The Capstone Experience:
Integrating Curricular Outcomes with Real-World Practice

Shaun M. Lynch, Ph.D.
Department of Business and Economics
University of Wisconsin-Superior
slynch@uwsuper.edu

Abstract

A capstone class can provide a quintessential experience for students in their program of study and is a critical component of an information systems curriculum. This paper identifies the activities necessary to secure capstone projects, provides an overview of the capstone class in the Computer Information Systems major at the University of Wisconsin-Superior, addresses the relevant issues associated with managing a capstone class, and presents an illustrative example that summarizes the 2003 capstone experience. The purpose of this paper is to expose the processes and mechanisms that underlie capstone courses and attempts to stimulate discussion among educators on ways to improve capstone offerings. It is intended to appeal to a broad audience with interdisciplinary interests.

Introduction

A capstone class can provide a quintessential experience for students in their program of study and is a critical component of an information systems curriculum. A capstone course serves four functions. First, it integrates concepts, skills, and practices students learn throughout their academic career. Second, it provides a mechanism to practice and apply learned knowledge and skills to real-world applications. Third, it offers a means to assess curricular performance and teaching effectiveness. Fourth, it creates an opportunity for an academic program to interact with the world of practice and the professional community at large.

CIS 456 Project Management is the designated capstone class for the Computer Information Systems major in the Department of Business and Economics at the University of Wisconsin-Superior. The class is offered once a year during spring semester to seniors in the program. Students registering for the class are expected to have completed the majority of classes in their program of study, which includes foundation, general education, core business, and major specific classes [1].

The capstone class of 2003 examined the feasibility of implementing a campus-wide, wireless network at the University of Wisconsin-Superior. The goal of the project was to identify and evaluate different wireless infrastructures and application alternatives, recommend a configuration, and propose a plan that would enhance the educational experience for students and faculty. This project was a cooperative effort between the Computer Information Systems program in the Department of Business and Economics, Network and Programming Services, and Computing and Media Services at the University of Wisconsin-Superior.

The purpose of this paper is to expose the processes and mechanisms that underlie capstone courses and attempts to stimulate discussion among educators on ways to improve capstone offerings. In particular, this paper
- Identifies the activities necessary to secure capstone projects,
- Provides an overview of the capstone class in the Computer Information Systems program at the University of Wisconsin-Superior,
- Addresses the relevant issues associated with managing a capstone class, and
- Presents an illustrative example that summarizes the 2003 capstone experience.

It is intended to appeal to a broad audience with interdisciplinary interests.

Background

The original idea for the course came from a class the author participated in during his undergraduate program of study. The class, IE 490 Program and Project Management, was taught by Elvin D. Isgrig in the Department of Industrial Engineering and

Management at North Dakota State University[1]. The class was unlike others in that it exposed participants to interdisciplinary practices and immersed students in a project environment. The projects selected for the class stimulated interest and encouraged students to apply their knowledge and skills. The author was fortunate to have the opportunity to continue to participate in the process after that first experience as a graduate student and faculty assistant.

The capstone course offered in the Computer Information Systems major at the University of Wisconsin-Superior descends from the author's original experience. The class uses Kathy Schwelbe's text, *Information Technology Project Management* [2] in conjunction with the Project Management Institute's publication, *A Guide to the Project Management Body of Knowledge* [3] as a supplemental reference. However, a number of changes were made to adapt the course to a major housed within a business department. For instance:

- Course content was modified to emphasize the core competencies associated with a Computer Information Systems curriculum.
- Functional department activities were organized around procurement, human resource, finance, quality, scheduling, and risk management to coincide with the knowledge areas identified by the Project Management Institute [3].
- A project archive was introduced to capture and communicate participant contributions from year-to-year.
- An online document reference that includes fact-sheets and checklists was implemented to facilitate on-demand learning.
- A module on stress management was added to help students manage the inherent demands of the discipline.

Additional changes include the improved use of electronic forms and document templates to enhance student productivity, weekly activity reports to improve progress tracking, and the ability to scale the course to accommodate small to medium sized classes.

Securing a Project

Projects are more than just a task to accomplish. They entail a working relationship with a professional willing to invite students into an activity not normally available in a classroom setting. They form the backbone of the capstone experience and stimulate learning through application of knowledge and skills. In many cases, a capstone experience is the first opportunity students have to engage professionals in a project environment.

Securing a project entails three basic activities: finding a sponsor, selecting a project, and funding a project. This section examines these activities and identifies key factors to consider when preparing to offer a capstone experience.

---

[1] The class number and department name shown reflect catalog information the year the class was taken. The following class number and department name reflect current catalog information: IME 456 Program and Project Management and Department of Industrial and Manufacturing Engineering.

Finding a Sponsor

A project sponsor is an active partner in a capstone experience and contributes time, resources, and expertise. Facilitating a working relationship enhances sponsor efforts and promotes effective use of their resources. Differences between academic and business paradigms are the biggest challenge to developing a good working relationship. These differences occasionally lead to divergent perspectives and miscommunications. Therefore, listening and seeking to be understood is an essential part of creating a mutually positive relationship.

Sponsor demeanor is the first consideration in deciding whether to develop a relationship that may lead to a student project or not. Factors to consider include:
- Sponsor's ability to work with the instructor and students,
- Sponsor's willingness to negotiate with students,
- Sponsor's flexibility to accommodate evolving project requirements,
- Sponsor's inclination to share control with student project teams,
- Sponsor's readiness to assume some of the risk, and
- Sponsor's suitability as a positive role model.

Regardless, the decision to enter into a project with a sponsor often hinges on mutual goodwill and trust.

Managing sponsor expectations ensures that there exists a realistic understanding of the capstone experience. This is particularly important when discussing the nature of a student project with a potential sponsor. Where a project sponsor may focus on project outcomes, the instructor may be really emphasizing the learning opportunity. This situation can be remedied by providing example documents from previous projects, offering copies of relevant class materials, communicating class objectives, identifying constraints and limitations, and emphasizing mutual opportunities and benefits.

Explaining the role and duties project sponsors have reduces the uncertainty of the process. In particular, deliverables and requirements should be clearly articulated. For instance, a project sponsor may have access to project team findings and rights to all project deliverables. In return, the project sponsor would be expected to make a presentation at the project kick-off, make time to meet with student project teams during the semester, and attend the final presentation.

Selecting a Project

Selecting an appropriate project is one of the most important factors in creating a successful capstone experience. A challenging but achievable project offers students a sense of accomplishment and confidence in their abilities when completed. Projects that fail leave students dissatisfied and may cause them to question their abilities. Selecting a project is a matter of evaluating and weighing characteristics that may have conflicting tradeoffs.

Resource availability frequently determines project feasibility. Computer hardware and software, facilities, and access to expertise are important considerations; however, student time is generally the most critical resource to manage. It is reasonable to expect that a full-time student can allocate ten hours per week to a three-credit class, which translates to about 150 hours per semester. Based on experience, approximately 25 percent of this time can be budgeted directly to a project. Therefore, a project team that consists of four members (considering span of control issues) has about 150 hours available to complete the project.

A complex project is inherently unmanageable and should be evaluated carefully. Factors that lead to complexity include: new technology, limited visibility, technical difficulty, restricted access, steep learning curves, *et cetera*. The key to managing complexity is to carefully choose which complicating factors to accept, employ a compartmentalization strategy, and develop contingency plans in advance to help students mitigate risk.

Project breadth and depth are often opposing aspects that influence project scope. A project that is too broad may underutilize student skills and give superficial results. A project with too much depth may exceed student capabilities and prevent completion. Having a clear idea of a project's scope before making a decision to accept a project improves an instructor's ability to help students define project scope, prevent scope creep, and utilize student resources effectively.

Funding a Project

Project funding is inherently a difficult topic for an instructor to discuss with a potential project sponsor. However, the author's experience suggests that many project sponsors are willing to contribute financial resources to student projects to offset incurred costs. Purchasing special software, covering telephone and copying expenses, paying for document printing and binding fees, and reimbursing travel expenses are reasonable and negotiable.

It is the observation of the author that funded projects seem to elicit more interest and commitment from students than projects that are not funded. In addition, contributing sponsors tend to be more focused on project outcomes and appear more attentive to student needs. On the other hand, having alternate funding sources, such as grants or department allocations, increases an instructor's ability to accept projects from financially strapped sponsors. Not-for-profit organizations, start-ups, and small businesses benefit from this arrangement and offer academic institutions opportunities for increased visibility and recognition in the community.

Capstone Course Overview

CIS 456 Project Management is the designated capstone course for the Computer Information Systems major. It is designed to immerse students in a project management experience to prepare them for the world of practice. The class creates an environment

where participants must show initiative, be able to communicate with one another, collaborate to solve problems, and justify their actions.

This section provides an overview of the capstone course as offered. It details the expected outcomes, and describes the class organization and activities that facilitate the experience.

Expected Outcomes

Outcomes for this course reflect the goals and objectives expected of a capstone experience. Expected outcomes are reviewed the first day of class and students are reminded of them frequently over the course of the semester. Class activities are carefully planned to ensure objectives are accomplished and outcomes achieved. In addition, handouts listing the expected outcomes are distributed at the final presentation to focus the audience on the accomplishments the students have achieved. The following outcomes are listed on the class syllabus.

Students will be able to:
1. Understand the underlying computer information system concepts and principles and apply them to problems found in business and industry.
2. Communicate with professionals in business, engineering, and computer science, as well as, with other project team members.
3. Interact and negotiate with clients with regard to project scope, expectations, and outcomes.
4. Analyze system structure and behavior using systematic decomposition.
5. Create requirements that address the specific needs of clients.
6. Design solutions based on the requirements that are economically justified and provide value to clients.
7. Implement solutions in a systematic manner that utilize the techniques of project management to include resource management, budgets, and schedules.
8. Work in a team environment and encourage cooperation between individuals.
9. Promote open channels of communication and maintain ongoing dialogs between project team members and clients.
10. Think critically, innovate, and manage ambiguity and uncertainty.

Class Organization

The class employs a matrix organization to integrate functional department services with project-driven activities using a hybrid structure. Students participate in cross-functional teams that interact and adapt to a dynamic and ever-changing environment subject to uncertainty and ambiguity.

Functional departments are generally identified as centers of ongoing activity and offer domain specific knowledge and expertise to the organization. They provide services and expertise in the areas of procurement, human resources, finance, quality, scheduling, and

risk management. Each department is assigned a Department Director to manage department activities and efforts.

Projects, on the other hand, are temporary ventures undertaken to achieve specific objectives that often include producing value-added deliverables. Project teams consist of members drawn from the various functional departments. This facilitates an interdisciplinary approach to problem solving and utilizes the expertise individuals bring to the team. A Project Manager is assigned to each team to manage project activities.

Committees facilitate the ability to accomplish specific organizational tasks. Standing committees, such as the Steering, Programming, Document, and Facilities and Equipment Committees, are active over the course of the semester. *Ad hoc* committees, such as Capstone Presentation and Capstone Luncheon Committees, are activated only when needed. Membership is either assigned or solicited from the organization depending on circumstances and the charge of the committee. Selected committees appoint Chairs to manage activities and duties.

Class Activities

The capstone class is structured as a chain of value-adding activities. These activities build upon one another and reinforce prior lessons learned. In addition, they stimulate student involvement and encourage participants to master the skills necessary for success.

The class begins with a welcome letter and call for applications. Application packets must include a letter of application and current resume. Students must specify both a preferred functional department and project team position in their letter. Placement is competitive and based upon a student's qualifications and experience.

Once assignments have been made, students are asked to write a formal position description for each position they hold. Position descriptions are approved and signed by their immediate supervisors and processed internally through the organization's human resource department.

Next, project sponsors are invited to make a brief presentation to the class and meet with their respective student project teams at the project kick-off. The event establishes an ongoing dialogue between sponsors and students in which both parties negotiate project scope, outcomes, and expectations.

Scope reviews begin approximately two weeks after the project kick-off and require project teams to present and defend the scope of their project. Project teams present their work to the organization and submit a project charter, statement of work, a draft of the work breakdown structure, and a tentative project schedule for evaluation. The review concludes only after each project team successfully defends their project scope and communicates essential project activities.

In the sixth week, students must take a qualification exam that tests their ability to retain concepts and solve problems. The exam is modeled after professional certification tests and is divided into two parts. The first part tests a student's general knowledge of the six functional areas associated with the organization's departments. The second part tests a student's specific knowledge of the functional areas associated with the department they are assigned.

Functional reviews follow shortly and ensure that departments are capable of providing the services and methodologies associated with their particular functional activities. Each functional department submits a mission statement, list of department services, and functional methodologies for evaluation. The review concludes once each department member demonstrates command of the functional knowledge associated with his or her area.

Project reviews begin in the tenth week and provide an opportunity to assess project team progress and review project team plans to accomplish stated objectives. Each project team submits evidence of progress, a final work breakdown structure, and a working project schedule. The review concludes when each member of the project team demonstrates their contribution to the project and proposes a realistic plan to complete the project as scheduled.

The group exam follows shortly after the project reviews and is a collaborative exercise that encourages cooperation and team work. Functional departments and project teams compete to solve interdisciplinary problems that emphasize project management concepts such as the project lifecycle, project scope, integration management, and communication management. Students are asked to diagnose and resolve problems framed in real-world scenarios.

The client presentation in the fifteenth week marks the end of project related activities in the class. Project objectives, alternatives, methodologies, and recommendations are documented in project reports and presented to the sponsors at a formal presentation open to the public. Project team findings are put forth for evaluation and comment. Time is allocated at the end of each presentation to answer questions the sponsors or audience may have of the project team.

Finally, a lessons-learned exercise brings the class to a close and offers a final look back at the experience just completed. Actual achievements are put into perspective and attention drawn to the accomplishments made during the semester. Students are given one last assignment that entails writing an essay that offers advice and recommendations to future participants of the class.

Managing the Capstone Experience

Finding a project and creating a capstone course is one thing, managing a capstone course is another. Capstone classes are dynamic, interactive, and energetic by nature and stimulate the full range of human behaviors observed in the world of practice—good,

bad, and ugly! Giving students an opportunity to participate in this experience provides them with life-long lessons. Being aware of problems and monitoring them is the responsibility of the instructor.

This section discusses three key areas relevant to the management of a capstone experience: information management, problem identification, and measuring and assessing performance. Although not exhaustive, the experience of the author indicates these areas are pertinent to effective management.

Information Management

A capstone experience is an information intensive exercise that requires the right information at the right time. Course content is rarely presented or used in a linear manner; instead, content is on-demand and drawn upon as a reference for specific undertakings.

To facilitate effective information use, documents are made available online and organized into four categories that include fact-sheets, checklists, forms, and document templates. Fact-sheets provide tacit information about activities such as creating position descriptions, conducting reviews, presenting status reports, *et cetera*. Checklists enumerate the steps necessary to complete an activity and ensure completeness and consistency across the organization. Forms promote a standard means of organizing, formatting, and communicating information across the organization. Document templates improve the efficiency and consistency of student generated documents such as the final project report.

Problem Identification

The dynamic and interactive nature of the capstone experience makes it easy to hide problems, particularly if students are embarrassed or feel uncomfortable. Changing this mentality and encouraging participants to reveal potential problems and discuss them openly requires diligence and patience. Assisting students in this task requires complementary methods to root-out and identify problems in a timely manner without laying blame or embarrassing students.

Monitoring activity reports can help identify problems that occur within a group. Students must prepare weekly activity reports that list the activities and tasks to be undertaken. Supervisors must approve and sign the activity report a team member submits. At the end of the reporting period, the supervisor reviews progress and initials the report. Problems generally revolve around a student's inability to complete activities and tasks in a timely manner. Although this is not uncommon, the instructor should be cognizant of emerging patterns.

Monitoring status reports can help identify problems that occur between groups. Status reports are used to update the organization with the current state of a department or

project. Briefings must contain a progress report of the activities currently being worked on; new activities to be undertaken in the next reporting period; and potential, ongoing, or new problems the team is experiencing. The briefing is followed with a question and answer period where members from the organization are allowed to ask questions of the presenter. Problems generally entail a lack of communication between groups, or inter-group tensions or conflicts. Issues often appear during the question and answer session when one group learns information they feel they should have known earlier. In most cases, the presentation of a status report serves its purpose and issues are resolved.

Committees meetings provide a valuable avenue for uncovering problems and tracking organizational progress at the managerial level. Unlike functional departments and project teams that are organized around activities and objectives, respectively, committees can be used to organize members by their assigned role. This encourages interdepartmental communication that would otherwise be missing. Meeting with committees, such as the Steering and Programming Committee, often reveal the early stages of potential managerial and supervisory problems. In most cases, the problems stem from a lack of managerial knowledge and experience and can be remedied by creating a learning opportunity that addresses the issue at hand.

Talking with students and sitting in on group meetings often helps the instructor identify problems lurking in the background that may involve poor interpersonal skills. These types of problems are particularly insidious if not dealt with early by the instructor since students may have difficulty articulating them or feel uncomfortable discussing the problem.

Measuring and Assessing Performance

Measuring student performance requires a clearly defined set of metrics and measurement standards. This facilitates the ability to track student progress accurately and identify weaknesses. In addition, clearly defined metrics allows participants to track their own progress, manage their personal resources effectively, and enact course corrections as needed.

To adequately measure student activities, performance is measured and assessed in four areas. First, individual activities provide a measure of a student's ability to complete solo tasks, such as submitting an application packet, writing a position description, or presenting at a review. Second, group activities provide a measure of a team's ability to collaborate and collectively complete tasks, such as presenting scope, functional, and project reviews. Third, administrative activities provide a measure of a student's ability to complete assignments issued on behalf of the organization, such as exams, activity reports, and article summaries. Fourth, peer evaluation and participation allows members of the organization to assess team member performance or note particular individual contributions.

Illustrative Example

This section summarizes the experiences of the 2003 capstone class at the University of Wisconsin-Superior using the methods and considerations described in this paper. Special attention was given to securing projects and class implementation. Although not explicitly written, the techniques described in the Section, *Managing the Capstone Experience*, were used throughout the duration of the class.

Securing the Projects

The idea to pursue a wireless networking project originated from observations the author made while serving on several technology related committees at University of Wisconsin-Superior. Select individuals from Computing and Media Services were just beginning to explore the infrastructure and applications associated with a wireless network. Student Technology Fee funds were being allocated to install several wireless base stations in the student union and library to assess system capabilities and provide limited student access. However, a comprehensive plan did not exist and only modest consideration was given to how the wireless network would be used. This raised the possibility that developing a plan for a wireless campus might be a good capstone project to pursue.

Unfortunately, the original idea of creating a comprehensive plan for a wireless campus was simply too large, complex, and unwieldy to be managed effectively as a student project. A compromise was achieved by dividing the problem into two domains—infrastructure and applications—that could be managed independently. Each domain would define the goals and objectives for each project team.

In fall semester of 2002, the author approach David Prior, Provost and Dean of Faculties and Vice Chancellor for Academic Affairs, Mark Anderson, CIO and Director of Network and Programming Services, and Peter Nordgren, Director of Computing and Media Services, during a meeting with a proposal to develop a plan for a wireless campus as a capstone project. The proposal was well received, an agreement was reached, and a request for funding was submitted. In addition to other University resources to be made available, the Provost offered to contribute $350 to cover project expenses.

An invitation was extended to Mark Anderson and Peter Nordgren to be the designated project sponsors for the wireless infrastructure and wireless applications projects, respectively. They graciously accepted the offer and agreed to serve as sponsors. Several meetings were scheduled during fall semester and winter break to introduce the project sponsors to the capstone experience, initiate a vision of how the projects would unfold, and to sketch out the anticipated scope of the project.

The Capstone Class

The first day of class for CIS 456 Project Management began on Tuesday, January 21, 2003. A welcome letter was given to each student and a call for applications made. To assist students in writing their application packets, Kathy Pykkonen from Career Services was invited to make a presentation. Students submitted their formal applications on Friday, January 24th.

On Tuesday, January 28th, students received a letter informing them of their position assignments in the class. The class was organized into three functional departments and two project teams. The functional departments included Procurement and Human Resource Management, Scheduling and Risk Management, and Finance and Quality Management. The two project teams included wireless infrastructure and wireless applications, respectively. Students were asked to write position descriptions for their assigned positions and submit them by Tuesday, February 4th.

The project sponsors, Mark Anderson and Peter Nordgren, were invited to speak with the class at the project kick-off on Thursday, January 30th. After making their presentations and answering questions, each sponsor met individually with their respective project team. The project teams began working through the process of defining project goals, objectives, and scope. Scope reviews began on February 13th and were completed by February 20th. Both project teams passed on their first attempt.

The qualification exam was scheduled for February 27th. The two part exam tested student's general and specific knowledge of the functional activities associated with the departments in the organization.

Next, functional reviews were scheduled between Tuesday, March 4th and Friday, March 14th. Functional departments completed preparations for their reviews and presented during the times they scheduled. All three departments demonstrated competence in their areas. Only one department was asked to return for a second try due to a minor difficulty.

Project reviews began on Tuesday, April 1st and were completed by April 15th. Both project teams successfully demonstrated progress on their projects and had reasonable plans to complete their projects in a timely manner. One team suffering a minor setback was asked to return for a second try.

The group exam was scheduled for Thursday, April 17th. The two part exam consisted of a debate between functional departments and a game between project team called "Project Jeopardy." Dr. William Higbee was invited to serve as an unbiased judge for the events.

The project teams documented their objectives, alternatives, methodologies, and recommendations in two project reports [4, 5] that were presented to the sponsors for their review. The final client presentation was organized and presented on Tuesday, May 6th [6]. Sponsors, faculty, students, and guests were invited for the event. Once all the

presentations were finished and the last questions answered, a luncheon was held to allow faculty, students, project sponsors, and guests an opportunity to socialize and discuss the events of the day.

A lessons-learned exercise was held on the final day of class, Thursday, May 8th. First, a letter of congratulations was given to each student recognizing their accomplishments and wishing them success. Next, the class reviewed the experience just completed and considered what worked and what didn't. Finally, the students were given their last assignment to write an essay describing their experience and make recommendations to future participants [7].

Summary

This paper presents a comprehensive look at the activities and undertakings necessary to offer a successful capstone experience. Topics discussed include: 1) the activities necessary to secure a project, 2) an overview of the capstone class in the Computer Information Systems major at the University of Wisconsin, 3) managerial considerations important to conducting a capstone class, and 4) an illustrative example demonstrating the methodology.

This work provides a first step toward exposing the processes and mechanisms that underlie capstone offerings. Additional steps are needed that quantitatively evaluate mechanisms and processes to understand their effects. In addition, discussion among educators is encouraged to stimulate new ideas.

Finally, this work serves as the basis for continued effort to examine the capstone process. Areas to be considered include tracking student performance from year-to-year, assessing the validity of the experience as students enter the world of practice, and the use of information technology to streamline processes, minimize overhead, and maximize learning potential.

References

1. University of Wisconsin-Superior (2002). *2002-2004 General Catalog.* Superior, WI, 58-59.

2. Schwelbe, K. (2003). *Information Technology Project Management.* Course Technology.

3. PMI Standards Committee (1996). *A Guide to the Project Management Body of Knowledge.* Project Management Institute.

4. Lynch, S., Hilson, D., Bailey, I., Schroeder, T., and Shaul, T. (2003). *UWS Wireless Infrastructure.* University of Wisconsin-Superior, Superior, WI.

5. Lynch, S., Holte, E., Jenkins, K., Johnson, K., Osio, M., and Rust, J. (2003). *UWS Wireless Application.* University of Wisconsin-Superior, Superior, WI.

6. CIS 456 Project Management (2003). *Capstone Presentation—Wireless Infrastructure and Application.* University of Wisconsin-Superior, Superior, WI.

7. CIS 456 Project Management Class of 2003 (2003). *CIS 456—Project Management Cookbook, Class of 2003.* University of Wisconsin-Superior, Superior, WI.

Acknowledgements