DESIGN EXPERIMENTS IN KNOWLEDGE MANAGEMENT

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ABSTRACT
As organizations try to become more competitive, their success depends on how they capture the tacit strategies and activities that are embedded in their work processes and product developments. Narrative-based success stories and case studies can play an important role in externalizing and socializing such knowledge. Computer-based tools can support this process. In this paper, we present and discuss experiments in the design of story-based knowledge and learning support systems. We believe that such systems will play an important role in the knowledging activities of organizations. We need to develop a deeper understanding of the issues involved in the design and use of such systems—an understanding which is grounded in and informed by the theoretical models and frameworks of organizational learning and knowledge management.

1. INTRODUCTION

As organizations try to become more competitive, their success depends on how they capture the tacit strategies and activities that are embedded in their work processes and product developments. Some companies capture this knowledge in the form of case study narratives and success stories to transfer it to other employees or for future use (Skok, 1999; Snowdon, 1999). Narrative and stories can play a quintessential role in the externalization mode of knowledge conversion (Allee, 1997; Davenport and Prusak, 1998; Nonaka and Takeuchi, 1995; Wenger, 1998). Good stories provide emotional involvement through the recreation of the characters' experience for those who engage with the story. Stories and narratives provide organizing structures for knowledge to be indexed in memory, and hence be recalled easier (Mandler, 1984; Schank, 1990). Additionally, stories and narratives transport the reader into the activity context and preserve the complexity of real-world situations.

Case studies are a form of narrative which have long been a staple of instruction in business and other professional schools. Multimedia case studies have been shown to be effective for learning about human-computer interaction (HCI) and other knowledge areas (van Aalst et al., 1996; Carey et al., 1998). Unlike stories, which invoke an imaginative response, case studies are frequently more expository and didactic in nature. Multimedia representations of case studies and stories often contain elements of a third genre, vignettes—personal reactions, recollections or reflections which express a participant's experience without the intentional design for an audience and purpose that is provided by a good storyteller or case author (Goodyear and Steeples, 1998).

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There has been much interest in developing computer-based tools to support knowledge management processes (Tiwana, 2000). Most of these tools, however, address issues such as data mining, searching, browsing, and mapping of information spaces. Design of narrative-based knowledge support systems has not received much attention. However, there has been recent interest in the HCI community on the use of stories to share expertise within knowledge communities (IBM Research, 2001).

We have been working with a number of organizations (e.g., Bank of Montreal, IBM Canada, and Nortel Networks) to see how to design learning and knowledge media to support their work in the design of HCI products. HCI design often involves teams of multidisciplinary people working with each other for a period of time to develop products that satisfy customer needs. The knowledge of the experiences and activities of the team members can be captured in the form of case-based narrative—made of the thoughts and impressions of the members of the management group, the design group, the quality assurance group, and so on captured in print and other media.

We are doing design experiments by creating a number of innovative prototype systems that capture and organize these case studies and stories. These systems are intended to support the learning, socialization and transfer of this knowledge to other HCI practitioners—either within the same company or in the context of their communities of practice. Our research in design experiments strives to be informed by current theoretical frameworks developed by theoreticians in the areas of knowledge management and organizational learning. However, as Olivera and Argote (1999) point out "Despite the important role of product development groups in organizations, the literature has not yet produced adequate frameworks for analyzing their functioning and performance." The aforementioned authors propose a model (CORE) as a framework for analyzing group processes involved in product development. But, such models, though quite useful for analytical and descriptive purposes, do not readily lend themselves as prescriptive frameworks to guide the design of knowledge management support media. There is much need to develop new knowledge management and performance support systems, test them within real workplace settings, and evaluate and improve them in the context of emerging theoretical frameworks.

In this paper we describe and discuss the design experiments that we have been working on, some of our usability findings, and our thoughts on new directions of development.

2. LAUD – LEARNING ABOUT USER-CENTRED DESIGN

In a previous paper (Carey et al., 1998), we have described a system which used interactive narrative to teach the User-Centred Design (UCD) method for designing human-computer interaction. This is an example of knowledge capture from the introduction of a new business process with a pilot team, and the sharing and transfer of that knowledge through an interactive narrative.

2.1. Scenario of Use

The UCD case study system was originally conceived as a tool to assist corporate employees to acquire knowledge about UCD methods, either as part of their personal

career development or as part of a formal curriculum. The sponsors of LAUD and their representatives on the development team were technical professionals in the information technology development area. They had built their own knowledge of human-computer interaction from personal motivation, demonstrated the benefits of UCD through involvement in a pilot project, and wanted to use this experience to improve the resources available internally to support learning about UCD.

There were two scenarios of use for LAUD. During the development, a project manager in one of the test groups requested that the system be made available for his teams to work through at an early stage in a new project. The need to apply UCD in the imminent project would increase the teams' motivation. Additionally, the opportunity to immediately apply the information would reinforce the knowledge and make the method seem concrete. This was adopted as the primary scenario of use for LAUD.

In the secondary scenario of use, project managers introduced the UCD tutorial during an initial project team meeting and assigned team members to three-person groups to work through the tutorial. Groups worked on the tutorial in a Learning Centre or other workplace setting, in a time slot equivalent to a project team meeting (two to three hours). In the subsequent team meeting, the project managers would lead a discussion of how UCD fit their needs, where the team would need coaching or further instruction, and who else needed to be included on the team, based largely on the memos received from the groups.

Figure 1

Figure 2

2.2. LAUD Components

The system contains 3 main components:

- an authentic Case Study (Figures 1 and 2), in which the pilot team which used UCD to develop an interactive system shares that successful experience
- a Methods Tour (Figure 3), which provides an overview and practical help for common methods in UCD
- a Test Drive (Figure 4), in which learners play simulated roles in a design project to experience UCD methods.

In the short term, the objective was to raise awareness about UCD methods and their impacts; in the long term, the objective was to link the initial product into an electronic performance support system for HCI. The Case Study success story was intended to

provide the credibility needed to win acceptance of UCD. The Methods Tour was intended to demonstrate that deliberate choices and careful use of methods is an important component of project success. The Test Drive was intended as a mechanism for the learners' self-assessment.

Figure 3

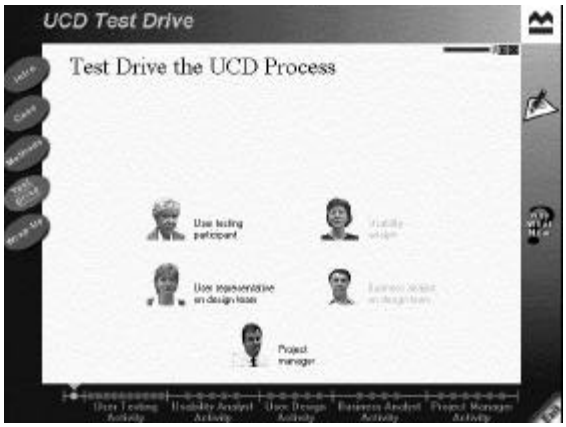

Figure 4

2.3. Lessons Learned

We have learned a number of lessons by conducting usability studies of LAUD in workplace settings.

Engagement value of narrative: We were fortunate to find a pilot case in which external pressures had caused some deviations from the UCD process which set back the schedule when the resulting designs were rejected by the users. The team treated this as a learning opportunity and were able to speak frankly about it in their video vignettes. Our test users all commented favorably on the engagement this storytelling genre produced.

Ownership: Ownership was a major issue in preparing the case study: the pilot team's experiences and their reflections on it were sometimes inconsistent with the Bank's "big picture" of terminology and recommendations for UCD methods. In the end, we chose to let the team tell their own story in their own words, without commentary by UCD coaches. This preserved authenticity but at some cost in generalization.

Narrative context versus expository content: As a prelude to a more extensive performance support system, the tutorial was to contain an overview of UCD methods. This was also intended to introduce methods which were not part of the case study. We included video vignettes from other projects to make these methods come alive with their own mini-stories. However, the Methods Tour was essentially expository in nature, and the video vignettes were not as well-received as the elements of the case study itself. We discuss below our current approach to making this additional material more effective as narrative, by incorporating such tutorial elements as a coach's story about the larger learning experience and as peer stories added as part of a dynamic exchange process within the community of practice.

Focusing on deliverable to support active learning: The learning model used in the UCD tutorial is an adaptation of the Experiential Learning Cycle (Kolb, 1984), which proceeds

from observation [Case Study] through conceptualization [Methods Tour] and experimentation [Test Drive] to concrete experience [the upcoming project that provides the final element of the cycle]. The project context allowed us to include a 'deliverable'—a memo back to the project manager, which each group produces as a report on their use of the tutorial and a position paper on how UCD could be applied in their own team project.

Reflection elements are included at the end of each of the three UCD tutorial units, where the memo to the project team manager is created. In many cases, users who had skimmed through the content of the unit went back to it when they came to create their memo – with a better understanding of the extent and limitation of their own knowledge based on their ability to respond to the memo requirements.

Limiting navigational complexity for group processing: The collaborative setting for use meant that we had to reduce the richness of the content and the non-linearity of the interactivity to support effective group dynamics. For example, we reduced the level of user choice available in the initial parts of the tutorial. While this is normally the opposite of our objective as interaction designers, we found that the groups had to build internal rapport before they could tackle difficult navigational choices. In the Introduction unit there is very little user choice required. In the Case Study unit, learners could navigate by moving back and forth between events or use the navigation timeline at the bottom of the screen to move directly to an event. Most groups chose to move sequentially.

We also reduced the visibility of the hypermedia nature of the tutorial. While it is possible to move directly from a case study event using a method to a description in the Methods Tour or to a Test Drive activity using it (and back again), we removed any emphasis on this from the tutorial introduction or the visual cues. This was partly to preserve the integrity of the case story line and partly to reduce the amount of choice confronting the learning groups.

Just in time, just enough: The combination of Case Study, Concepts Tour and Test Drive appears to be of significant value for collaborative learning in a project context. For developers of multimedia tutorials using such authentic case studies, the evolution of our design yields the following guidelines:

- a "just-in-time" learning context requires more reflection on current work and less role-playing exercises
- a more collaborative usage context requires a reduction in the complexity of the navigation decisions, thereby decreasing the group's cognitive load and allowing effective deliberations by the group
- an interaction genre with more authentic story telling requires engaging media, whereas a role-playing exercise can rely on engaging interactions.

3. CURRENT DEVELOPMENTS

The LAUD tutorial was built as a stand-alone resource. However, the intent has always been to incorporate such tools into larger frameworks for knowledge management and performance support. Currently, LAUD has some shortcomings which are being addressed by the following developments. Most of these developments are intended to reduce the reificative effects of the tool and enhance its participative, imaginative, reflective, and meaning-making features (Wenger, 1998).

3.1. Modularize Story Elements

Currently, the story elements are embedded in the Case Study component along with the learning tasks. This organization does not allow the story to support knowledge conversion along multiple tasks. To accommodate additional tasks with the same story or additional stories, the story will have to become modularized.

3.2. Build Event TimeLine

Our current work structures the narrative into a timeline of event information and related stories. The event information comes from records generated by the event: meeting minutes, decisions made, documents generated. We also collect individual reflections on the contents, processes, and outcomes of the event. The basic event TimeLine will be separated into a multi-thread TimeLine—a timeline allowing multiple overlays on top of it. This will allow for custom versions of the story to be presented for different learners and contexts.

3.3. Elicit Individual Stories

Currently, the story is narrated by a project team member on behalf of the team—i.e., the 'voice' of the story is a collective one; individual versions of the story are embedded within the collective story as vignettes on individual events. However, each participant in the narrative of events may have a particular perspective on the meaning of the events. In the original LAUD case study, most of this information appears in the narration which opens each event frame. As a result, if a learner wished to follow a particular voice/role (e.g., project manager) through the tutorial, LAUD would not be able to support this well; similarly, additional voices/roles cannot be easily added.

In the new structure, there are multiple threads through these events, each representing the story meaning as viewed by a participant. In particular, this allows a learner to follow the case from the perspective of a role such as the usability analyst or project manager (although there are questions about the extent to which an individual's reflections come from their role versus their personal history and circumstances). The individuals link the events together into meaningful stories, by reflecting not only on what happened but also on why it happened, how it felt to them, and what it meant in the larger picture.

In the LAUD case study it was a useful process for the team to generate a collective version of the story, to provide closure to their project experiences (see [Lawrence and Thomas, 1999] for the collaborative nature of storytelling). We believe there could be significant knowledge stewardship value in a team reflection on the individual stories. This might still be presented as additional vignettes within the framework of individual stories, rather than as an authoritative voice over and above the personal role stories.

3.4. Create TaskLines and TopicLines as Narrated Threads

We described above the importance of having learner tasks as a way to engage with the story. In our new structure, these tasks will be supported by navigational threads (TaskLines) through the story which select relevant events and perspectives. Learners will

still be able to navigate on their own using the TimeLine, but the Next/Previous navigation buttons will follow a particular thread designed specifically for the learning task. This allows for easier customization of navigation to learners' tasks and roles. The TaskLine is another story, being told by a tutor and utilizing the case narratives and its stories.

Similarly, a process coach could construct a TopicLine which is another story focused on a particular set of methods. The story would probably centre around the learner's progress in understanding the methods, using the case as an illustration augmented by other vignettes from practice. Alternatively, the narrative structure for the TopicLine could be provided by the coach's own learning process or that of the case team as interpreted by the coach. This allows the coach's voice to be presented in a way analogous to that of the other role players.

3.5. Navigation and Content Visualization

Sometimes, making sense of the narrative-based story and developing insight into why things work or fail, and how to improve existing processes may not be apparent, even to those telling the story. At times, discovering the know-whys is not possible, as the person who is studying the story may not easily perceive the causal interactions and relationships among the situations, decisions, and processes described in the multimedia chunks. An aspect of our design experiments involves visualization of navigation and content dimensions of the story to facilitate this sense-making process. Visualization of information can encode scattered information into perceptually concise and efficient visual representations (Card et al., 1999). Thus, it can support the learners' perception, amplify their thinking, and help them make sense of the deeper layers of the story by highlighting structures and patterns implicit in the story (Sedig, 2001). Story visualization may also facilitate construction of mental maps of the information space (Card et al., 1999).

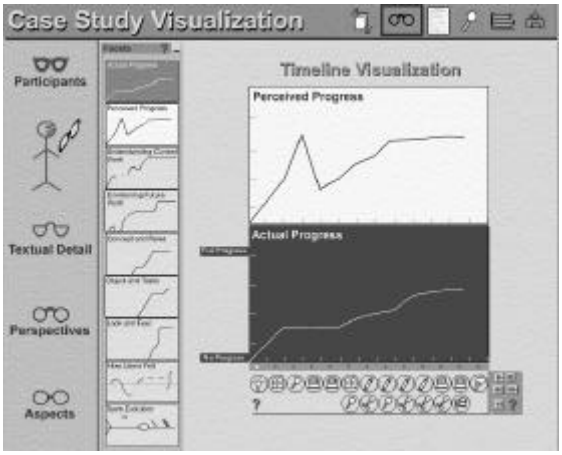

Figure 5

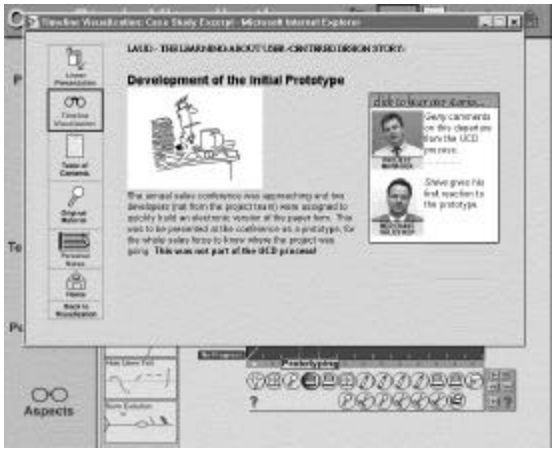

Figure 6

The content of the narrative can have several dimensions that are embedded in multimedia chunks (e.g., text, speech, video). Examples of these dimensions in the context of a team-based HCI project include the actual progress of the team during the project, the perceived progress of the team, understanding of the work by the team members, and understanding roles and concepts. Figure 5 shows the TimeLine of the story represented visually on the horizontal axis. The events on this TimeLine are iconic (e.g., scissors representing paper mock-up creation) and link to event information (i.e., description and outcome of these

events as embedded in story elements). Story dimensions are visualized as graphs, where the vertical axis represents a range of values pertinent to a given dimension. For instance, in Figure 5, the learner can see the two story dimensions of perceived progress and actual progress simultaneously. During prototyping the team perceived that they had made more progress than their actual progress. The graphs are interactive and are linked to the story elements. The learner can click on points on the graph to read (or watch) the portion of the story as narrated by the participants (Figure 6).

4. FUTURE WORK

We are continually conducting usability studies involving our corporate partners. The designs we have presented are undergoing change in the light of the feedback received from our users. The following is a brief list of some of the future work needed to improve the designs presented here.

4.1. Integrate Ongoing Reflections on Practice

By its very nature, narrative and story elements can appear dated more quickly than expository material. On the other hand, ongoing reflection in the community of practice can continue to add new vignettes and possibly new stories. Many current initiatives around organizational memory and knowledge management capture stories as a critical element in practitioner knowledge. Such capture adds a generative dimension to the designs—learners need to engage in generative learning in addition to analytic sense making of the story (Jonassen et al., 1999; Wenger, 1998). However, the new challenge to our design will be to allow dynamic growth of this ongoing story resource while preserving the tutorial structure of initial resources like LAUD, which have a specific role in drawing newcomers into the knowledge community.

4.2. Provide Explicit Narrative-Building Tasks and Tools

The tasks which we provided to engage learners in LAUD could be conceived as narrative-building tasks. Learners either placed themselves in the story in a ‘what if’ scenario, reflected on the story which would emerge from their own project, or participated in a related story (e.g., the Test Drive elements in which they took on roles in the development process of the LAUD tutorial itself).

Given the story elements, such as the TimeLine, which structure the use of the existing story, future work should investigate how to apply these tools in the learner tasks. For example, the ‘memo writing’ task, around which the use of the Case Study is structured, can be presented as building a TimeLine for the learner team’s project story. This may provide additional engagement, and also provide an artifact which can be re-examined for reflection during the life of the project. It can also provide a natural mechanism for the team’s learning during their project to be later linked to the Case Study material.

4.3. Visualization of Narrative Dimensions

We believe that the visualization and linking of navigation to dimensions of content can foster reflection on and promote insight into the not-easy-to-see and embedded ideas in the captured story. Our informal usability studies show that such visual representations help

users get a quick overview of the story. However, the graphs seem ad hoc since they represent the designer's understanding of their values. More research is needed to identify alternative methods for visual representations of the different dimensions of the narrative.

5. CONCLUSIONS

In this paper, we have presented and discussed experiments in the design of story-based knowledge and learning support systems. Such systems will play an important role in the knowledge management activities of organizations. However, the design of such systems requires much research and development. We need to develop a deeper understanding of the issues involved in the design and use of such systems. We believe that such design experiments serve two purposes which are reciprocal. On the one hand, they can provide interesting and challenging test-beds to validate and modify theoretical frameworks in knowledge management and organizational learning. On the other hand, such newly developed conceptual frameworks can guide the design of innovative and effective knowledge and learning support media.

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