The Instructional Software Development Center (ISDC) at the University of Missouri-Rolla

Robert L. Davis [1], Ralph E. Flori [2], David B. Oglesby [3], Timothy A. Philpot [4]

[1]*Director, ISDC, University of Missouri-Rolla, Rolla, Missouri, USA, http://www.umr.edu/~isdc*
Tel:(573)341-4922; Fax:(573)341-6593; rdavis@umr.edu
[2]*Research Associate, ISDC, University of Missouri-Rolla, Rolla, Missouri, USA, http://www.umr.edu/~reflori*
Tel:(573)341-4588; Fax:(573)341-6593; reflori@umr.edu
[3]*Research Associate, ISDC, University of Missouri-Rolla, Rolla, Missouri, USA, http://www.umr.edu/~beststat*
Tel:(573)341-4598; Fax:(573)341-6593; doglesby@umr.edu
[4]*Research Associate, ISDC, University of Missouri-Rolla, Rolla, Missouri, USA, http://www.umr.edu/~philpott*
Tel:(573)341-4285; Fax:(573)341-6593; philpott@umr.edu

Abstract: This paper describes the history, rationale, and role of the Instructional Software Development Center (ISDC) at the University of Missouri-Rolla. A unique feature of this center is that a number of its research associates are engineering faculty members who have, by experience, gained expertise in software development. Non-engineering faculty are now associated with the center as well and contribute valuable expertise. A software development center such as this provides much needed expertise to educational software development efforts that individual faculty/student teams working alone simply do not have. This paper discusses some of these areas in which the center gives assistance to these projects. This paper also briefly describes some of the main projects of the ISDC, many of which are engineering projects.

Keywords: software engineering, computer-based learning, distance learning.

1. Introduction

This paper describes the Instructional Software Development Center (ISDC) at the University of Missouri-Rolla (UMR). Its mission is to serve the UMR campus community by encouraging development of instructional software, recruiting faculty who are interested in this activity, and providing them training, software engineering, and student programmers to support their efforts. Quite different from educational software development centers on other campuses housed in education or instructional design departments, a unique feature of UMR's ISDC is its strong connection to engineering mechanics faculty. The ISDC is based in UMR's Basic Engineering department and its founding faculty members were largely engineering mechanics faculty who teach statics, dynamics, and mechanics of materials. The faculty base has now expanded to include faculty from Psychology, Economics, Engineering Management, Geological Engineering, Civil Engineering, Nuclear Engineering, and other UMR departments. Its funding, now coming from campus-wide (non-engineering) sources, also demands that its services extend to all academic departments at UM-Rolla.

2. History

The person mainly responsible for the inception of UMR's Instructional Software Development Center (ISDC) was Dr. Robert L. Davis. Davis, a long time dean (from 1979-1994) of UMR's School of Engineering was one of the original Consulting Scholars for IBM's Academic Computing Information Systems division. His passion for student learning and success and his interest in the potential of instructional technologies to enhance this led him to sponsor several projects in seed form while still dean. Several of these projects were conducted by engineering mechanics faculty in the UM-Rolla Basic Engineering department, with the support of their chair, Dr. D. Ron Fannin. A success from this early support was the BEST (Basic Engineering Software for Teaching) Dynamics project, produced by a faculty/student team led by Dr. Ralph E. Flori. This project gained additional funding from the University of Missouri's Institute for Instructional Development and also from NSF. BEST Dynamics was licensed by John Wiley Publishers and bundled with the Riley-Sturges Dynamics textbook. A second venture, BEST Statics, led by Dr. David B. Oglesby (who had been a key player in the quality and success of BEST Dynamics) also quickly gained stature by receiving funding from the University of Missouri's Institute for Instructional Development. From these early projects we learned that student learning, particularly of difficult-to-visualize topics, was improved, and that students, when required, enjoyed using the software. We also learned

lessons about the potential and pitfalls of software development. All of these lessons led to the formation, in 1998, of University of Missouri-Rolla's Instructional Software Development Center (ISDC). Dr. Robert L. Davis, by then a faculty member in basic engineering, serves as the director. The ISDC, though housed in the basic engineering department, now is a campus-funded center and serves the entire campus. Faculty from a variety of departments now serve as research associates. Dr. Richard Hall, a psychology professor who is an expert in web interface design, and Dr. Ken Ragsdell, an engineering management professor who is very active in developing on-line courses to teach Taguchi design principles and Total Quality Management, are two examples. Two full time software engineers—John Petrikovitsch and Ed Feltrop—provide a continuing influence of software expertise so that lessons learned from some projects are shared with others.

3. Rationale

3.1 Potential

The power and potential of instructional technologies to improve teaching and learning is compelling to all thoughtful observers, and early reports from pioneering efforts are positive. The potential is too obvious to ignore and too compelling to sit aside and do nothing. Increasingly, it seems everyone everywhere—including private enterprise—is developing instructional media, and many educators feel that doing nothing will suffer an institution the ignominy of ignorance, missed opportunities, and erosion of market share.

3.2 Opportunities Remain

Though it seems at times that others are far ahead in instructional technologies, there remain many opportunities to make positive contributions. Most of the well-publicized efforts are still experimental and remain relatively one-dimensional. They lack either coverage of an entire course of study, or they lack many quality features that a truly robust learning environment should contain.

3.3 Many Degrees of Freedom

Though opportunities remain, there are many concomitant frustrations as well. The target for instructional media is not yet clearly formed. The exact look, shape, feel, components, and features of the media, plus the software platforms for delivering this educational content, are not standardized. Many choices must be made. These many choices, or degrees of freedom, lead to potential frustration. Virtually as soon as a delivery vehicle is chosen, and certainly as soon as expertise is gained in its use, an educational media project may become obsolete in some dimension.

3.4 Limitations of Isolated Faculty/Student Teams

Many educational software projects of the past ten years or so were the work of an isolated faculty member and a grad or undergraduate student or two. They developed the software delivery portion *and* the educational content. Because these tasks are both huge, and because their teams and resources were small, usually the content was not comprehensive, only focusing on a few selected topics. The delivery system was basic as well. Typically the student(s) developed the software, and the faculty member created the content. When the graduate students graduated, however, their software expertise was lost. Faculty depression at that point was not uncommon because a significant portion of the project's funding and time was spent on the student(s) learning how to develop the software and then developing it. Few of these projects carried on successfully to later generations of grad students. Exacerbating the problem in the past decade was the rapid evolution in computer capabilities, operating systems, and authoring software. Systems developed and expertise gained with one authoring package became obsolete as new software and systems evolved.

4. The Two Missions of the Software Development Center

The ISDC has a general mission to the entire UM-Rolla campus, and it also has a specific mission aiding ongoing software development efforts. Its general mission to the campus includes the following:

- Recruit faculty and new projects, especially for high enrollment classes.
- Recruit soon-to-retire master teachers of engineering or other core classes, give them support, and encouraging them to preserve their expertise in an instructional software package that other instructors can build upon and use to aid future students.
- Promote a vision for the potential of instructional technologies for improving learning.

- Cultivate better understanding of teaching and learning in general, to all constituents – seasoned faculty, new faculty, and graduate students.
- Provide seminars showcasing cutting-edge technologies and ideas to provide vision and creative energy.
- Provide intensive software training workshops, ranging from one day to one week, to ensure center faculty, staff, and students are up-to-date with the latest software packages and requisite skills.
- Improve continuously ISDC products by software engineers working continuously to refine the standard software elements shared by multiple educational software projects.

The ISDC's mission to aid ongoing software development projects includes the following functions:

- Help faculty project directors to secure external funding or to identify campus match for external grants.
- Assist in building faculty/student content expert teams.
- Provide instructional and graphic design assistance.
- Provide project management consultation/services upon request.
- Provide software engineering and software delivery system support.
- Recruit and train student programmers to assist on projects.
- Give educational assessment expertise and consultation.

5. Details of Project Services Supplied by the Software Development Center

Developing, using, and evaluating educational software requires considerable expertise. An important mission of the ISDC is to provide ongoing expertise, a cadre of experienced, trained experts who can provide assistance in the following areas.

5.1 Content Development

The faculty/student teams are best qualified (indeed, they are the only ones qualified) to develop the educational content of the software. The educational content to be developed depends on the scope and aims of the project. Typically this involves instructional objectives, basic theory (like a teacher's lectures, not as thorough as a book), example problems, simulations, conceptual quizzes (with answers), and homework problems (with answers). It also includes some combination of media such as pictures, video demonstrations, audio/video mini-lectures, or other. Developing and collecting all of this content is nearly on the scale of preparing a textbook, if the aim is to develop an entire course.

5.2 Interface (Design for Usability)

This is particularly a function of the software delivery system. ISDC staff have developed both CD-ROM and web-based architectures which are easy and clear for the learner to use. The interface and navigation should be intuitive; a student should not have to continuously think about how to navigate. A learner should never feel lost; the interface should give some indication of where the learner is and how to return to the main portion of the system. The interface should give the student some overview of the structure of the system and of the relationships between the educational elements. The learner should be able to easily see how each part fits into the whole overall structure. The system must be responsive; a student must not have to continually wait on the system. Downloads from the web must be reasonably quick, or media elements must be offered via CD-ROM as an alternative. A system that is not easy to use and responsive will frustrate the learner.

5.3 Design for Learning

Learning, not teaching , should be the aim of every educational software project. To achieve this, every development activity must focus on learning outcomes. All of the educational content is chosen, prepared, ordered, and presented in a way to make learning accessible to targeted learners. The educational elements also should promote learner acquisition of higher order learning. The interface should facilitate learners understanding the structure of the knowledge, that is, the relationships between topics. The software should contain built-in assessment methods – quizzes, problems, other activities – whose results inform both the learner (and give direct, helpful feedback) and the instructor. The ISDC has recruited faculty who are master teachers in their fields, plus it has Dr. Richard Hall, an expert in educational psychology, as a research associate and consultant, to ensure that learning is optimized. Furthermore, software developed in the center is subjected to multiple levels of evaluation and assessment, both by faculty and by student users.

5.4 Software Delivery (Learning Management) System

This system delivers the educational content to the student, provides some means of interaction with the student, administers assessment, and tracks student progress through the course. This system should be customizable by the instructor for the particular way he/she chooses to teach the course. For example, an instructor can reorder the lessons, choose the homework problems to be assigned, and edit and manage a gradebook which tracks student progress. ISDC staff, particularly Ed Carney, David Oglesby and their students, developed a prototype, Statics On-Line, which is evolving into a full featured learning management system.

5.5 Educational Assessment

For a learning environment to be of greatest real value to teachers and students, it must contain some type of built-in assessment capability. As a practical matter, a teacher's workload is lessened by utilizing a software system which deliver quizzes and homework assignments to the student, grades them, reports results to the student, and records the student grades in a gradebook. Students also benefit. They need the assessment deadlines for motivation. Furthermore, students greatly benefit from assessments in small, regular doses such as is easily provided by on-line quizzes and homework problems. Student also benefit from the opportunity to retake on-line quizzes (the computer selects random numbered cases similar to previous problems). This gives students a safety net, a chance to redeem themselves, if they discover that they really didn't know how to work the problem, or if they made a simple mistake. The ISDC is creating such a quiz/homework system, plus some faculty are experimenting with a commercially available web courseware system.

5.6 Project Management

Educational software projects, like many real-world construction, software, or other industrial projects, benefit greatly from the application of project management techniques. Ultimately, the success of the ISDC will be measured by the number and quality of its projects. Achieving successful projects depends on choosing projects well, carefully specifying objectives, identifying funding, creating realistic schedules, building talented and balanced teams, training or bringing up to speed those needing training, wisely deploying personnel, monitoring progress, and assessing outcomes. An important role of the ISDC is to provide project management expertise to its project teams.

6. Projects Supported by UMR's ISDC:

The success of a center such as the ISDC is measured by the quality and success of its projects. In this section we give a brief overview of some of the projects connected with UM-Rolla's Instructional Software Development Center (ISDC). A special feature of these projects is that most of them are engineering related. As stated earlier, a number of the faculty of associated with the ISDC are engineering faculty, and the ISDC is housed in UMR's Basic Engineering department. The ISDC has campus funds primarily to support software engineers and student programmers; its funds for supporting faculty consist of seed monies only. It does, however, help project directors identify external funding sources and provides project and on-campus matching funds.

BEST Dynamics (www.umr.edu/~bestdyn): Initiated in 1992, this project was developed by a faculty/student team led by Ralph Flori [1]. It consists primarily of simulations to help students visualize engineering dynamics problems. It is currently being modified and expanded to form the basis of an engineering dynamics on-line learning system.

BEST Statics and Statics On-Line (www.umr.edu/~beststat, www.umr.edu/~oci): These originated as two projects, with BEST Statics created by David Oglesby and Statics On-Line created by Oglesby and Ed Carney. These projects have now been combined to form the basics of an on-line learning system for engineering statics. This work is ongoing, led by Dr. Oglesby [2].

MDSolids (and BEST Mechanics of Materials) (www.mdsolids.com, www.umr.edu/~philpott/be110): Dr. Tim Philpot, who created this award-winning product for learning mechanics of materials while he was a faculty member at Murray State University, has recently joined UM-Rolla's department of basic engineering and is a research associate in the ISDC. He brought MDSolids with him to UMR. His plan is to continue to use MD-Solids as is, and to create a complimentary, comprehensive on-line mechanics of materials course titled BEST Mechanics of Materials [3].

BEST Total Quality Management (www.umr.edu/~design): Created by Dr. Ken Ragsdell of UMR's Engineering Management department, this is an interactive, CD-ROM based, multimedia tutorial which provides an in-depth look at TQM tools and philosophies [4]. Dr. Ragsdell has also created on-line courses for his EMgt 475 (Quality Engineering) course focusing on Taguchi methods and for his EMgt 375 (Total Quality Management) course.

BEST DrillSim: The Subsurface Geology Investigation Simulator (www.umr.edu/~psanti/simulator): Created by Dr. Paul Santi of UMR's Geological Engineering department, this amazing tool enables students to practice subsurface hazardous waste and geotechnical investigations [5]. The system consists of an extensive multidimensional database of real hazardous waste and geotechnical data gleaned from maps, soil boring logs, ground water well tests, and laboratory test information. A student investigates the site by requesting locations and depths of borings and by requesting laboratory testing. These tests are "charged" to the student's account and results of these tests are presented to the student in a very attractive, visual way. Based on this information, he/she reaches conclusions and orders more tests. This process continues until the student has correctly characterized the site or has run out of money. The student's goal is to optimize expenses and the number of borings while determining the limits of ground-water contamination or the range and variability of geotechnical properties at the site.

Psych Connections (www.psychconnections.com): This is the work of Dr. Richard Hall of UM-Rolla's Psychology department [6,7]. It is the foundation of an on-line general psychology course.

BEST Engineering Economics: This is a software-based engineering economics course being created by Dr. Charles Dare, a retired UMR Civil Engineering department faculty member. Dr. Dare taught this course for years and is leaving as a legacy in software form his perspective of how this course is effectively taught.

7. Conclusions

This paper has given an overview of University of Missouri-Rolla's Instructional Software Development Center. Its mission is to serve the UMR campus community by encouraging development of instructional software, recruiting faculty who are interested in this activity, and providing them training, software engineering, and student programmers to support their efforts. A unique feature of UMR's ISDC is its strong connection to engineering mechanics faculty, though it is now serving many departments on the UMR campus. A center such as this can provide considerable expertise to educational software projects that individual faculty/student content expert teams working alone often lack. Some of these areas of expertise include software engineering, providing both CD-ROM and web-based software delivery (learning management) systems, advice in content preparation, instructional and graphic design, project management consultation, and educational assessment.

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