JISC/NSF
JISC/NSF Digital Libraries in the Classroom Programme

Biannual Progress Report

Reporting Period: 1 September 2004 – 28 February 2005

Project Acronym	DIDET (Distributed Innovative Design, Education and Teamworking)
Project Title	Accelerating Globally Distributed Team Innovation: Building an Experimental Testbed to Leverage Digital Libraries in the Transformation of Design Engineering Education
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Confirmation Statement
I confirm that the project development is being conducted under the terms agreed in the initial contract with NSF and JISC

Section Two

1. Project Outcomes

8.1 Progress against key objectives

The key objectives for the reporting period as stated in the last 6-monthly report were:

- To develop materials to improve student information literacy skills.
- To identifying ways to measure the impact of a shared workspace and repository on the learning of the students. It is hoped that reflective learning opportunities may provide some positive information on this.
- To identify and test practical ways to begin collaborative work with Stanford/Strathclyde students given the constraints of credit ratings and timetables.
- Evaluation for the next academic session will focus on specific issues within identified teaching modules. For example, reflective learning within one module, applying metadata in another.
- To update the "digital library" by identifying and enabling access to digital resources, improving searching and browsing functionality and defining a controlled "search vocabulary".
- To develop a controlled experiment to monitor and evaluate student use of information resources when conducting design tasks and evaluate such use in the 'quality' of the design produced.

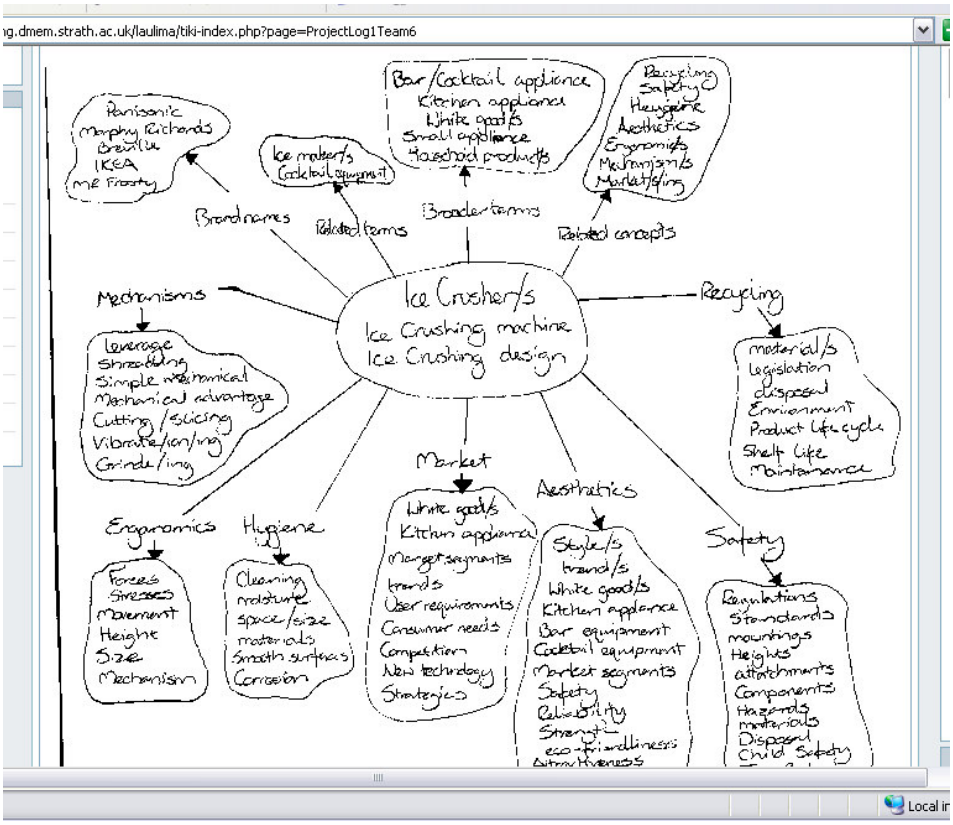
Progress against these objectives are detailed below.

To develop materials to improve student information literacy skills.

Materials were developed to support selected classes in all years. These were used to provide one or two sessions focussed on information literacy and were adapted to reflect the needs of students within each different context. All sessions were all connected to an assessed piece of work and were further supported by individual/or group sessions on request. All classes focussed on the use of concept and/or mind maps (see Figure 2) to support the planning stages of information searching, including identifying search terms, using appropriate sources, modifying searches, evaluating resources, copyright issues and referencing.

For classes that incorporated the use of the LauLima Learning Environment (LLE) to support collaborative team working, the concept maps were also presented as a tool to help teams identify and record their understanding of the design problem, a focus for allocating team roles and activities, and a starting point for identifying ways to organise file folders and information. Reflective project logs were required to find out how far students found the concept mapping useful to support all of these elements (see Figure 3) Students also reported that producing a team map at the beginning of the project served as a useful ice breaker.

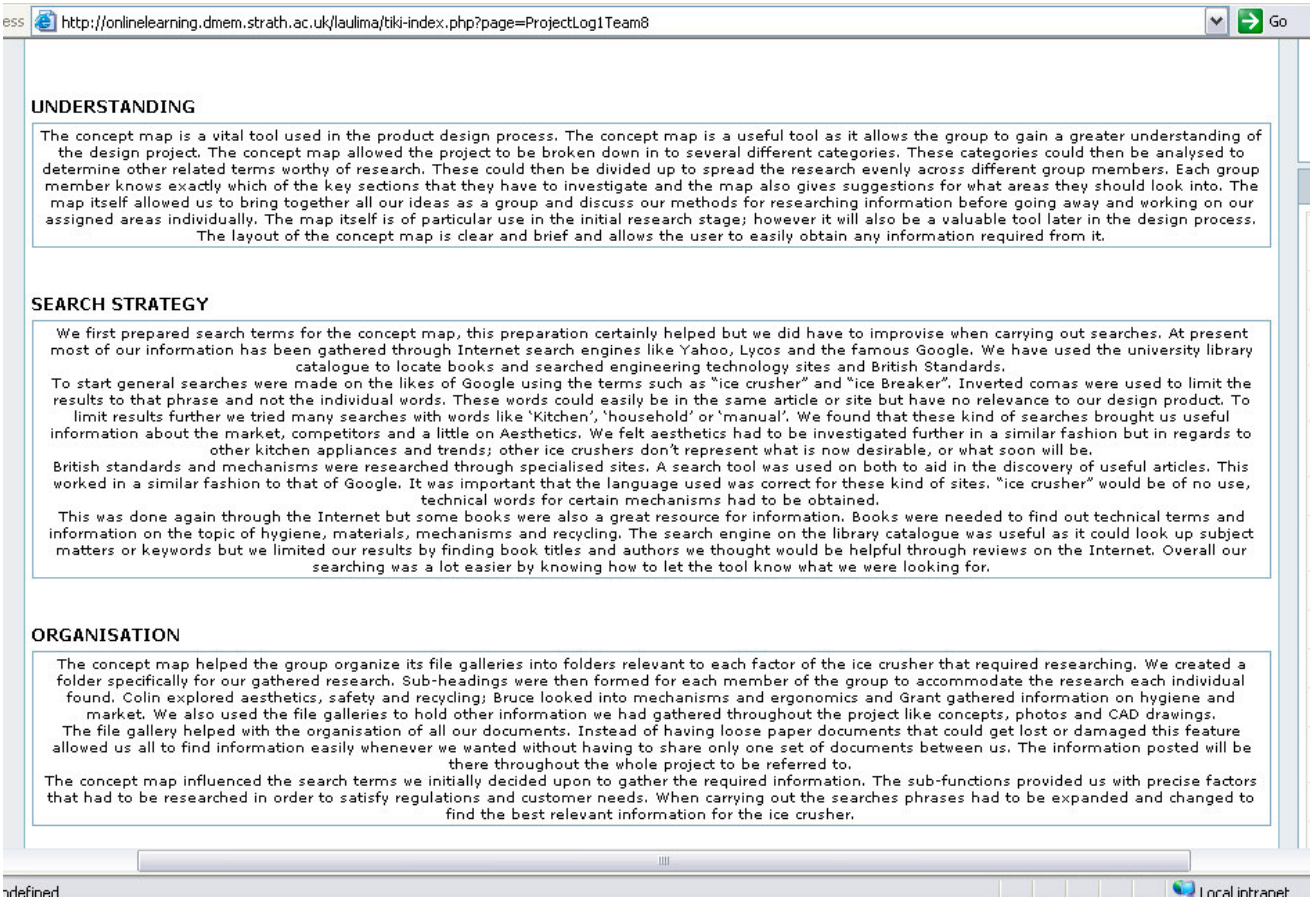
Figure 2: Example of concept map in project log.



In addition to developing and teaching formal classes a librarian was involved on the coaching team to ensure that information literacy support was available throughout the design project. Stanford have recently taken some of the materials used in the classes for adaptation, and have also recognised the value of including a librarian in the coaching team.

This period included a first attempt to integrate information literacy into the core 1st year class *Integrating Studies*. Students were offered an introduction to the library during student induction. Some class materials were adapted during the first semester in preparation for information literacy sessions at the beginning of semester two. Early in semester two students carry out a group assignment which requires significant research into a wide range of resources including books, journals, newspaper articles, legal and official sources. In preparation for the assignment two workshops were provided which included practical exercises, for inclusion in student log books. One of the workshops took place in a computer laboratory where students had a chance to practice with the support of the University Engineering Librarian. Student log books and reports will be examined to see if the support has widened the range of sources used and how well the students have used the resources to support their arguments.

Figure 3: Example of reflective statement about the concept mapping exercise



To identify ways to measure the impact on student learning

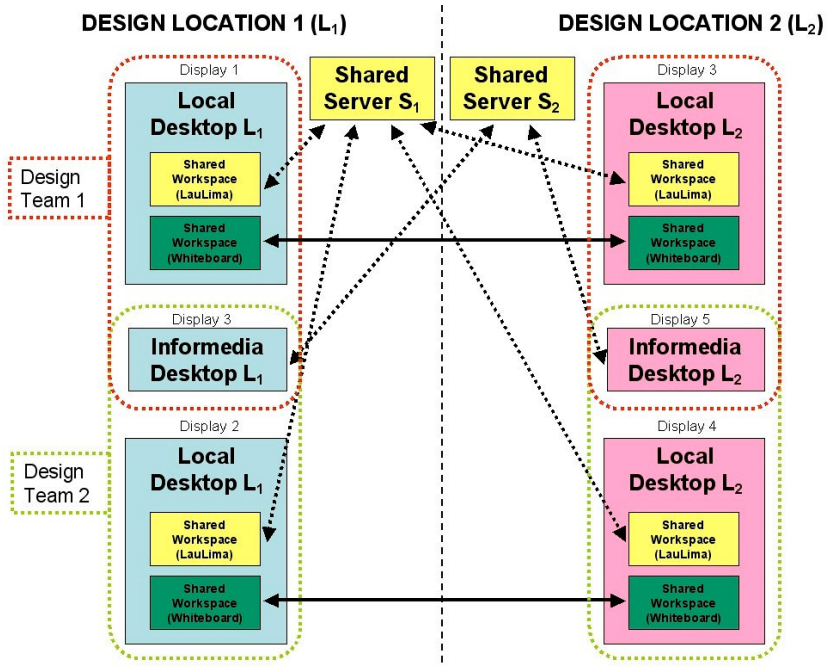
To date the team has identified a number of areas worth investigating in relation to measuring the impact of the shared workspace and the digital repository. These are, reflection (currently being implemented in the classroom); change of behaviour or practice; and, change of attitude. This is discussed further in section 10.

To identify and test practical ways to begin collaborative work

The first collaborative experiment between Stanford and Strathclyde is currently being developed. A highly productive meeting was held at Stanford in January where the team had an opportunity to test the technology to support global collaborative design work. Issues raised included the quality of audio, types of support required from coaches and clarifying the task to be set.

The aim is to provide an immersive design experience in which students search, store and exchange ideas and information digitally. To this end, the students should be presented with a shared workspace which allows them access to Informedia, LauLima (LLE and LDL) and a sketching module while being able to discuss what they are doing using Skype, an Internet telephony program. This will be where they carry out the bulk of their design work. Additional face-to-face communication will take place in the form of a videoconference at the beginning and end of each day of the experiment. A representation of the set-up is shown in Figure 4.

Figure 4: Configuration for Collaborative Experiment



There will be 4 students in 2 design teams, each with 1 in Strathclyde and 1 in Stanford. This ensures a high degree of control and means that all communication takes place in the digital environment. The participants will be students from DMEM (Strathclyde) and Mechanical Engineering (Stanford), recruited for the experiment and compensated ~$50 per participant. One team will have access to the LLE and Informedia resources, the other will not. Both will use the collaborative environment. This will allow us to evaluate the usefulness of the digital resources in the design work. The teams should work independently of each other and therefore it would be desirable to have two separate rooms.

The results of this experiment will inform a joint Collaborative Class with Stanford and Strathclyde students next academic year (2005-2006).

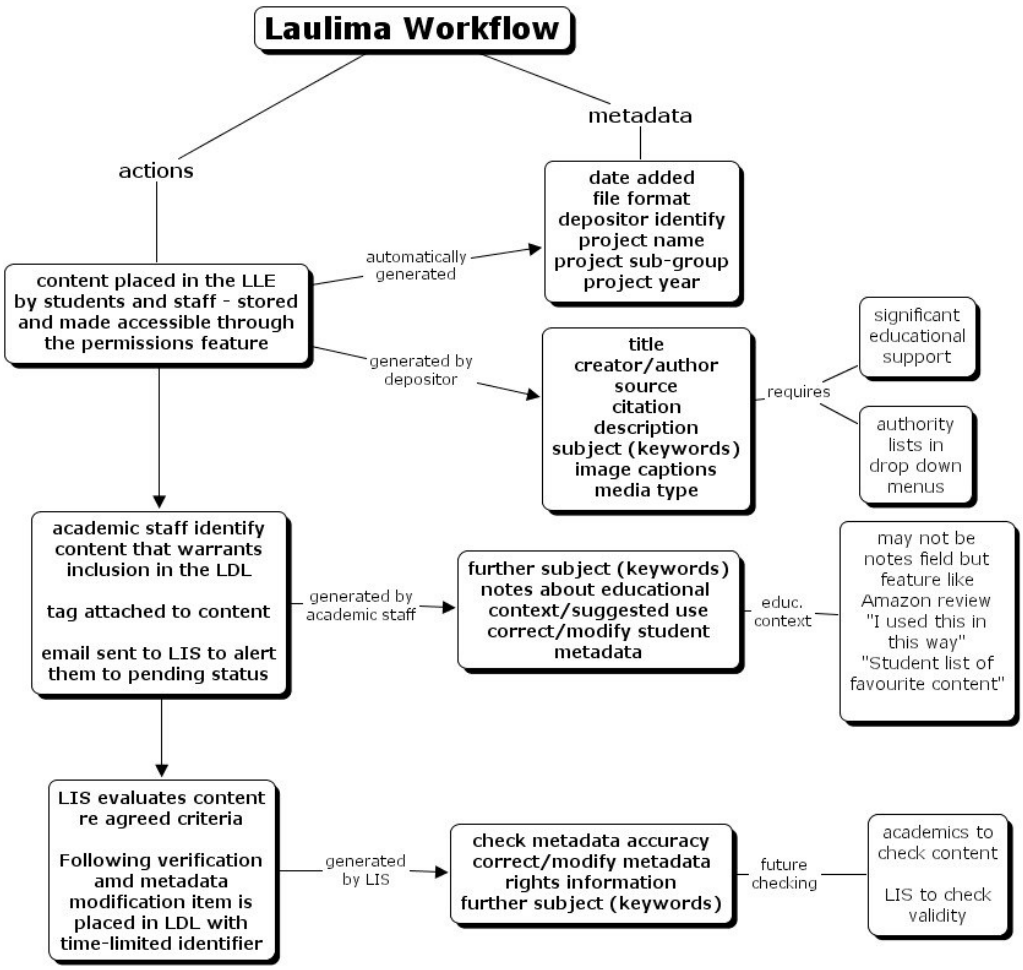
Evaluation will focus on specific issues within identified teaching modules.

See section 10.

To update the "digital library"

A workflow was produced (see Figure 5) to illustrate the movement of information between the informal workspace (LLE) and managed formal repository (LDL). This also included the types of metadata to be included and how this would be applied. The need for a Librarian/Information specialist (LIS) at the final stage was acknowledged in terms of checking legality of content and adding metadata.

Figure 5: Digital Library Workflow



The LauLima Digital Library was further developed and tested using a small amount of content created by students in the TikiWiki environment. The library was demonstrated to the team and final adjustments completed. The INSPEC Thesaurus was selected as the controlled vocabulary, although the Stanford team have produced a small product design thesaurus. Both of these will be used during the next phase of testing to find out which product is most appropriate.

To develop a controlled experiment to monitor and evaluate student use of information resources

The Stanford team conducted a series of explorative experiments in order to understand how two digital library technologies enable design information handling behaviour. The Informedia video processing system[12] was used to index and retrieve design team interactions that have been captured on videotape. Audiovisual data is inherently “richer” than traditional text data. Therefore, video is an effective medium for the capture of tacit knowledge such as design rationale. In conjunction, the SMETE library system[3] was used to index and retrieve design documents since text-based design documents are effective in capturing formal design knowledge such as product representations and specifications.

[1] Wactlar, H.D., Kanade, T., Smith, M.A., Stevens, S.M. "Intelligent Access to Digital Video: Informedia Project," IEEE Computer, 29(5): p. 46-52, 1996.

[2] Wactlar, H.D., Hauptmann, A.G., Christel, M.G., Houghton, R., Olligschlaeger, A.M. "Complementary Video and Audio Analysis for Broadcast News Archives," CACM, 43(2): p. 42-47, 2000.

[3] Dong, A., Agogino, A. M. “Design principles for the information architecture of a SMET education digital library,” proceedings of the 2001 ACM/IEEE Joint Conference on Digital Libraries, Roanoke, VA, June 2001.

As a part of the initial exploration of these technologies, a laboratory experiment was designed and conducted. In the experiment, four teams of two engineers were asked to redesign the wheel of an existing "paper bicycle," which was designed by a student team during the 2003 offering of Mechanical Engineering 310, a graduate level design course at Stanford University. The paper bicycle exercise is a two week long design activity that takes place at the beginning of the course every year.

Subjects were given access to the Informedia and SMETE systems. The Informedia system contained over six hours of video footage of ME 310 teams engaged in paper bicycle design during the past five years. The audiovisual data contained team meetings, prototyping and testing activity, presentations, and lectures on paper bicycle design. All video footage was processed using Informedia's indexing capabilities. The SMETE system contained design documents of eight teams from 2003 (over 400 pages of text and images), including the report produced by the team whose wheel was to be redesigned in the experiment. The eight design documents were indexed at the paragraph level according to a subject taxonomy that was developed in a previous study on the information retrieval and reuse behaviours of mechanical engineers[4] as well as the relevant SMETE metadata fields.

During the experiment, subjects were videotaped, and their interaction with the information systems were documented in detail by digitally capturing the computer desktop environment in real-time. Video interaction analysis was performed on the data with an emphasis on understanding if and how subjects reused design concepts that were communicated in the digital libraries in their own design work. This process was termed, "Design Concept Migration."

8.2 Implications of progress on programme

Issues arising in relation to information literacy, management of the LDL, adherence to legal restrictions and the application of metadata have developed an understanding of the need for LIS support. This had not been accounted for in the original bid and has implications for sustainability of digital library use in design teaching beyond the end of the project.

Issues relating to re-use of resources have begun to emerge as we have examined content previously created by staff and students. One issue currently under consideration is that of granularity. Granularity refers to the number of small resources that comprise a larger resource. LLE contains both the small resources, such as individual files (e.g images, text) and larger resources, such as wiki pages. The wiki pages incorporate individual files in relation to other files, pages or external web sites and may have linking text, all of which provides a specific context. Re-use of these two different types of content by future students and by staff to support teaching are both likely to be valid, but they require a different approach in relation to long term storage. This is currently under investigation.

8.3 General Lessons

The following is a summary list of lessons learnt that could be applicable across all digital library in the classroom projects.

1. Integration of information literacy within the curriculum is highly appropriate for design education as information searching, management and assimilation is an essential part of the design process
2. There is a need for substantial LIS support both in the classroom and for longer term maintenance of the digital repository.
3. To aid student learning in later years it is as important to capture information about the design process as to capture product related information.

[4] Baya, Vinod. Information Handling Behavior of Engineers in Conceptual Design: Three Experiments, Ph.D. Dissertation, Stanford University, California, 1996.

4 If information resources are to be re-used by teaching staff it is important to capture the educational context in which they are used. Adding notes/comments like the feature on the Amazon site might be appropriate.

5 Using and customising software, particularly freeware, is subject to keeping abreast of updates. DIDET has required a skilled and full-time software expert.

8.4 Objectives for Next Reporting Period

During the next six months the project will

- produce learning outcomes for all elements of information literacy and incorporate these within departmental (DMEM) learning outcomes at the appropriate point
- identify which DMEM classes throughout the years would be most appropriate for embedding information literacy
- start to develop a framework outlining the principles, aims and structure of information literacy support throughout all years of a curriculum
- populate the LDL with content from previous classes to test the workflow, produce written procedures and identify the extent of work required by a LIS
- revise, in collaboration with the JISC Legal Information Service, student agreements, rights statements to be included as metadata in relation to rights ownership and conditions of information use/re-use. The revision will also be in the light of lessons learned in the Spoken Word Project with respect to international issues.
- Specify, and begin to implement, version 3 of the DIDET system

2. Intellectual Property Rights

Whilst the international IPR issues are still being investigated, the UK team have encountered several challenges. IPR has not presented any problems in relation to content generated by students during the design process as they are required to sign an agreement transferring property rights to the University. However, externally sourced content, which is equally important in the design process, poses a significant problem, as this content cannot be legally stored in electronic format without obtaining rights clearance. This is not a realistic option for students on time-limited projects. Teaching staff felt that these legal restrictions would have a negative impact on the fluidity of the design process.

We have identified a series of measures to minimise this including the education of students, use of copyright cleared content available in other repositories, and the creation of our own content. Students responded positively to the guidance offered during information literacy sessions. They created links to externally sourced content either in a Word document or on the wiki pages, and provided team members with a description of the content. Although this method is unlikely to be effective as a long-term solution, due to longevity issues of web sites, it added to the extent and breadth of resources used.

We plan to investigate the use of copyright cleared content available in other repositories during the summer and are identifying types of content that we may want to create as an ongoing task. This exercise could be fed back to JISC if gaps exist in what is available for engineering design.

3. Evaluation

Evaluation is an ongoing element of the project (Work Package 12). Results of the evaluation are being published (see Section 13).

Evaluation during this reporting period focused on specific issues within identified teaching modules; e.g. global design team issues in the Manufacturing Operations Management Class, project management and reflection in the Product Development Partnership Class (Strathclyde) and the use of Informedia and SMETE (Stanford). These are detailed below.

Evaluation at Strathclyde

One study examined the use of the shared workspace and digital repository (i.e. the LLE) to support distributed teams of UK (Strathclyde) and US (Iowa) students undertaking a joint class assignment in Manufacturing Operations Management. Evaluation focussed on team communication, sharing of information and resources, and team management. A 'pyramid-style' class evaluation session gathered rich data from students using a questionnaire for individuals followed by group and open-class discussion to extract issues midway through the class and prior to the issuing of the joint class assignment. During this session students reflected on and shared experiences; gave valuable student-generated feedback to others; identified issues relating to the use of the learning environment and repository and generated recommendations to overcome difficulties. Both the mixed teams (UK/US students) and the UK-based teams were in agreement that the most positive aspect was the LLE's ability to allow teams to share information and resources. The UK-based teams tended to report similar benefits to the US teams in this area because these team members also reported difficulties in meeting face-to-face due to timetable clashes. This study highlighted a need to:

- improve co-ordination amongst teaching staff across continents in terms of workflow management, timetabling and local technologies (hardware and software);
- spend more time and effort clarifying task requirements for remote students;
- improve cohesion within the UK-US teams (tendency for members to work as two separate but loosely connected team);
- ensure all members of teams contribute to learning tasks throughout the class and not just for assessed work;
- spend more time at the beginning building trust within distributed teams.

US students also responded to an online survey and the UK students reported feedback on the use of the system as part of the class assignment report. These, and the above findings, will inform both the Joint Strathclyde and Stanford Collaborative Experiment and in session 2005-2006, the Joint Strathclyde and Stanford Collaborative Class.

Another study, in the Product Development Partnership Class, is focussing on the ways in which the LLE supports student management & documentation of design projects and reflection. The class, designed around Cowan's[5] reflective model, encourages students to store and share all project documentation (externally-sourced and student-generated; product-, people- and process-related) in the LLE, reflecting on this to progress project designs. Each team has key milestones to achieve during the project and following these students are also required to complete online reflective learning logs. These take the form of blogs within the LLE. Students reflect-on-action and for-action (Cowan, 1998); listing positive and negative learning experiences and identifying their needs and learning objectives for the next stage of the project. Teaching staff have access to these blogs and can modify class design and support accordingly, within the duration of the project. Initial informal feedback from staff and students on the use of the LLE system within this class indicates:

- that having students record their workflow (including processes) within the LLE helps develop good reflective practice appropriate to the professions;

[5] Cowan, J. 1998, On Becoming an Innovative University Teacher (Reflection-in-Action), The Society for Research into Higher Education & Open University Press Imprint.

- that the blogs are supporting reflection by encouraging students to match current progress to their learning goals and identify gaps and take actions to close these gaps;

- that the blogs are also useful to staff as they highlight areas of student difficulty early on and in time for staff to take corrective action.

This class runs from November to May 2005 and further evaluation (e.g. observation in class, focus groups, questionnaire and monitoring of system logs) is being planned.

Evaluation continues to focus on students' and teaching staff's perceptions and experiences of use of the shared workspace and digital repository in relation to the Design Knowledge Framework – the three-loop learning model[6]. This model provides a tool to explore how technologies might support the design process, the needs of design coaches and resource reuse issues (eg, metadata tagging, intellectual property rights, the management of digital collections). Through close collaboration with teaching staff in the classroom, formative evaluation (e.g. online surveys, reflective project logs, reflective learning blogs, class discussion and informal discussion with staff and students) of the LLE system is integrated into each class and is not only being used to inform LLE development but also to inform class design and meet project learning outcomes. *For example, content of the project logs in the early stages of the Integrating Design Project 2004/05, the ice crusher, showed that following information literacy instruction had improved students' referencing of resources and understanding of the design problem through the use of concept mapping.*

The required skills and conceptual understanding of the design students in relation to their use of the LLE system and digital resources is still being decided through discussions within the DIDET team of teaching staff, educational and learning technologists, software developers and evaluators. Additionally current research literature is informing the team of latest requirements for industry-related projects, e.g. use of online logs; online recording of activities and workflow to allow for reflection, planning and action; structuring and managing of resources in shared workspaces to support distributed design team working.

Evaluation at Stanford

The experiments conducted in order to understand how two digital library technologies enable design information handling behaviour are described in Section 8.1

Initial qualitative and quantitative analysis yielded the following findings:

1. Designers search and learn differently when dealing with text-based information as opposed to video-based information. They prefer to access text-based information when they are interested in retrieving formal knowledge such as specifications. This type of searches can be characterized as deep and narrow. On the other hand, designers prefer to access video-based information when they are interested in retrieving informal knowledge such as design concepts. This type of search can be characterized as shallow and broad and resembles "browsing" more than searching.
2. A video-based documentation paradigm in engineering design projects allows for the automatic capture and indexing of informal design knowledge, which has constituted a major barrier to tacit information reuse. A paradigm shift from text-based documentation to video-based documentation in design projects should be explored.
3. Existing summarization and representation schemes for video data are not effective in conveying a quick "sense of content" to designers seeking information. New visual summarization methods need to be developed.

[6] Eris, O. & Leifer, L. (2003). Facilitating product development knowledge acquisition: interaction between the expert and the team. International Journal of Engineering Education, special issue on the Social Dimensions of Engineering Design Vol. 19, No. 1, p. 142-152, 2003.

In conclusion, these findings strongly suggest that the autonomous learning behavior of design teams would significantly benefit from innovations resulting from the integration of "digital library technologies" into design practice.

Future Plans

The objectives for the next reporting period are:

- Continue evaluation of PDP class session 2004/05
- Carry out and evaluate the Joint Strathclyde and Stanford Collaborative Experiment using DIDET systems (LLE, LDL, Informedia).

4. Impact on the Institution – Wider involvement of academic staff (faculty) not directly involved with the project

Within the Department of Design, Manufacture and Engineering Management (DMEM) the LLE has been adopted for three purposes, outside the DIDET Project:

AsiaLinkPaedia:an encyclopaedia of technology companies in Asia
Used as directory and information exchange tool

Design Special interest Group
Used by a National network group for knowledge management, information exchange and collaborative working

Manufacturing Operations management class
Used for a global collaborative team assignment between DMEM and Iowa State University, USA

LLE has also been used outside DMEM:

ALT/SURF wiki
Established following a research seminar between the Association for Learning Technology, UK and SURF (the Dutch higher education and research partnership organisation for network services and ICT) to facilitate a collaborative writing exercise on digital repositories and e-portfolios

PredictWiki
Used as a knowledge management tool for a distributed group by the Policy Research and Development in ICT for Education group of the University Information and Resources Directorate.

5. Learner Collaboration

A collaborative project is planned in the next reporting period as detailed in Section 8.1 (see Figure 3).

An experiment was also conducted outside DIDET with Iowa State University – see Sections 10 and 11.

6. Dissemination

The project website is live at: http://dmem1.ds.strath.ac.uk/didet/

Publicity
Contributed to article in JISC Inform (7) Autumn 2004 pp 5-7

Demonstrations
Lou McGill. Web people meeting: web developers from Scottish Institutions, December 2004
JISC meeting, Santa Barbara, January 2005. Presented recent developments to other DLIC project teams.

The following papers have been written and published/presented:

1. Eris, O; Mabogunje, A; Leifer, L; Jung, M; Khandelwal, S; Neeley, L; Hutterer, P; Hessling, T; 'Capturing and Reusing Tacit Knowledge via Video: a Paradigm Shift in Engineering Design Documentation' in *Proceedings of the International Conference on Engineering Design*, Melbourne, August 2004.
2. Juster N P; Grierson H; Nicol D; Ion W J; Stone A; Wodehouse A; 'Using digital libraries to enhance distributed design team performance' *Proceedings of ASME Design Engineering Technical Conferences*, Paper Number DETC2004-57600, September 2004, Salt Lake City, Utah, USA.
3. Ion W J; Stone A; Grierson H; Wodehouse A; Juster N; 'A Study of Student Learning in Design Projects', in *Proceedings of the International Engineering and Product Design Education Conference*, Delft, The Netherlands, September 2004.
4. Wodehouse A; Grierson H; Ion W J; Juster N; Lynne A; Stone A L; 'TikiWiki: a tool to support engineering design students in concept generation', in *Proceedings of the International Engineering and Product Design Education Conference*, Delft, The Netherlands, September 2004.
5. Wodehouse A; Grierson H; McGill L; Ion W; Juster N; Stone A; 'Efficacy of a digital repository for retrieval, storage and use of technical information in a student product development project' in *Proceedings of the Advanced Engineering Design Conference*, Glasgow, September 2004
6. Grierson, H.J. The DIDET project, *ALT-Conference Blue skies and pragmatism- learning technologies*, September 2004.
7. Hutterer, P.; Eris, O.; Jung, M.; Leifer, L.; Lindemann, U.; Mabogunje, A.: What do Designers really need? - An Explorative Experiment before Developing Teaching Tools and Methods. In: Kinshuk; Sampson, D. G.; Isaías, P.: Cognition and Exploratory Learning in Digital Age CELDA 2004, Lisbon (Portugal), 15.-17.12.2004. Lisbon: IADIS Press 2004, S.419-422.
8. Nicol, D, J. & MacLeod, I, A. (2004). Using a Shared Workspace and Wireless Laptops to Improve Collaborative Project Learning in an Engineering Design Class, *Computers & Education*, 44(4), 459-475.
9. Nicol, D.J., Littlejohn, A. & Grierson, H. (2005). The importance of structuring information and resources within shared workspaces during collaborative design learning. *Open Learning*, 20(1), 31-49

The following papers have been accepted and are awaiting publication/presentation

1. Eris, O; Mabogunje, A; Leifer, L; Jung, M; Khandelwal, S; Neeley, L; Hutterer, P; Hessling, T; 'Capturing and Reusing Tacit Knowledge via Video: a Paradigm Shift in Engineering Design Documentation' in *Proceedings of the International Conference on Engineering Design*, Melbourne, August 2005.

2. McGill, L. & Littlejohn, A. Using knowledge structures to enhance reflective practice *Reflective learning, future thinking: ALT Spring conference and research seminar* March 2005

3. MacGregor, G. & McGill, L. Digital Libraries and Information Literacy Issues within Virtual Learning Environments: An e-Learning Impasse? *LILAC 2005: Librarians' Information Literacy Annual Conference*. April 2005

4. McGill, L., Durkin, C & Littlejohn, A. Not just the usual suspects: a strategic approach to developing literacies for learning in the higher education community. *Elit 2005: eLiteracy and eLearning 4th International Conference on eLiteracy,* June 2005

5. Wodehouse, A. The Implementation of Digital Libraries in a Design Engineering Project. *15th International Conference on Engineering Design (ICED 05)*, Australia August 2005

6. McDonald, D. & McGill, L. The Emergence of eLiteracy: enhancing our understanding. *Elit 2005: eLiteracy and eLearning 4th International Conference on eLiteracy,* June 2005

7. Grierson, H., Wodehouse, A., Ion, W.J., Juster, N., Student use of digital resources in the engineering design process, *3rd Engineering and Product Design Education International Conference*, Edinburgh, September 2005

The following paper is under review:

1. McGill, L. , Nicol, D.J., Littlejohn, A., Grierson, H.J., Juster, N and Ion, W.J. Creating an information rich learning environment to enhance design student learning: challenges and approaches. *British Journal of Educational Technology: special issue on Innovation in e-Learning: Lessons to be Learned*, July 2005

Plans are to continue publishing findings at conferences and in journal articles in each of the key areas of design education, educational technology, information literacy, digital libraries, and systems development. In particular the project aims to produce at least two good journal papers a year.