study 2 proved too short to take best advantage of such a 'project memory' however Study 1 found keeping records everyone could share easily improved project management. Good project management supports project progress. A 'project memory' supports project management by helping teams store information and structure design tasks so that awareness of where they are in the process and the next steps to take are more readily apparent. A lack of awareness is often determined by a lack of engagement with team work and problems with for instance negotiating and decision-making [8]. Reassuringly the students in the paper bike experiment asked for more time to be built into the project to reflect and to have opportunities to discuss actual design processes. They recognise there is much to be learnt from the different approaches and methods others use to solve design problems particularly when global team design crosses different cultural zones.

4.1 Developing a framework for information and knowledge in global team design

These early studies are beginning to determine a framework for a digital 'project memory' to support global team design. It must support not only the declarative (formal) information which is most commonly stored, but also the procedural and organisational (informal) information and knowledge. This includes the ideas, assumptions, decisions, meanings, stories, all very seldom recorded during student design projects. The 'memory' should capture product aspects, management aspects, task aspects and the culture of the student team in a coherent environment. (*Fig. 2*) This type of information, often more contextual & rich in detail, can be linked to and support formal documentation and therefore be of more value to the decision making process and greater in terms of student learning.

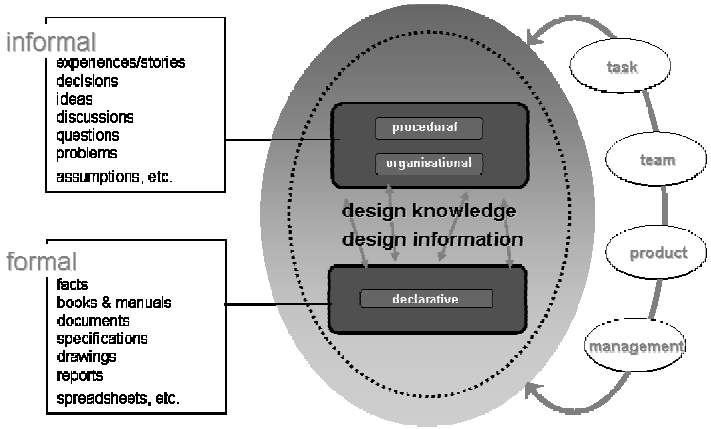

Figure 2. Information and knowledge in a project memory for global team design

6 FUTURE WORK

The development of a new joint class project with Strathclyde University, Stanford University and Olin College as part of a global design class at each institution starting the academic year 2006-2007 will offer the opportunity to further examine how students store and share information and knowledge in global teams. Other studies will examine design information and knowledge reuse drawn from 'project memories'.

REFERENCES

[1] Walsh, J.P. and Ungson. G.R., Organisational Memory, *Academy of Management Review*, Vol. 16, 1991, pp.57-91.

[2] Conklin, E.J., Capturing Organisational Memory, in *Readings in groupware and computer-supported cooperative work; assisting human-human collaboration*, pp561-565, (ED) R.M. Baeker, Morgan Kaufman, San Mateo, California,1993.

[3] Perry, M., Fruchter, R., Rosenberg, D., 'Co-ordinating Distributed Knowledge: an investigation into the use of an Organisational Memory', in *Cognition, Technology and Work: An International Journal for the Analysis, Design and use of Joint Cognitive Systems*, Springer-Verlag, 1999, pp142-152.

[4] Fruchter, R., Demian, P., Knowledge Management for Reuse, *Proceedings of the CIBw78Conference 2002, Distributing Knowledge in Building,* Vol 1, pp93-100.

[5] Van der Veen, J., Collis, B., *Telmatic Tools to Support Group Projects in Higher Education.* 1997, University of Twente, http://doc.utwente.nl/fid/1314 (03/2006)

[6] Ion, W.J. & Neilson, A.I., The use of shared workspaces to support the product design process; *Proceedings of the International conference on concurrent Engineering*; University of Rochester, Detroit, 1997.

[7] Sclater, N., Grierson, H., Ion, W. J. & MacGregor, S. P., Online collaborative design projects: overcoming barriers to communication. *International Journal of Engineering Education*, 17, 2, 2001, pp. 189–196.

[8] Van der Veen, J., *Telematic Support for Group-based Learning*, Twente University Press, Enschede, Dissertation, 2001, pp. 340.

Contact info: Hilary Grierson, DMEM, University of Strathclyde, 75 Montrose Street, Glasgow, G1 1XJ. Phone: 0141-548-4573 email h.j.grierson@strath.ac.uk