Changing the CIS Academic Culture: Using Senior Design Projects to Unify the Curriculum

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ABSTRACT
Recently we initiated an effort to create a synergistic relationship between the senior design sequence and the sophomore software engineering course that resulted in a cultural change to our CIS academic community. Because of the enthusiastic response from students and faculty, we are extending this initiative to generate early interest among freshman and sophomore majors for electives in artificial intelligence and decision support. With hardware acquisitions obtained through an Instrumentation Laboratory Improvement (ILI) grant from the National Science Foundation, teams in the Senior Projects capstone sequence are preparing projects that will be employed in early courses in the curriculum. The projects will be used to provide students with insight about each of the elective areas of the curriculum through demonstrations and activities. This paper describes the five project initiatives and how the projects will be employed to generate interest in the elective areas.

KEYWORDS
CIS curriculum, artificial intelligence, decision support, database, software engineering.

INTRODUCTION

Motivation
While students often view individual courses in isolation, curricula models are plans for the careful integration and the iterative development of concepts to higher levels of knowledge (Bloom 1956). The integrated laboratory experience (Doran 1994b, 1995, 1997a, Langan 1996), using a cognitive-based framework, illustrated how a hands-on approach can re-enforce topical contents to accomplish a depth-of-knowledge approach. Whereas this pedagogical approach serves the curriculum well at the introductory course level, the initial benefits disappear unless there is reinforcement throughout the remainder of a curriculum.

Although a cognitive-based approach is primarily focused on depth of knowledge, curricula should also provide for a breadth-first approach in some areas. Students who are exposed to the many facets of a curriculum can understand expectations of later courses and to make practical sense out of abstract concepts. This knowledge of future use of basic concepts and options of study can also serve as a motivation for students to build the necessary foundation to insure success later in a curriculum.


The remainder of the paper will explore how we have attempted to further enhance the curriculum by addressing these issues.

We will discuss the focus of a recently awarded NSF-ILI grant that extends the hands-on laboratory beyond the introductory levels to advanced levels of the curriculum. The projects from these upper-level courses will be integrated back into the lower courses to challenge the “isolated view” of courses and to incorporate a breadth-first view in the introductory courses. Faculty mentoring of the development and implementation of the projects are critical for extending elective course experiences to meaningful applications.

BACKGROUND
A prior paper (Daigle 1997) described a novel approach to modeling relationships among courses in curricula. This approach involved establishing a formal relationship between members of a sophomore software engineering course and a senior design project course. The resulting “synergy by design” produced benefits for both classes: sophomore
Software engineering students were introduced to the expectations of the senior design sequence early in the curriculum; senior design students were peer-reviewed. The early preview generated awareness in sophomores for the importance of intervening courses to prepare for the senior capstone experience. This paper describes an extension to the original approach to acquaint sophomores with the elective areas of the CIS curricula.

About the University of South Alabama
The School of CIS, one of nine academic units on the campus of the University of South Alabama, provides a choice of specialization areas for undergraduate students in: Computer Science (CS),
information Science (IS), Information Technology (IT) and Computer Engineering (CpE). Students of each specialization initially share a common core of courses in the first two years and then, after two years of courses specific to a specialization area, they share a common senior capstone experience. Specialization curricula are supplemented with elective CIS courses including artificial intelligence (AI), decision support systems (DSS), Advance Database and Real-time Computing. Typical enrollments for these elective courses are 20-25 per year. The senior capstone experience is a two-semester senior design project course sequence in which students (perhaps from different specialization areas) work in teams to undertake real-world projects and to produce production quality systems for a wide range of applications. Successes have been reported in the literature (Daigle 1997, Donan 1997b, Holt 1996).

Curriculum Structure and the Role of Electives
CIS curricula, such as the ACM model (ACM 1991) and the 1998 IS model (Longenecker 1996), address an agreed upon body of knowledge with activities that provide breadth and depth of knowledge. A specific implementation of these curricula result in a required core set of courses in the major as well as a set of required and supporting courses from other disciplines. CIS electives are an opportunity for a student to customize, at least a portion, of the curriculum in the direction of their special interests.

It has been observed through student advising that, in general, students decide to enroll in an elective course for a variety of reasons: personal interest in the course content, recommendations from members of a previous class or from an advisor, publicity by the instructor, perception of ease in grade assignment, perception of importance for job search, or availability in the course rotation. Of course, a selection based on interest is generally regarded as optimum. Once the class is formed, the instructor begins a familiar battle to generate student enthusiasm and motivation in students with diverse expectations who may not be truly committed to the study of the elective material. How does a student, immature in the curriculum, identify an area of interest early so that direction of special interest can be identified and nurtured early? We elected to develop projects in the senior design sequence, that could be used to provide insight, through activities and assignments in the freshman and sophomore courses for CIS elective courses such as Artificial Intelligence, Decision Support Systems, Advanced Database topics, and Real-time Computing.

The ILI Grant
In the past, the specific elective areas, AI, DSS, Advance Database, and Real-time Computing were taught with limited hands-on experience. The primary obstacle to extending the notion of "synergy by design" was the absence of sophisticated laboratories to provide advanced hands-on experiments for the upper division undergraduate students in the junior/senior electives and the capstone sequence. In order to meet the special resource needs to carry out the objective, several members of the School of CIS collaborated to prepare an ILI grant, which was subsequently funded by the National Science Foundation.

The plan for utilizing this equipment in the target courses will be accomplished as follows. Juniors and seniors who take elective courses will build upon these elective experiences in the senior design sequence, combining theoretical concepts and hands-on applications to prepare projects that can be used in the lower end of the curriculum. During the development of the senior project, sophomore software engineering students will be given class assignments, e.g. documentation review or test case development, that require interaction with senior design project teams. Selected core courses from the first two years would use the completed project for a breadth-first learning approach, directed to creating an awareness of the elective areas that relate to the project. The elective courses would make use of the completed project for a depth-first learning approach, examining the implementation strategies, replacing modules, extending the functionality of the project, or reverse engineering the project.

METHODS
Four projects are under development in the senior design sequence; one project is under development in a directed study. A primary goal is to create a resource that could be used in the current curriculum and that could be further developed by students as senior projects, directed studies or other undergraduate research activities.

AI Projects
Two senior projects that directly focus on AI and Real-time Computing are under development: one involves simulation and the other specialized hardware.

RoboCup Simulation Project: The Robot World Cup Initiative (RoboCup) is an international research and education initiative to foster AI and intelligent robotics research by providing a standard problem, virtual soccer, in which a wide range of technologies can be integrated and examined. A senior project team composed of individuals who recently completed the AI and Real Time courses, committed to leveraging the RoboCup initiative to provide project-oriented activities involving AI. The team's objective was to improve the user interface and to develop a collection of decision support modules (FINN 1992).

The absence of a flexible library had caused processes to be unreliable and hindered the development of player models. The project team developed a new enhanced inter-process communications library to simplify use by future teams. The library was also used to enhance the Linux client capabilities, to improve client performance, and to develop sample clients that can be used as templates for future client behaviors. A Visual Basic client was also implemented.

Hexapod Walker Robot Project: Specialized hardware and accompanying controlling software present additional opportunities for examining AI concepts. The objective of a second senior project team was to create stand-alone tools and software libraries for activities to control a hexapod walker robot. Demonstrations would employ prepared activities for the hardware and collaborative experimentation with the controlling software (Flynn 1993).

The team developed a motion library for a wide range of forward, backward, turning behaviors. A second product was a sensor library for infrared line tracking. The team was unable to physically apply the sensor library for the chosen platform because
the up-down jerky motion of the hexapod walker caused the sensor to produce inaccurate and unreliable data. However, a graduate student has established the capabilities of the sensor library by successfully integrating the sensor library on a mobile platform.

**Decision Support Systems, Advanced Database**

The DSS part of the ILLI grant focuses on the development of two major resources: a data mart using Oracle 8.0 and a medical decision support system.

**The Data Mart Project:** The Data Mart Project: Inman defines data warehouses as a "subject oriented, integrated, non-volatile, time variant collection of data in support of management decisions". A data mart is a subclass of the data warehouse that focuses on a narrow part of a business activity. The goals of the senior project were to establish a data mart in the Oracle environment and provide drill-down capability, advanced data visualization, and update triggers.

A local firm provided the opportunity to construct a composite data file from sales, item and customers files. The data mart was established in the Oracle 8.0 environment made available through an academic agreement. The 125,000 record ASCII file covered five years of sales history. The file was transferred via magnetic media, although the ftp option was available. Using SQL Loader, the file was loaded onto a Unix-based Oracle server and imported into the school's database.

The data was examined and some records (minor sales outside the United States) were removed. The states were divided into five sales regions and an appropriate code added to each sales record. The company's divided sales into 13 categories which were retained in the data mart.

The drill-down structure consisted of a series of pre-processed tables which organized the data for quick access and display. Sales data could be viewed in terms of dollars or units sold. All data could be displayed, then drilled down from annual to quarterly to monthly reports. Sales dollars could be drilled down by region and state. Units sold could be drilled down by category and specific item number. Advanced data visualization incorporated a map of the United States which displayed each selected region in color along with the data and a graphical output derived from a link to Excel.

Because of start-up problems (mostly learning curve) and the short summer semester, automatic update triggering was not completed. However, a database administration (DBA) class being conducted that summer was able to use the work of the senior project. The DBA class utilized Personal Oracle 8 and each student was able to perform an export at the server, then ftp the dump file to the lab and import it into the local database. This permitted each student to get a "real world" feel as to how long it takes to run processes on a large file. Students were also able to access the server from home using the SQL*NET utility.

A second senior project is already formed for the fall/spring semester. One goal is to set up a second Oracle NT server. Although still in the planning stage, the task of developing software robots to analyze the data mart is of interest. A second data mart consisting of 30,000 accounting records from a local municipality is available. Other possibilities include combining the data mart activities with the web crawler project, the work of another senior group.

**Medical Decision Making Project:** The ILLI grant also supports the development of resources for decision making curricula. This project, developed in collaboration with a local heart rehabilitation clinic, was initially explored in a past senior design project and is presently a subject of a directed study. The intelligent part of the project, a system to support medical decision making in risk analysis and therapy planning, involves the development of medical logic modules (MLMs) in a standard ASCII format called the Arden Syntax. An additional project is directed to the development of voice-recognition applications for use in rehabilitation. These knowledge-based tools will be linked to an existing patient database and will provide students with an opportunity to investigate how data and knowledge are linked to provide decision support.

**A Hybrid Project**

The last project we will describe, an intelligent web-crawler, is one that spans many core and elective areas in the curriculum: AI, Decision Support Systems, large-scale databases, Real Time Computing, and web-based applications. Because of the complexity involved in this project, it is expected to be an on-going project several years.

This project focused on the issues relevant to existing web search tools: huge, unsorted databases with dramatic storage growth rates and impervious, general query strategies that provide users with a large number, mostly irrelevant, web sites. By combining standard web crawling, artificial intelligence-based sorting and sifting of data, and a client-server database-centered user group subscription services, the senior design team's goal was to prepare a user profile management system coordinating personal web robots discoveries for group-oriented collaboration. The team worked with faculty mentors to develop a vision and a framework for the project and to implement a web crawler, a prototype database, and a query/filter component for a limited number of specific web site types.

The team was able to develop a crawler to retrieve URLs and their page descriptions. They were able to include the coordination of multiple crawlers with results filtered by a preliminary parameterized matching equation. Information was saved in a general text format to be used as input into a large database.

**DISCUSSION**

Students should be exposed to large complex systems throughout the curriculum. The laboratory experiences that the authors are directing will accomplish this at the breadth-level and depth-level of learning.

In the early part of the curriculum, the initial interactions with these systems will provide breadth-level experiences of many diverse topics. Demonstrations and assignments based on the projects supplement the depth-level experiences from the use of an integrated laboratory experience and a cognitive-based approach. Sophomore software engineering students will have assignments, such as design review and test strategy design, involving upper classmen working on real projects. These initial interactions provide awareness of later course requirements and objectives. Specifically, the proposed projects will give students a pre-enrollment understanding of the topics in electives such as AI, DSS, or...
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