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# Two Different Approaches To Successful Capstones

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## TWO DIFFERENT APPROACHES TO SUCCESSFUL CAPSTONES

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### Abstract:

Many universities offer capstone projects as an integrating, experiential learning device for diverse theories that students might otherwise not be able to practice. This research describes two variations on capstones as exemplifying the diversity of such courses. This research develops a conceptual mapping of types of capstones, discussing two variations in real-world capstones in depth. The risks and oversight requirements of professors for the two variants differ considerably. Prescriptions for managing the risks with each type of project are offered.

**Keywords:** Capstone, information systems, risk management

## I. INTRODUCTION

A "capstone" is a high point, a finishing touch, and a crowning achievement. In many MS and MBA programs, a capstone course is meant to be a student's crowning achievement, proof of expertise in integrating two years of courses in a single project.

Capstone course designs differ considerably, varying by purpose, criteria for success, conduct, and even outcomes. As a result, it is difficult for a professor embarking on capstone teaching to determine how to structure and manage such a course.

This research describes two very different approaches to capstone teaching. The approaches can be viewed as ends of a spectrum for consulting project capstone courses. By comparing the risks, benefits, and management options via the two methods, we develop recommendations to professors new to teaching capstones so they may make informed choices for structuring their courses.

Although a diverse body of research on capstone courses exists, no cumulative tradition has developed. Therefore, there is no base upon which to build a knowledge base for capstone course structuring decisions. We propose that this research become the first upon which to begin developing that tradition.

In the next section, we describe the environments at the two universities and their capstone programs. Then, the risks relating to course structuring decisions with potential mitigations are defined. Finally, we analyze the risks to identify the course structuring decisions for new capstone professors.

## II. CAPSTONE DEMOGRAPHICS

The university capstone programs for the Walsh College MS in Information Assurance (IA) program is compared to the technology capstone for University of Dallas Graduate School of Management (UD). Table 1 summarizes the university demographics. The courses are similar in length with one 11 and the other 12 weeks. Walsh's capstone is for MS students in IA and IT programs and at UD the capstone is part of the MBA program. In both programs, international students are more likely to have little or not work experience and average about 27 years old.

**Table 1: University and Student Demographics**

Category	Item	University of Dallas	Walsh College
School	School Type	Business Graduate School	Business Graduate School
	School Main Location	Irving, Texas	Troy, Michigan
	Length of Term	12 weeks	11 weeks
	Degree Type using Capstone	MBA	MS
Student Profile	Age	33	34
	Average Work Experience	11 Years	12 Years
	% Foreign Students	20+%	15%

Table 2 summarizes the capstone courses for the two universities. Both schools use real-world projects as the basis for capstones. The table illustrates that, except for team projects at UD and individual projects at Walsh, the programs, on paper look similar. This similarity makes the programs an interesting contrast.

**Table 2: Summary of Capstone Courses**

Category	Item	University of Dallas	Walsh College
Project and Client	Capstone Project Type	Technology Capstone, including Information Technology (IT), IT Service Management (ITSM), and Information Assurance (IA) projects; Must be for an organization (i.e., not the professor)	Information Assurance and Information Technology programs and projects
	Client Cost of Capstone Project	Non-profit organization project are no fee; other projects are \$500 - \$3000 plus expenses	No fee
Project	Project Selection	Professor	Student (when student does not have a project the professor helps select project)
	# of Students on Capstone Project	Groups ranging from 2-5; Must be group	Most are individual capstones (with permission 2 students may work on a significant project)
Graded Items	Project Deliverables	Statement of Work (SOW)	Proposal and SOW
		Non-Disclosure form; can be client NDA	Risk Assessment and Mitigation Plan
		Project Plan (Part of SOW)	Project Plan

**Table 2: Summary of Capstone Courses -- Continued**

Category	Item	University of Dallas	Walsh College
Graded Items	Project Deliverables	Weekly Status Report for professor; Bi-weekly meeting with professor	4 Status Reports throughout the semester
		Change Management and Process (As needed)	Change Management Form and Process (As needed)
		3 In-class Presentations: SOW, Mid-term status, Final project report (paper and CD)	Three meetings. At the end of the semester the students complete a "Lessons learned" document as well as Final Product on a CD or DVD.
		Update report for client as agreed	Professor contacts clients on project progress several times during the semester. Clients are invited to the capstone fair. Projects without a client have reports to the professor
		Custom deliverable for client (final report, program, web architecture, working web site, research, user guide, technology guide, etc.,) depending of project type	Lessons learned
	Final client presentation	Capstone Fair poster presentation	
Grading	Grading Components	15% -- Peer Evaluation 50% -- Professor Evaluation 35% -- Client Evaluation	100% Professor assessment of ... Nan to provide
	Grade Ranges	A-F	A (Pass) or Fail

### III. CAPSTONE PROJECT COMPARISON

Capstone management can be characterized as project conduct, goals, and measures of success. Each of these is discussed in this section.

#### Capstone Research

Capstone project can be projects or cases [Diamon, et al., 2008; Livermore and Poullos, 2008]. Cases tend to traditional classroom exercises with readings that culminate in a student paper [Carrano and Thorn, 2005]. Real-world projects tend to develop a product for a client [Gupta and Wachter, 1998; Livermore and Poullos, 2008]. Further, projects can be unstructured or structured in terms of student activities, responsibilities, and deliverables [Carrano and Thorn, 2005]. Projects also differ by who obtains the project—student or professor. Student projects tend to be work projects for which they get college credit while professor projects tend to be work for organizations with which their university has a relationship.

Capstone goals are pedagogical or practical. Criteria for success pedagogical success are evidence of learned skills and behaviors, and development of reasoned courses of action [Murray, et al., 2008]. Real-world, practical projects expect successful resolution to the problem being addressed [Gupta and Wachter, 1998].

Capstone success measures vary with the course goals. Pedagogical, case capstones tend to rely on quizzes, papers, surveys, and other empirical means to evaluate learning. Project capstones are evaluated based on quality of both process and product. Class evaluation is performed by the professor; project evaluation might include the professor, student peers, and clients.

Both Walsh and UD use project courses but Walsh uses individual projects while UD uses team projects. Walsh capstones are individual proof of technical expertise and are also used for assessment of learning (AOL). The UD capstones are cross-functional in nature and can integrate any of the skills taught in the MBA program with an emphasis on technology skills.

At Walsh, the capstone projects are obtained by the student while at UD, the professor obtains the projects. Both universities require specific documents, such as a statement of work that includes a project plan, status reports, and final project reports. There are many differences in content and use that relate to the project risks discussed below.

The main means of grading differs at the schools while the content – process and product – is similar. At Walsh, the professor does all assessment, using pre-published criteria. At UD, peer team members, clients, and the professor all provide assessments.

### **Project Characteristics**

Project structuring at UD and Walsh differs substantively; as a result of the structuring differences, the project risks also differ. Therefore, the professor's managerial actions taken to mitigate the risks also differ. This section describes the risks relating to conduct, goals, and success measures for the capstone projects. In addition, the capstones differ in the extent of structuring. The differences between UD and Walsh capstones lead to different risks and potential mitigations.

UD projects are unstructured in the pre-class planning for project work. The students' responsibility is to define the scope and deliverables, develop a work breakdown structure to define the details of the work to develop the deliverables, acquire any technical skills needed to conduct the work, manage the work to a successful conclusion, and document the project in a final project report. Students begin the project on the first class day and end some time from mid-class to ten days after the assigned course end.

The basic goal of a UD project is client satisfaction through satisfactory completion of project work. Project success measures both process and product, with 40% of the grade based on quality of the project process and 60% based on quality of the finished work. UD has been running capstone projects for about 50 years. The two technology capstone professors have ten and three years of capstone mentoring and over 180 successful projects between them. About 10 projects have not been successful and were redone; only about four students actually failed the course.

Walsh projects are procured by students and approved by the professor. Projects are structured to fall within student skill sets and have mostly fixed deliverables. Students are allowed to begin the project in an earlier, non-credited semester with completion in the actual capstone course semester.

The basic goal of a project is satisfactory project completion as evidenced by a Capstone Fair at which projects are showcased. Project success measures quality of the finished work and is conducted solely by the professor with client input. AOL rubrics are developed to describe the outcome for the entire group of capstone projects.

Walsh professors have been running capstone projects for eight man-years with over 175 successful projects. About seven projects have resulted in failures with another one student per semester dropping the class when a failure is imminent. Consistent assignment of the same

professor to capstones allows students to pre-start their projects and reduces student anxiety because the professor and process is known.

### Unstructured Project Risks

The differences in capstone projects described above lead to different project risks that require different methods of mitigation (see Table 3).

Unstructured projects are defined as projects for which there are two known deliverable products (statement of work and progress reports) at the time of project initiation. Students must interview the client to determine the full scope of their endeavor and to define the deliverable products that will satisfy the work request. The deliverables must be agreed upon by both the client and the professor. If students cannot determine or perform the needed work, the professor is required to be more involved than desirable and student grades ultimately suffer.

The final project report contents differ by project type and may range from supporting documentation for work completed or may be the project work.

**Table 3. Risks and Mitigations for Unstructured Projects**

Type	Risks	Mitigations
Professor Solicited	Scope may exceed ability of the team to complete	<ol style="list-style-type: none"> <li>1. Requires professor notice to the client at the time of project definition that the amount of work is subject to the number of students assigned.</li> <li>2. Requires customer negotiation on final project, type of effort, and deliverables</li> </ol>
	University and professor reputation is risked	<ol style="list-style-type: none"> <li>1. Professor seeks to define scope adequately during the solicitation process.</li> <li>2. Professor led activities that result in lower grade</li> </ol>
Unstructured Project	Lack of student technical or project-required skills	<ol style="list-style-type: none"> <li>1. Professor led training</li> <li>2. Access to experts or expertise (e.g., W3C schools)</li> <li>3. Self-study and sweat-equity</li> </ol>
	Lack of student project management skills – structuring work, decomposing work to task level, assessing time required for tasks, task assignment	Professor led activities that result in lower grade
	Lack of technical resources	Professor ensures before the project start that it is not dependent on funding or special resources that may not be available.
Project team	Lack of student commitment – lack of intellectual engagement, lack of team spirit, other?	<ol style="list-style-type: none"> <li>1. Professor led activities that result in lower grade</li> <li>2. Removal from team</li> <li>3. Expulsion from the course</li> </ol>
	Lack of student leadership	Professor led activities that result in lower grade
	Lack of follow through on commitments	Professor led activities that result in lower grade

**Table 3. Risks and Mitigations for Unstructured Projects -- Continued**

<b>Type</b>	<b>Risks</b>	<b>Mitigations</b>
Project team -- continued	Lack of work quality	<ol style="list-style-type: none"> <li>1. Professor review with revisions and re-review before any presentation to clients.</li> <li>2. Client approval of work products and sign-off of final project report and deliverables for any grade.</li> </ol>
	Lack of writing skills	<ol style="list-style-type: none"> <li>1. Document outline approval required.</li> <li>2. Professor review of all work products with revisions and re-review before any presentation to clients.</li> <li>3. Use of prior capstone's similar documents as guidelines.</li> </ol>
	Poor student strategy	<ol style="list-style-type: none"> <li>1. Extra effort by student</li> <li>2. Unsatisfactory outcome</li> </ol>
	Students exhibit novice behaviors that cause them extra work	<ol style="list-style-type: none"> <li>1. The course's only lecture on the 1<sup>st</sup> day counsels students on typical novice behaviors and how to circumvent them to consciously become expert in new areas.</li> <li>2. Self-study and sweat-equity</li> </ol>
Client Satisfaction as primary goal	Lack of client commitment – insufficient meetings, information, content (web sites), contact with right people, timeliness of all work but particularly reviews	<ol style="list-style-type: none"> <li>1. Client is cited as critical path problem in status reports.</li> <li>2. Professor discusses issues with clients.</li> <li>3. Work goes on without them.</li> <li>4. Final project reflects omissions.</li> </ol>
	Inability of students to complete the work	Requires mid-project re-negotiation and could result in reduced project fee
	Lack of student technical or project-required skills	<ol style="list-style-type: none"> <li>1. Professor led training</li> <li>2. Access to experts or expertise (e.g., W3C schools)</li> <li>3. Self-study and sweat-equity</li> </ol>
	Clients may develop unrealistic expectations	<ol style="list-style-type: none"> <li>1. Professor discusses scope, schedule, maintenance, etc. issues as part of project while obtaining projects. It may also take continuing dialog throughout the semester to keep expectations realistic. Occasionally, this has meant added work for the student teams.</li> <li>2. Student seeks to manage scope creep as part of their project management. Occasionally, the professor negotiates scope changes with students and the client.</li> </ol>

### Structured Projects

Walsh College's capstone is structured by provision of a series of documents and analyses that are required of students during project work. For instance, a risk analysis and mitigation plan is required before a statement of work is signed off by the professor. Process scope is approved by the professor before any project work begins and can be approved one

semester in advance of the actual capstone course to allow students to work in advance on their projects. Risks and mitigations are summarized in Table 4.

Every semester, a Capstone Fair showcases poster presentations of each project. The fair provides visibility of the projects throughout the business school and client community. As a result of this open exposure, students are motivated to develop quality projects so they are not embarrassed at the fair.

The professor meets with the client before a project is approved and may discuss the project with the client several times during the semester. Clients sign off approval upon project completion.

**Table 4. Risks and Mitigations for Structured Projects**

<b>Type</b>	<b>Risks</b>	<b>Mitigations</b>
Student Solicited	Scope too small to be significant	Professor and client approval before project initiation
	Scope too large to be completed	1. Professor and client approval before project initiation 2. Mid-term project re-negotiation by the student
Student Solicited	Student reputation is at risk. Project issues may be overlooked to avoid renegotiation.	1. Correct scoping and knowledge of company. 2. Change management to renegotiate scope.
	Client removes funding in the middle of the project	Finish the project for the class but the company probably does not use the project work.
	Procrastination reduces likelihood of success	1. Status reporting to professor results in counseling to get working 2. Student drops the class
Structured Project	Student meets all requirements and little else, i.e., quality of output might be low	Visibility of projects at the Capstone Fair at the end of the semester exposes clients and the entire business school to student work. Low quality projects usually result in students not getting desirable jobs.
Individual project	Lack of student commitment or Unable to complete project	1. Mid-term project re-negotiation 2. Grade of 'F' and re-take the course
	Lack of student project management skills	1. Required program knowledge? 2. Grade of 'F' and re-take the course 3. Drop before the week eight deadline
	Lack of work quality	1. Project plan methodology requires identification of best practices to be applied to the work 2. Interim reviews by professor 3. Client approval of work products 4. Public exposure at Capstone Fair motivates higher quality outcomes
	Lack of student structuring, coding, testing, or documentation skills for the project	Students are required to complete the projects. They are counseled to choose a project for which they have, or can reasonably expect to learn, the appropriate skills



**Table 4. Risks and Mitigations for Structured Projects -- Continued**

<b>Type</b>	<b>Risks</b>	<b>Mitigations</b>
Client	Lack of client commitment – insufficient meetings, information, content (web sites), contact with right people, timeliness of all work but particularly reviews	1. Requires professor to be aware of student and client to assess commitment issues 2. Student does his/her best to overcome the issues
	Clients may develop unrealistic expectations	Because students are responsible for their own projects, it is their responsibility to deal with these issues. Occasionally, this places student grades at risk.
AOL as primary goal	AOL goals may be met while client goals are not	This problem usually relates to unrealistic expectations. Expectation management is as much a pedagogical goal as technical project completion so it may happen that AOL goals are met even though the client is ultimately not happy about the project. This is a student responsibility but professors are sympathetic to unrealistic clients.
	AOL goals are predominantly the professor's rating but include customer input.	Students likely to fail drop the class.

#### **IV. DISCUSSION**

In the previous section, project risks and multiple methods of dealing with them were presented. The mitigations must recognize that the severities of problems are not the same across or even within projects. As a result, a set of potential mitigations should be developed to ensure the most efficient means of dealing with problems.

Professor-obtained projects cannot be cancelled because the university's reputation is invested in the capstone projects and teams. This means that professor involvement becomes mandatory when a project might fail. UD projects often have professor led activities to guide work for groups that are not sure how to proceed. This risk is unique to the professor obtained projects and one that causes significant professor problems.

Most risks relating to unstructured, group projects relate to the group nature of such projects. The methods for dealing with them have to incorporate multi-cultural awareness, multiple learning methods, and alternative mitigations that relate to the context. As a result, most of the problems occur during project execution and require constant professor vigilance on the status of the project.

On the other hand, most risks in structured, individual projects relate to the individual student. Since the Walsh course is essentially pass/fail in nature, the motivation for the student is built into the grading. This in turn, affects the nature of the projects selected and relates to the risk that the scope may be too small to be significant. As a result, most of the problems with a structured, individual course should occur at the beginning of the course during project approval. In event of a project failure, students will drop the capstone class before actually failing. They retake the class the next semester. If there is a loss of reputation with a client, the student bears the loss.

Client expectations management is an issue for both types of capstones. Both types of projects are subject to problems relating to unrealistic client expectations. Some clients have expectations of the students providing on-going maintenance in perpetuity. Some clients have

just wanted free labor with no concern for program goals. Scope creep has also been an issue which has put student's grades at risk because they must finish at the end of eleven weeks. Other issues include client's ability to synchronize schedules with the college calendar

In the unstructured projects, this task is partly the responsibility of the professor in obtaining the project and partly the responsibility of student teams throughout the semester for scope creep. If students are unable to cope, the professor steps in to manage the relationship. In structured projects, these issues become the student's and can put the student grade at risk. In both cases, as long as the project as stated in the SOW is completed, the AOL goals and the client goals are considered satisfied whether or not the client is, in fact, satisfied. Project success in these cases becomes a judgment call for the professor.

### Research Shortcomings

This research evaluates two types of real-world capstone project courses at the graduate level. Capstones variations -- student vs. professor solicited, individual vs. group, and undergraduate vs. graduate should be evaluated to determine universality of risks and mitigations reported here. In addition, some capstones use cases rather than real-world projects. Cases offer different risks and require different mitigations. As a result, capstones that rely on cases also require more careful research to develop prescriptions for their management.

## V. CONCLUSION

This research compares two methods of capstone management for real-world projects. These two approaches highlight the decisions needed in structuring a capstone, defining its risks, and developing risk mitigation plans. Professors embarking on mentoring capstone projects should consciously define project management techniques to be applied and define the risks and possible escalations that relate to their project choices.

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**Sue Conger**, Ph.D. is the Director of both IT and IT Service Management programs and has mentored over 130 capstone projects for the Graduate MBA program. She is the author of three texts and over 20 journal articles. Her work focuses on innovation in computing, governance, and privacy. She is on the editorial boards of four journals and is actively involved in the profession as a VP of AIS, President of SIG SVC, member of the itSMF-USA Education Committee, Chair of the itSMF-USA Research Sub-Committee.

**Jeff A. Livermore**, Ph.D. is currently the Chair of Business Information Technology and Information Assurance at Walsh College. Jeff has run the Walsh BIT capstone course for several years and published his first article about capstones in 2008. He published eleven papers in 2007-2009 on agile software development and pedagogical ethics in information assurance.

**Nanette Poullos**, is a CISSP, CISM, PMP and holds an MA degree from Wayne State University. She has been a security consultant, instructor, standards specialist, corporate communications consultant, and project manager in information protection and security for large and small-scale computer networks for the last twenty years. She has taught various topics within information assurance which included training security teams for fortune 500 clients. She is currently the Director of the Information Assurance Center at Walsh College. She is currently enrolled in a doctoral program at Nova Southeastern University specializing in information assurance.