

# Integrating a Capstone Project into an Information Assurance Program

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**Abstract** – *Walsh College included a capstone course into their Information Assurance graduate (MSIA) program. The IA capstone course is modeled after the MSBIT/MSIS capstone course developed by Dr. W. Don Gottwald. The capstone course was designed to be integrative, broadly focused, and demanding on the student. To complete the capstone course, the student needs to demonstrate their knowledge of project management techniques and a mastery of the skills taught across their program.*

*The capstone course meets three times during the 11 week semester. The students are sent an e-mail prior to the first week of the semester where they are asked to have a project selected prior to the first class meeting of the semester.*

*Capstone students are required to present their capstone projects at a capstone fair held at the end of the semester. Students, faculty, and local business leaders attend the fair to see the projects and meet the graduating students.*

**Index terms** – capstone, curriculum

## I. INTRODUCTION

Capstone courses have been successfully used in a variety of academic disciplines including: accounting, construction, electrical engineering, general education, information technology (IT), technology management [1, 2, 3, 4, 5, 6]. Capstone courses serve a variety of purposes in any curriculum. One of the most important purposes is to help manage a student's transition from the educational environment into the workplace.

Capstone courses are an opportunity to integrate the knowledge picked up in the variety of courses within a program's curriculum [7]. A correctly designed capstone project shifts the student's focus from what was learned in one course to all of the courses in the program [8]. Completion of a capstone project should require mastery of skills from across the curriculum.

### A. Goals of a Capstone Course

Capstone courses have different goals and objectives than the typical college course. A capstone course should encourage reflection and interpretation on the program that they are completing [8]. At California State Polytechnic University at Pomona, the faculty meets to discuss their classroom experiences and provide input to

the faculty members conducting the capstone project [8]. The University brings in an external evaluator to regularly review their capstone program to ensure that it is meeting the University's goals.

### B. Assessing a capstone course

Capstone courses provide a mechanism for schools to assess the abilities of their graduating students [3, 7, 1]. Capstone courses allow students to demonstrate the depth and breadth of the knowledge they acquired during their education [7, 9, 10].

A good capstone course should provide students with an opportunity to acquire new knowledge and explore new topical areas while demonstrating their mastery of completed course material [7, 12, 13]. Students should be forced to integrate material from several classes to complete a capstone project.

Some schools assign the topic of the capstone course while others allow students to choose their own capstone topic. One example of an assigned topic would be Cleveland State University which assigned their IT students to reverse engineer the existing Do Not Call Registry (DNC) in UML notation [5]. The Cleveland State faculty wanted to select a topic that was based in real-life and of an appropriate length to be accomplished in one semester [5]. This topic forced the student to utilize technical skills from the curriculum as well as use social skills to accomplish this problem in a group setting.

By assigning this topic, the Cleveland State faculty requires the students to fill various roles on business teams to successfully reverse engineer the DNC registry and then forward engineer a workable alternative application. The students were required to produce use-case, sequence, and UML diagrams. The students took this business model and were required to produce a relational database. The students then built a web-based application utilizing the database under a Microsoft .NET platform. The student team must establish a Web server with Microsoft's Internet Information Services tool to host their application.

## II. CAPSTONE COURSE AT WALSH

Students taking the Capstone course at Walsh have three basic options: writing a thesis, writing a significant paper, or completing a capstone project. Students writing a thesis or significant paper must work individually while students may pair up or form small groups to work on a capstone project. The majority of students choose to complete a capstone project.

Writing a thesis is the least popular option. Students writing a thesis are expecting to write a thesis between 50 and 120 pages in APA format. The thesis must be based on research conducted by the student and structured in the thesis format specified in the publication manual of the APA. The research must collect data that does not duplicate prior research.

Students that choose to write a significant paper must write a well researched paper between 75 and 125 pages long. Most of the significant papers consist of either a critical review of an important research paper, proposing a solution to a problem, or conducting a comparative analysis of solutions to a problem. Significant papers may take another direction than one of these options with the approval of the capstone faculty.

The students who choose to complete a capstone project can select from a wide variety of projects. The project should solve a business problem or create a new business opportunity. Trivial or non-practical projects are rejected in the first week of the course. The faculty member must apply judgment in determining if the project will be rigorous enough to meet the capstone requirements.

Every project must include complete system documentation, project documentation using the capstone templates, a user manual, and a training manual in the CD or DVD submitted at the end of the course. Exceptions may be granted by a capstone faculty member.

All of the students are required to submit a CD or DVD at the end of the semester that contains all of their work from the semester. The progress reports and all course documents must be on the CD or DVD along with the thesis, significant paper, or project files.

### A. BIT 599 BIT Capstone Course Structure and Schedule

The capstone course does not fit into the traditional model of weekly class sessions. The capstone at Walsh only meets three times during the semester and then reconvenes at the capstone fair during finals week. Students work individually or in small teams on their projects and keep the instructor informed via formal status reports and e-mails. The second and third meetings of the

capstone course are to allow face-to-face discussion of project progress and instructor feedback on the project and the progress being made. The capstone schedule is laid out in table 1.

Table 1: Capstone Course Schedule

Meeting	Deliverable Due	Week
First meeting		One
	Project proposal	Two
	Project plan	Three
	First status report	Four
		Five
Second meeting	Second status report	Six
		Seven
	Third status report	Eight
Third meeting	Fourth status report	Nine
		Ten
Capstone Fair	Presentation, CD, and Lessons learned checklist	Eleven

### B. Forms used in the Capstone

The capstone course uses a number of forms that support the rigor of the course. Templates for these documents were developed by W. Don Gottwald specifically to support the capstone process. Table 2 details the various forms used in the capstone course.

Table 2: Forms used in Capstone Course

Form
Capstone Proposal
Significant Paper Proposal
Capstone Project Plan
Status Report
Risk Criteria
Risk Response
Change Request
Lessons Learned Checklist

### C. The Capstone Fair

The final deliverable to the instructor of the capstone course is a CD that contains all of the student's work products. The capstone project must then be presented at a capstone fair. Held at the end of the semester, the fair is held in a large room on campus. Each student is given a table to set up a presentation on their project, an electrical outlet, and Internet access. The students are expected to provide all of their presentation boards, computers, and exhibition materials.

The fair is open to students, their families, faculty, employers, and local businesses. The goal of the department is to have the fair publicized as widely as possible. A memo is sent out in the middle of the semester to remind all of the stakeholders of their role in

the capstone fair. Reminders are sent to insure that: the fair is mentioned on the College Web site and alumni newsletter, a press release is issued, invitations are sent to all BIT/IA students and faculty, and all of the facilities arrangements are completed.

There are several rituals associated with the capstone fair. The most important ritual is the photo shoot at the end of the fair. Parents, family members, faculty, and visitors are asked to step aside while a class photograph of the students and their instructor is taken. The instructor closes the fair with a short speech to the students that recognizes their accomplishment and points out their potential in the future. This ritual both ends the capstone fair and provides closure to the students on their degree program [9].

#### D. Student Assessment of the Capstone Course

The capstone course is highly rated by the students. Walsh distributes a course evaluation form to every student every semester in every class. The students express their satisfaction on a number of course elements and pedagogical factors. Each course receives a score between zero and 100. The capstone course is consistently the highest rated course in the BIT and IA programs. The student ratings are contained in table 3.

Table 3: 2007 Student Assessments of Coursework

	Winter 2007	Spring 2007	Fall 2007
Capstone	98	94	97
All BIT Courses	98	91.16	91.78

#### E. Lessons Learned at Walsh College

Many of the projects undertaken by students take longer than eleven weeks to complete. Walsh has an eleven week semester so we have learned to encourage students to begin their projects before they register for the capstone course. This means that the same faculty member needs to consistently teach the course so students can get their project ideas evaluated by the same faculty member who will be teaching their capstone course.

The capstone course and capstone fair are mentioned in the new student orientation every semester for incoming graduate students. The BIT/IA faculty is all aware of the capstone course and many of them mention the capstone project during their courses and encourage students to discuss potential project ideas with capstone faculty. This continual exposure to the capstone course encourages students to begin planning their project before enrolling in the course. The students are encouraged to attend a capstone fair as early in the program as possible so they can begin to understand the rigor of the capstone course.

The bar is set very high in the capstone course and the faculty teaching the capstone course does not lower the bar. Students are not granted extensions or allowed to turn in a project that does not meet the scope or depth requirements. Students repeat the capstone course until they complete a project of sufficient rigor.

### III. IA CAPSTONE PROJECTS

Information assurance capstone projects at Walsh College provide students with a variety of opportunities to showcase their knowledge. Many students are attending the program using employee benefits. Capstone projects offer projects that often benefit these employers [14]. Students are able to complete a project for their organization with faculty oversight benefiting the student and the organization. Other students complete projects for community and non-profit organizations. Still others may lead to new business ventures.

#### A. Sample Projects

In December of 2007, two students completed a capstone project titled "A Practical Guide for Conducting a Computer Forensic Investigation." that developed an open-source toolkit and methodology for risk assessment. Both of these students hold the CISSP industry certification and have professional experience conducting forensic investigations. The sponsor for this project was NPower, a non-profit organization whose mission is to provide other non-profit organizations with technology solutions. NPower is providing training on this methodology for volunteers to service non-profit organizations.

The project developed a procedural, software, and hardware toolkit for conducting a forensic investigation. The project began with specifying the equipment that an organization should equip their forensics investigation team with. Specific products were recommended along with comparisons to other products.

The investigation methodology completely covered the areas of assessment, collection, analysis, and reporting. Best practices were provided at every step of the investigation process along with forms for documenting progress and the chain of custody for all evidence.

At the capstone fair, these two students set up a computer with the Linux distribution that they created and installed. They had a copy of their report and explained their project to all who stopped by their table. Their project was an example to other IA students of a successful capstone project.

These students have presented their project at a local Great Lakes Chapter of ISSA meeting. The toolkit is also being used by another local group for a regional skills alliance training program. Automation Alley is using this toolkit and methodology as a basis for a security assessment available to new and developing businesses in southeastern Michigan. Again, these students followed best practices in their methodology. This adherence to best practices provides guidance to the community when using open source tools.

An important aspect of capstone projects is the addition of continuing phases of a previous project. The eleven week semester schedule presents a time constraint on possible projects. Some projects may be divided into phases and continued by another group of students in subsequent semesters. For example, the forensic project just discussed is currently in use by these two students at their employer. Other students from the same organization will be using the forensics project as a baseline to develop more specific forensic procedures and case analysis tools in their own future capstone project.

Another facet of the capstone project is the exploration of new business ventures. Many Walsh students have a business background rather than a computer science background. Most of the capstone research centers around practical applications of information assurance in the business sector. Two students with accounting backgrounds developed a business plan for securing information for other accounting firms. They actually created a security program, assessment plan, and best practices for accounting firms. This plan was tested on a Michigan accounting firm with positive results. This project is now offered as a service by the students' accounting firm.

Yet another capstone project has also been a model for a new business. Two students with security clearances have completed a site survey to repurpose unused tempest sites as secure storage sites for secret data. They detailed the requirements needed to securely store government data. They visited unused tempest sites to determine the feasibility of bringing them up to current standards. One site was unusable and the other site was usable. The students have contacted their local Small Business Administration for assistance with starting their business.

#### B. Faculty Suggested Projects

Some students do not have an appropriate project idea. The faculty members mentoring these students will suggest a project that benefits the student and the school. For example the faculty member might suggest that the student take on a project that would otherwise have to be done by a faculty member. For example, a project might be suggested to design a remote access computer lab for

the IA department. Faculty suggested projects like this should include the following or similar steps:

- Survey the IA and BIT faculty for their lab needs.
- Assess the current lab hardware and software that might be available for use in a remote lab.
- Contact other schools and document their remote lab solutions. It should be possible to capture best practices and solutions.
- Specify the hardware, software, s and network access that would be needed for the remote access lab.

The deliverables at the end of this faculty-suggested project include a lab design that has been approved by the Director of the Information Assurance Center and the department chair, a RFP document for the hardware, software, and Internet access needed for the lab.

Another project that will be suggested to students would be to create captured stream of network traffic for use in various IA classes. IA Faculty need new and varied sets of captured packets to illustrate TCP handshakes, SYN flood attacks, malformed packets. And large sets of packets for use in student exercises in utilizing filters to isolate connections. This faculty suggested project would need to include the following steps:

- Survey the IA faculty for their needs.
- Obtain the software necessary to create the desired packet streams and packet types.
- Configure an isolated network to create and pass the traffic.
- Contact other schools and document their remote lab solutions. It should be possible to capture best practices and solutions.
- Specify the hardware, software, s and network access that would be needed for the remote access lab.

Other examples of potential projects would include: designing a micro-site for the IA program's encryption class that contains course information, slides, no cost encryption tools, and java or php scripts for solving simple ciphers.

#### C. Maintaining project and employer confidentiality

As these projects are often very confidential in nature, Walsh College has a responsibility to maintain student and employer confidentiality. Employer sponsors often require the students and the faculty advisor to sign a non-disclosure agreement. These agreements are maintained in a locked cabinet in the Director's office. The advisor normally does need to meet with the sponsor regarding the outcomes of the project several times during the semester, so the advisor is cognizant of the name of the employer. However, all capstone documents may be submitted without the employer's name. Weekly projects and communications make use of the Walsh College

learning management system. This system uses Secure Socket Layers (SSL) and does not transfer information over the network in clear text. All login data and communications are protected by SSL. Combining this technical security with the anonymous submission practices protects the confidentiality of students and employers.

During the public capstone fair, employer names are not used if confidentiality is required. Certain aspects of the project may not be displayed publicly. For example, the results of a security assessment may not be displayed, but the methodology following best practices may be displayed. When students first approach their advisor with a sponsor, the advisor does contact the employer and ask about the need for confidentiality. As students prepare new business ventures, there is also confidentiality required. Again, the advisor will sign a standard non-disclosure agreement with the students to not reveal their new business plans. All confidential student projects are stored in a locked in a file cabinet in a locked office.

#### D. Plans for the Future

Walsh College has plans for expanding the visibility and effectiveness of the capstone course. Walsh is seeking IACBE accreditation and a capstone course is an accepted method of assessing student learning. We would like to expand the capstone concept to other programs to improve our assessment capabilities.

The collection of the non-confidential student capstone projects need to be cataloged and placed on-line with appropriate indexing and search capabilities. A library of capstone projects would help students determine what projects have already been done as well as provide a sense of the scope required for a capstone project.

Walsh College is expanding the list of organizations that are notified of the capstone fair. We are currently reaching the local chapters of the Information Systems Security Association (ISSA) and the High Technology Crime Investigation Association (HTCIA). We plan on expanding that list to the local chamber of commerce and the local chapter of the Project Management Institute (PMI).

Walsh has recently expanded their internship program. The BIT capstone course should be able to be integrated into an internship to bring additional value to the student and the organizations providing student internships. We also plan to expand our outreach into local K-12 school districts by encouraging students to take on projects with a school district that will have the students using their newly acquired IA skills to assess and improve the security of the districts security.

#### IV. RECOMMENDATIONS

For any school considering the implementation of a capstone course, the IA department at Walsh College would recommend the following:

- Determine the goals for a capstone course at your school and design your capstone to meet those goals.
- Determine the standards for project scope and depth to meet your school's capstone goals.
- Be prepared to provide students with a capstone project if they cannot develop one
- Develop a structure and schedule that allows adequate opportunities for assessment and progress monitoring
- Hold a capstone fair to provide closure to the degree program and provide the students an opportunity to communicate their project results to students, faculty, and potential employers

What has worked so well at Walsh College may not work in your educational community. We feel that a capstone course is a pedagogically sound way to end an IA degree program.

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