Johnson, J. & Tang, M. (2005). Integration of e-management, e-development and e-learning technologies for blended course delivery. *AACE Journal, 13*(2), 185-199.

Integration of e-Management, e-Development and e-Learning Technologies for Blended Course Delivery

LYNN JOHNSON AND MICHAEL TANG
University of Colorado at Denver
Denver, CO USA
Lynn.Johnson@cudenver.edu
Michael.Tang@cudenver.edu

*** Invited paper from E-Learn 2003 ***

This article describes and assesses a preengineering curriculum development project called Foundations of Engineering, Science, and Technology (FEST). FEST integrates web-based technologies into an inter-connected system to enable delivery of a blended program at multiple institutions. Tools and systems described include (a) technologies to deliver courses in a blended mode; (b) application of a learning management system to act as a content management system; (c) application of the same system to facilitate collaborative course development; (d) developing a Collaborative e-Learning Library System (CELLS) web site to serve as a learning objects archive; and (e) developing a mobile multimedia studio to produce learning objects. The article is divided into three sections devoted to (a) the e-Management of an educational project; (b) the e-Development of learning objects; and (c) e-Learning as it applies to enhancing, storage, and delivery of blended courses. It concludes with an assessment of the successes and the complexities of using these technologies in the described project. These complexities include using various software applications for varied purposes and unforeseen human factors that contributed to participant resistance to the new technologies.

The overall goal of the Foundations of Engineering, Science, and Technology (FEST) project is to increase the number of and enhance the quality of engineering graduates in the state of Colorado to meet the demands of an increasingly technological society. This article is a description and assessment of FEST project participants' use of diverse web-based technologies in a multi-purpose manner to develop, manage, and deliver preengineering courses in a blended mode (i.e., partly on-campus and online as the situation permits). Integration of these technologies into a coherent process enhanced potentials for learning, instructor collaboration, and multi-institutional project management.

The FEST project involves collaboration among faculty and administrators from several institutions, including the CU at Denver College of Engineering and Department of Mathematics, the Arapahoe and Red Rocks Community Colleges. These are the entities that develop and deliver preengineering courses preparatory to a four-year engineering degree. Engineers from the American Council of Engineering Companies provide guidance on applications of science and math principles in real world design projects. The courses include the basic science, mathematics, information technology, and introductory engineering mechanics courses (Figure 1). The FEST Certificate Program is being developed to allow flexibility of course offerings so that students can complete preengineering requirements with assurance of quality and transferability to a four-year engineering program.

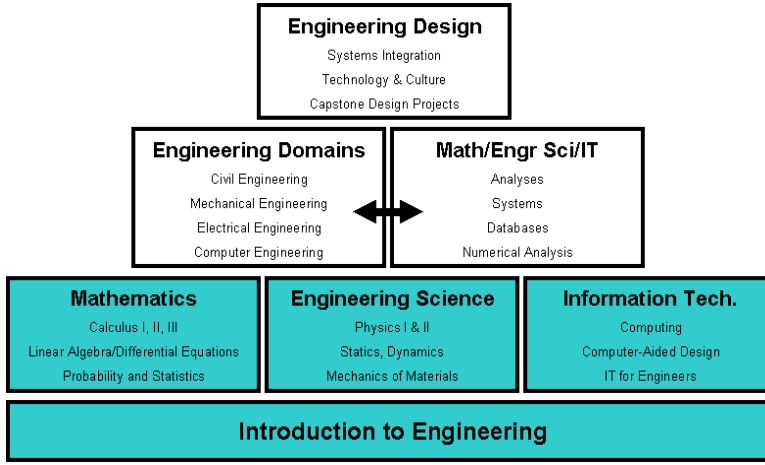

Figure 1. The FEST Program addresses the foundation courses of the preengineering curriculum, including mathematics, engineering science, and information technology, and an Introduction to Engineering course

An important aspect of the FEST Program is the development of Interdisciplinary Lively Application Projects (ILAPs). First developed through the National Science Foundation (NSF) Project Intermath (http://www.projectintermath.org/), ILAPs are carefully designed, real-world, interdisciplinary projects used to motivate students and to reinforce fundamental concepts. For FEST, ILAPs were developed jointly by a mathematics instructor and a partner instructor from another discipline (engineering, physics), and are presented to the class in a discovery-oriented manner. For the FEST Program ILAPs are being developed for other fundamentals courses, as well as for the math courses, combining concepts from a variety of disciplines to help review and reinforce fundamental concepts. From the student's perspective, ILAPs motivate the need to develop mathematical concepts and skills, provide interest in future subjects that become accessible through further study and mastery of mathematics, and enable a broader, more interdisciplinary outlook at an earlier stage of development. From a faculty perspective, ILAPs are valuable tools to accomplish a variety of course goals.

Tools and systems described include web-based technologies to help manage a project comprised of distant partners with disparate e-Learning environments. Other technological dimensions included application of a learning management system to act as: (a) a content management system and (b) a course development system for inter-institutional faculty who operate in the disparate computing environments. Also described are dissemination strategies using web-based technologies as they apply to producing content for the interdisciplinary preengineering curriculum.

The article includes a discussion of the academic objectives of using these new technologies and concludes with a discussion on the successes and challenges of the FEST systems approach to the management, course development, and delivery of preengineering courses to inter-institutional students in the State of Colorado.

E-MANAGEMENT, E-DEVELOPMENT AND E-LEARNING

Electronic Content Management (e-Management)

Development of an organizational e-learning strategy. The implementation and management of the FEST program required an innovative e-Learning strategy and e-Management strategy because the project consisted of diverse

higher education entities, each with its own method of managing, developing, and delivering online courses, scattered through the Denver Metropolitan area. For example, the Colorado Community Colleges use WebCT ©, Blackboard©, or eCollege© learning management software. Faculty at the University of Colorado at Denver use Blackboard© for blended delivery and eCollege for online courses delivered completely at a distance.

Faced with these difficulties—distance and disparity among e-Learning environments—FEST participants needed to devise new methods of project management and faculty collaboration; these included: (a) web-based project management, (b) inter-institutional collaborative course development, and (c) a collaborative e-learning library system.

Inter-institutional web-based project management system. During Phase I, we modified a learning management system (LMS) to serve as a project management system. Faculty and staff used the modified Blackboard© platform to help manage the FEST multi-participant project within the university and at distance to facilitate:

- work flow management;
- inter-institutional communications, including list serve e-mail;
- white paper and other document distribution and collaboration;
- discussion board for FEST program topics;
- distance conferencing for workshops and staff meetings; and
- tracking and coordination of FEST courses.

Other uses included online:

- project announcements;
- project assignments;
- calendar;
- paper work, such as reports, scope of work descriptions, and so forth; and
- group management for committee work.

Use of the LMS for project management was straight forward in application. All of the (approximately) 30 faculty and administrative staff participants were established as Instructors in the FEST Project site and provided initial default login privileges. This allowed a natural accommodation to the various participant roles. After initial login, each participant provided their Profile, including personal information and their e-mail. Announcements on scheduled workshops and other events could be posted by those responsible for organizing the events. E-mail reminders could be broadcast to the entire group, or to individuals as desired. Project management documents were posted to the site to allow all participants to review the original proposal, work plan and progress reports. Threaded discussions were conducted to address workshop planning and other topics.

Electronic Content Development (e-Development)

Inter-institutional collaborative course development system. Because FEST is an inter-institutional and interdisciplinary project, we needed to deal with the challenge of course development involving faculty at distant locations. Part of the solution was using a learning management system (LMS) as a collaborative course development system. This included using:

- learning management functions for course development sub-functions;
- threaded discussions for brainstorming course development ideas and issues;
- digital drop boxes for document sharing and collaborative writing and editing; and
- group functions to facilitate at-distance online course development teams.

Other course development functions are similar to project management functions already described:

- announcements;
- assignment of project tasks;

- calendar; and
- distance conferencing for workshops and staff meetings.

Teams of faculty collaborating on ILAPs and other course materials development were established as Groups, but these restricted access domains were not used very much. It ended up that the Project Documents site was used for each collaboration area, and all participants had open access to each others documents. The documents included various text files (e.g., syllabi, ILAPs, homework problems, etc.), presentations (e.g., PowerPoint), and audio and video recordings. These materials are termed Learning Objects which can be shared and used by participating faculty in their course developments and deliveries. The Discussion Board was used extensively for follow-up dialogues on techniques for online course development and delivery, intellectual property issues, and other topics. Overall, the FEST Course Development application was well received by participating faculty who endorsed the collaborative usage as way to improve their courses. A significant aspect of adoption of a particular ILAP, for example, seemed to be participation as an author, and the interdisciplinary structure of the authoring teams enhanced this process.

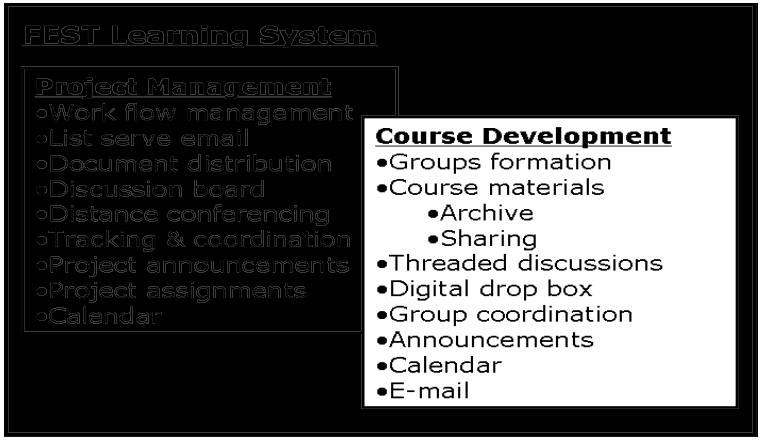

Figure 2. The FEST learning system was developed using Blackboard© as a project management system and a collaborative course development system

Development of a mobile multi-media blended course development studio. During Phase II of the FEST project we expanded and continued to translate contents and processes of FEST courses for blended (online and

in-class) delivery. To enhance the courses, a multi-media production and learning laboratory is important. FEST faculty will use this laboratory for ILAPs and recitations and for the development and production of interactive course materials.

There are two versions of the Learning Laboratory (a) a fixed studio-type facility, and (b) a mobile unit to capture materials in classrooms and laboratories. These facilities speed up learning objects development for delivery and storage. A primary criterion was that faculty should not have to drastically change their preferred mode of delivery; the capture technology should fit their style. The classroom studio is equipped with digital video recording equipment for use with computer projector and documents. The mobile studio is a Tegrity© WebLearner multi-media production unit purchased by the FEST program and the University's CU-Online program. It is based on a MS PowerPoint format with options to portray and capture other software media interactions. The multi-media capture units are designed to facilitate**:**

- on-demand and live delivery;
- easy switching between PowerPoint, close-up video, snapshots and screen recording;
- teaching naturally by interacting with learning content on whiteboards or LCD tablets; and
- anytime, anywhere instruction from classroom to office or home.

Our experience with the learning laboratories is that the flexible, easy to use equipment is quickly adopted by participating faculty with a modicum of training. And student assessments endorse the availability of course materials in multiple formats. One hindrance to the Tegrity© unit was the PowerPoint format; it required conversion of lecture materials by those who do not normally use that format. We are experimenting with direct digital video recording which provides adequate quality but requires a technical teaching assistant (TTA) to run and process for web streaming. Online examples of learning objects developed through the FEST mobile learning studio are viewable for the calculus courses (http://bb3.cudenver.edu/Tegrity/Default.asp?folder=%5CRoxByrne). And a culture and technology course (http://bb3.cudenver.edu/Tegrity/Default.asp?folder=%5C037%5Cce5384).

Electronic Learning and Delivery (e-Learning)

Development of FEST blended courses. Blended courses are courses that combine regular teaching with online teaching delivery (Barnfield, 2000). Courses taught through this format can broadcast recitations and lectures synchronously and asynchronously while other parts of the course are delivered asynchronously online. Such courses are to be supported by an online tutoring with live and asynchronous interaction with graduate teaching assistants. FEST calculus courses are already delivering these components and the FEST technology and culture course has adopted several of these techniques.

Blended courses have the further advantage of facilitating team teaching and the sharing of learning objects. For example, in the case of team teaching, faculty from the same or different institution could teach a course with one or both instructors teaching at a distance synchronously or asynchronously. A University of Colorado course in blended mode could be cross-listed with a similar community college course with a university instructor teaching the course in the regular classroom and a community college professor teaching the same course online. The two instructors could mix and match different course modules and switch roles. For certain parts of the course/s the university instructor could teach online and the community college professor, the regular class.

Moreover, blended courses can be monitored and evaluated at a distance through the learning management system that delivers the online components of the course. By defining the administrator as a co-instructor in the learning management system that delivers a course, the administrator will have access to the course with management control privileges before, during and after the semester the course is offered. In short, blended courses facilitate:

- support for faculty in the delivery of high quality courses;
- sharing of course materials and learning objects;
- sharing of faculty workload;
- development of learning communities among students, faculty, and support staff;

- online tutoring for students;
- student assessment and feedback; and
- FEST program management and monitoring.

The advantages that blended courses bring to learning may enhance project management, learning management, and higher institutional learning itself. Our experience is that once students become familiar with online courseware they become advocates for its use. A traditional lecture course is enhanced by the use of online tools; a result evidenced by student assessments. For example, student assessments of on-campus graduate lecture courses which transitioned to the use of online courseware and multi-media appeared to show an increase in scores as the use of online tools increased over a period of five years (B to B+). Online students taking these same courses also seemed to assign higher ratings over time (C+ to B). Comparison of on-campus and online course ratings indicated that the on-campus courses received higher ratings overall (B+ versus B). These results are very tentative and may be due to a variety of factors such as instructor skill development as well as the richness of course materials.

Development of a collaborative e-Learning library system (CELLS). Once faculty developed their courses and learning objects for blended delivery, we created a library to store these leaning objects for continued and shared usage. CELLs is an electronic learning objectives archive where course materials, or learning objects, can be archived and shared by program participants. Participating faculty will use the archive to mix and match contents to deliver FEST courses in a consistent and quality controlled manner. The current instance of the CELLS is located at http://thunder1.cudenver.edu/FEST/home/.

The FEST CELLS is a content management system built from scratch to mimic systems such as the National Science Digital Library (NSDL) Communication Portal (NSDLP, 2002). Such systems allow users and developers to develop and share materials through online collaborative and information dissemination. The collaborative area includes public workspaces for sharing information, discussing management and educational issues, and supporting team building. Similar to the NSDL system, the FEST CELLS will accommodate heterogeneous participants, content, and technologies through a spectrum of interoperability that provides diverse and broad entry into the different components of the system. Eventually, we hope to

develop the CELLS in XML format to allow posting and retrieval of FEST teaching materials and other documents in multiple formats (Marchal, 2002).

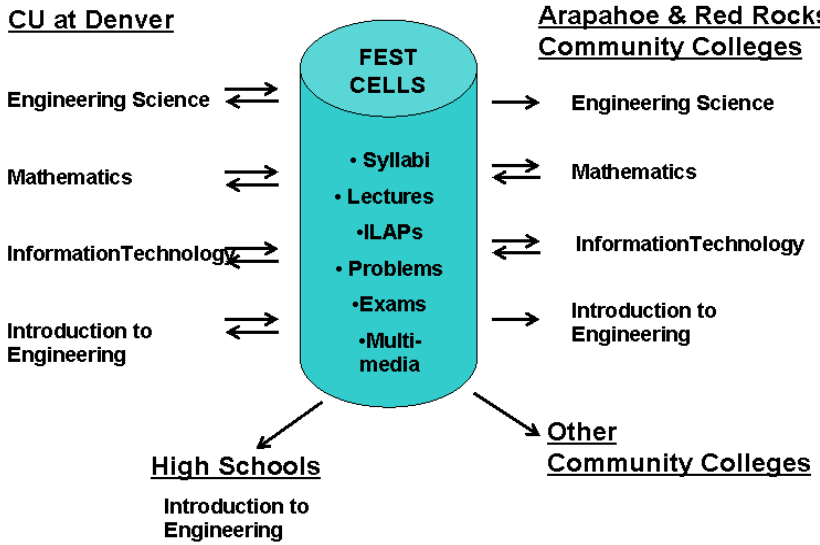

Figure 3. FEST CELLS provides a means for sharing of learning objects by participating faculty who can access and incorporate multi-media materials into their own courses

Enhancing FEST academic goals through technology. By implementing these new technologies into the FEST project we hope to achieve the following academic objectives defined by several proponents of e-Learning (Shank, 1997; Shank & Jona, 1999; Bransford, Brown, & Cocking, 2000) and others who have researched the effective use of new technologies in education:

- Bring real-world problems into classrooms through the use of videos, demonstrations, simulations, and Internet connections through learning objects developed in the FEST multi-media studio, stored in the CELLS eLibrary, and delivered in a blended course format. (Bransford et al., 2000, pp. 62-64, 124-125)

- Increase learning effectiveness through online tutors, teachers, and peers through blended courses that include web-based functions that

provide effective and efficient feedback, student centered self-modifying learning exercises, and effective communication on a high abstract level. (Bransford et al., pp. 204-212)

- Build local and global communities of teachers, administrators, students, and others interested in learning by developing an inter-institutional administrative strategy and management system. This system provides academic cooperation, process definition, and logistic collaboration among program partners. (Bransford et al., pp. 195-196, 212-214); and

- Create an online environment that facilitates extensive collection of data and research collaboration among FEST participants. (Bransford et al., pp. 127-132, 184-185, xxxiii, 239-230; Johnson & Tang, 2003; Tang & Johnson , 1999)

LESSONS LEARNED

A systems integration of e-Learning technologies for the University of Colorado at Denver's Foundations of Engineering, Science, and Technology (FEST) project reveals that learning management systems can be used for purposes other than delivering online courses. We developed these systems on an *ad hoc* basis with some initial success. At the same time, this initial success brought with it several lessons learned. First, advancing technological integration is a people as well as a technical challenge. The difficulty in getting some faculty to use new technologies to develop courses and learning objects exemplifies this challenge. Research on obstacles for adoption of new technology is relevant here. For example, Nedovic-Budic (1998) described how human factors such as fear of change, computer-related anxiety, and possible interpersonal conflicts prevent organizations from readily adopting new technologies. We also found that content ownership issues need clarification as faculty are reluctant to post their learning objects for shared use until copyright issues are clarified.

Some of the barriers may be overcome with organizational factors such as political and technical support, and time release for FEST faculty. In addition, we propose to seek to identify personal rewards for participation, provide opportunities for exposure and training, and assign technical

assistants to help instructors with our mobile multi-media learning studio. In the future technical teaching assistants (TTAs) may be as valuable as teaching assistants in the new e-Learning environment.

In the area of electronic content management, we discovered that using a modified proprietary learning management system such as Blackboard© for purposes other than course delivery had its successes as well as difficulties. The first and most obvious difficulty was proprietary systems such as Blackboard© are platform specific and only available to clients who have a license to use the systems. Consequently, to create a more universal and portable system to store and retrieve learning objects and other material, we had to develop and use a regular web site to house the e-Library. This web site, however, lacks the multiple functions of modified proprietary course management systems. Moreover, it is not directly integrated with the project management system. The main problem with the FEST *ad hoc* system can be summarized as follows: "too many different software applications for too many purposes."

One proposed solution to the challenge of using too many *ad hoc* applications would be to integrate all of the FEST Program's systems into one content management system. This single system could be used to deliver FEST courses, manage workflow, author, publish, and store e-Learning materials.

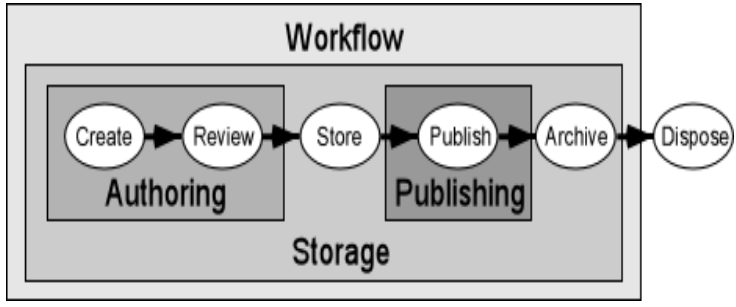

Figure 4. An ideal content management system will have these functions (from Browning & Lowndes, 2001)

The benefits of implementing such an integrated content management system, according to Browning and Lowndes (2001), included:

- engender the re-use of information by allowing the ready integration of data from diverse sources;
- permit the efficient re-purposing of information;
- allow information maintenance to become devolved but at the same time preserving central control;
- ensure presentational consistency by separating the design of Web pages from the content they display;
- de-skill the task of putting information on the Web;
- facilitate good information management practice so that appropriate metadata are captured at the time of content creation or modification; and
- permit some past state of the content management system to be re-created or restored.

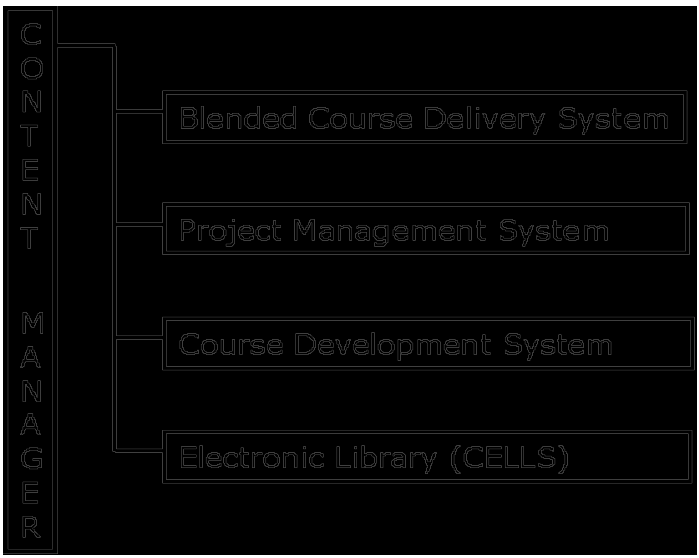

Figure 5. In a content management system, each "folder" is a subsystem connected to a lower system (root) which has higher administrative rights over the subsystems. (Browning & Lowndes, 2001)

Integrating the present *ad hoc* FEST system into one content management system may be the next stage in the use of new technologies to help the FEST project achieve its objectives more efficiently and effectively. In such an integrated system, workflow functions become management and course development functions; authoring and publishing functions become learning management functions; and storage and retrieval functions become e-Library functions. Such a system, however, still would not solve the human factor barriers we encountered in integrating new technologies into the FEST project. An alternate design may be one in which faculty authors maintain their learning objects in their own archive (or have control over their portion of a centralized archive). Then, a process of petitioning to these authors for access to share materials could be adopted.

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Acknowledgements

The FEST Project was supported through funding by the Colorado Institute of Technology (http://www.coloradoit.org/). We also want to thank our partner institutional representatives, Patrick Enright of Arapahoe Community College and Colleen Jorgenson of Red Rocks Community College. We also acknowledge the valuable contributions and changes made by the participating faculty.