

The Graduate Capstone Software Project Management Class: A Review and Critique of Selected Designs and Delivery Modalities

Dr. Carl Clavadetscher, Professor
CLAVADETSCHERC@NDU.EDU¹
Information Resources Management College,
National Defense University
Ft. McNair, Washington, DC, 20319, USA
And
Adjunct Professor,
Graduate School of Management and Technology
University of Maryland, University College
[HTTP://www.umuc.edu](http://www.umuc.edu)
Adelphi, Maryland

Abstract

Three Masters level courses in Information Technology (IT) Program/Project Management taught on two sister campuses in both classroom and Distance Education (DE) format to two very different student bodies are explained, compared and evaluated for possible application elsewhere. Course foci are: (1) software engineering project management issues, (2) IT program management issues, and (3) Chief Information Officer (CIO) IT resource management issues. Conclusions are: (1) any of these three courses is appropriate for a suitable program, and with tailoring, (2) all three could be in the same program for complementary completion by graduate students. Consideration of the expected placement options of graduates should be paramount in determining which of the three is/are present, required, or an available elective option. Distance education (DE) tailoring is discussed in general and specifically.

Keywords: Software Engineering, IT, Project Management, CIO, Program Management

1. PAPER OVERVIEW

Curriculum design is always a "balancing act," a trade-off exercise between the very large domain of what can be taught and the small space of what there is room for.

In many programs where the author has had a role in curriculum design (including two DPMA standard IT curriculum efforts) the "capstone" or "management" course was/is a single one-term experience. Inevitably it was a very busy course, and represented major tailoring.

This paper reviews three courses that might individually or collectively present curriculum designers with options for a one, two, or three course package for Masters level courses in IT management. An IPO model is used for framing the discussion. Consideration is given to whether the course is to be presented within a traditional classroom or by online distributed or distance education.

2. PROCESS: THE INSTITUTIONS

This paper is based on the author's experience in the period 1995 to the present, teaching as adjunct faculty at

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units of the University of Maryland, located at the North edge of the greater Washington, DC area. [The author's fulltime job is in Washington, DC, teaching government employees: [HTTP://WWW.NDU.EDU/IRMC](http://www.ndu.edu/irmc)]

CAMPUS 'A'

The University of Maryland University College (UMUC) Separately accredited since 1970, and providing degrees for over 50 years, UMUC is a Forbes Magazine "Top-20 Cyber University," grants the doctoral degree, and has a world-wide student body consisting of "adult, part-time students." Annually the University serves nearly 70,000 students worldwide. It is headquartered in Adelphi, MD, adjacent to the UMCP campus.

The Faculty: Over 87% of UMUC faculty have Ph.D.'s; and an extensive successful record of management and professional experience in the relevant discipline.

The Programs: Master of Science In Computer Systems Management: The program serves the needs of programmers, developers, engineers, and other knowledge workers who aspire to move into technical leadership positions. The program is rich in real-life assignments and case studies. **Master of Software Engineering:** The mission of the program is to prepare students to engineer the development of software products and services for industry and government in a cost-effective manner. The emphasis of the program is on implementing software engineering projects within cost and schedule by applying proven and innovative practices. [This program was created as a joint effort with UMCP, listed below. It is now solely the responsibility of UMUC.]

Distributed/Distance Education: UMUC has a world-wide student body. Many students use the online distance-learning environment known as Web Tycho to complete courses. The author has worked with this product for six years, beginning with when the product was in "advanced beta" form. Classes are presented either 100% online or in WebTycho enhanced mode, where there is a blend of in-class and distance learning. Distance learning places special conditions (and possibly constraints) on the course designer and teacher. These will be discussed below.

CAMPUS 'B'

The University of Maryland College Park (UMCP). UMCP is a major educational and research University located in College Park MD. The University is a major national research and teaching university granting undergraduate and graduate degrees in many disciplines through the doctorate. Rankings vary by discipline but the University consistently is "top 25" and is in the "top 10" in a number of disciplines. Student population is primarily full-time "traditional" day students. The

faculty has a world-wide reputation for scholarship and teaching excellence.

THE WASHINGTON REGION

The campuses involved with the target courses are both large public (state) universities co-located in a major multi-state metropolitan area known not only as the national seat of governance, but also as one of the world's top research and software development market areas. Within the last five years growth in "high technology" in the area has outstripped even Silicon Valley. UMCP has a resident full-time day student population of "traditional" students, and UMUC has a mixed enrollment world-wide of part-time adult students. Two physically adjacent campuses in the same system reach radically different audiences in different areas.

3. INPUT: THE STUDENTS

UMUC: UMUC students represent one of the most diverse and geographically distributed student bodies in the world. As the catalog copy notes, these students are adult part-time students in evening programs. Most work full-time day jobs, many in the IT field. Professors are expected to bring to the classroom their job experience, and to relate course material to that experience. The litmus test is always "(How) Can I use this in my job?"

UMCP: Students come from a wide variety of backgrounds, and are generally traditional full-time day students. Many expect to pursue further graduate education.

STUDENT ARCHTYPES: Peer critics noted that any attempts at short summary of student population characteristics lack precision because of their brevity. To facilitate comparison and evaluation, the author offers two oversimplified stereotypical student profiles, which are NOT represented by the author to accurately reflect all of the diversity and complexity of the two referenced UM student bodies. They are presented to facilitate/simplify discussion herein only.

Traditional Student: Completed an undergraduate degree as a full-time day student, and directly entered graduate work as a full-time day student. Looks forward to beginning a career after completion of graduate studies.

Adult Learner Student: Completed an undergraduate degree either part time evening classes or possibly full-time day student. Possibly had a significant time break between finishing undergraduate work and beginning graduate work. Presently is employed at a full-time position, often in the field in which graduate

work is pursued. Average age is at least five years older than the traditional student.

4. OUTPUT: THE PLACEMENT MARKET

No single generalization would satisfactorily describe the market in the greater Washington DC area other than something like "huge, diverse, constantly changing."

While the federal government's needs for IT are immense, with annual IT related expenditures estimated at well over \$30billion/year, many major corporations and many more small organizations operate, and need IT, within the SMSA. Using figures from 2000, there were over 30,000 high technology IT jobs just in Northern Virginia, and a similar number in the area of Maryland adjacent to DC.

Job listings in the Washington Post run from calls for individual entrepreneurs to develop small websites to persons expected to play a role in projects with annual budgets of \$1billion. It is no local anomaly that employers stress "experience" not degrees. Companies are volatile and the smart worker is mobile--resumes should be kept current. Job ads for management personnel stress experience, measured in years, number of subordinate employees supervised, size of programs measured in budget dollars, and technical development environment measured by "C, C++, PKI, CMM, JAVA, COLD FUSION, XML, ORACLE 8I, DBA, SQL, COMSEC, CICS, MVS..." and many other acronyms of our field.

Position Categories: Three complementary jobs appear:

1. Hands on management of software in a specified environment (domain experience we call it). Generic skills in software engineering are called for, and prior domain experience is at least a bonus if not a necessity.
2. Hands on management of IT projects where technical background is complementary to, but does not outrank, general IT project management skills, and of course, domain experience.
3. Executive level leadership of a large organization managing portfolios of IT investment to maximize achievement of institutional goals and increase IT process and product efficiency.

DoD has an Advanced Management and CIO program at National Defense University specifically to satisfy this need. In 1995, the UMUC Graduate School formed an alliance with the National Defense University Information Resources Management College (IRMC). The purpose of this alliance is to expand academic opportunities by combining coursework from IRMC's Advanced Management Program and the Chief Information Officer Certificate Program with the Graduate School's technical track and capstone courses.

Position 3: Executive/Institutional CIO Decisions
Position 2: Hands On IT Project Management
Position 1: Hands On Software Development
Hierarchical View: Three IT Management Jobs

5. TAILORING THREE COURSES

CIO Jobs	Course C	Adult part-time
SW PM Jobs	Course B	mixed
SE PM Jobs	Course A	mixed

Relationship of IT Jobs to Course to Student Type

A wealth of local riches in students and jobs has allowed UMUC (and its original partner UMCP) to create three tailored courses which are represented in the table above. Given that there are many jobs in the UM market area for each of the three jobs, and a large student body wishing to enter the market, specialization is normal.

Why did they do this?: The design of the courses de facto "layers" to map against the three dominant general categories of IT jobs in the UM market area. Students can pick what they feel most comfortable with in terms of prior background or which program leads towards a career of the nature they want. Should a student complete more than one, and some do, that student would have a rich diverse academic background for IT project/program/institutional management.

6. DISTANCE LEARNING

DE Overview: Distance education (Web Tycho) is a normal part of the UMUC academic program, with the entire degree program for CSMN available online. Under UMUC, the MSWE program is 100% DE as well. UMCP is still basically bound by the traditional classroom but it has a traditional full-time day student population.

Students are widely different in attitudes towards DE. Most local students for whom the choice is real, prefer three-hour time-certain, bounded, face-to-face learning. But there is a significant and growing minority for whom the learning environment of DE is preferred, including many who self-identify as MBTI--ISTJ's. For many others around the world, it is DE or nothing.

Students strongly state a "dominant if not overriding value" that 'requiring DE for the sake of DE' is not smart. It is an acceptable option where choice is provided, and is preferred by some, some of the time. Most UMUC students work in social environments daily, and work in teams routinely, and they don't enjoy socially-devoid learning environments. But the wise professor can use the DE system advantages to overcome latent attitudinal negative pre-dispositions. And for students with geography as a decision factor,

and sometimes because of temporal job demands, DE is the only way to go.

DE learning environment: UMUC Web Tycho is hosted in Lotus Domino. It has the "usual" complement of DE options, including posting of syllabus and readings, posting of assignments and tests, and an E-grade book. It has EMAIL and distribution lists, and chat rooms (a most useful feature). Students can originate threaded discussions, build their own (team) private chat rooms for team projects, etc. Commercial equivalents such as Blackboard are available if your campus wishes to take this path but hasn't.

Perceived weaknesses of DE: Students see DE as requiring substantially more "overhead" when group projects are involved. Some (oral learner) students see some major loss of learning quality in the absence of class-discussions. But this can be virtually entirely overcome by professor initiative and guidance in the use of threaded discussions in chat-rooms. The student project-overhead or workload and workload efficiency issue likewise is ameliorated by the presenting of a carefully (instructor designed) segmented task, linked to the team work area and coordinating facility provided by team use of team-private chat rooms. Schedules have to be very carefully calibrated, and followed. No slips.

Perceived strengths of DE: students see DE as allowing truly asynchronous learning. They come, at UMUC, from all over the world, and can still function in small work groups "almost" as if in the same general area. Building audit trails of work performed is "automatic" and feedback can be swift and precise--and it must be both. Once students are briefed on meeting team responsibilities, they realize that "up front" planning can free them for task work, and that final assembly, testing, coordination of deliverables might be easier than if they counted on a more slowly and informally evolving social process from face-to-face communication. Many report buying "phone cards" though as a backup system.

DE without a DE environment: The author has used regular EMAIL for two terms to teach these classes. He has created EMAIL distribution lists and routinely sends out resources, readings, assignments, articles, etc. Students smile when they identify the author as the king of SPAM. But they value the resource enough to call and check if they haven't gotten anything for a period of time. They don't want to be off-line and left out. And they have found and regularly use, for business and pleasure, AOL's IM.

DE Course Adaptations: All three courses have been taught (by the author) in the DE format. All required "tailoring" to adjust to the medium and to student expectations.

Resources for any contemporary course can/should have considerable online material because it is good, it is there, and it is free. Note the Course B description which follows. The text was almost a sideshow to the WWW resources. Bookstores and associated difficulties suddenly are only marginally relevant.

DE students immediately perceive that it is in their immediate interests to avoid team projects because 'team anything' has high social overhead and risk. Students perceive likewise that assignment scheduling is critical, and push for delays much as in any other course. Wise faculty will resist such pressures.

Assignments were tailored with the expectation that all students had access to knowledge bases on the WWW or in their firms which contained "deliverables" with high re-use potential. Grading standards were higher for DE than for in-class work, and examinations were consciously more difficult and focused on the most recent issues to minimize that "re-use" factor. The author resists "time phased release" of readings and assignments, favoring letting all students have at the entire course starting on day one. Others might prefer to time phase availability, but if a student is taking a course DE, they might need the time flexibility to do work when they have available time, not when the instructor finds it convenient to release materials. Group tasks need a great deal of lead time because the FORM-NORM-STORM-PERFORM model works slowly on the WWW.

Faculty Time: you should allocate approximately 50% to 100% more "class contact time" than what traditionally would be budgeted: ~3-4 contact hours per week, ~5 hours in advising capacity, and 6-8 hours a week in preparation works fine for in-class teaching. Double this for DE.

Importance of communication: This author learned to read once, reply-to-all once, and to have a DE online log of announcements to avoid answering the same question 20-30 times serially. A non-graded activity included a "quiz" which forced students to navigate to virtually all of the course website. Questions illustratively included "when are your exams and what is their format?" Interest was high. Routine EMAIL to the class AMAIL list was valuable.

DE Lesson Learned: DE takes a different mind set, requires a large upfront investment in planning and preparation, but can lead to a really quality course. You might find DE lessons filtering into traditional classrooms. You can create either a supplement to traditional classroom exposure through EMAIL "virtual DE" class support, or you can do "most" of what is done in a DE classroom with IM and distribution lists for EMAIL. And to use the technology of IM and EMAIL enriches the instructional environment. Some students haven't considered the power of "REPLY TO ALL"

which is only a mouse click away. Most teens these days "live" through IM. Let your graduate students.

7. COURSE A: Software Engineering Project Management (MSWE)

Text: S.L. Pfleeger, Software Engineering: Theory and Practice, second edition, Prentice Hall, 2001.
<http://www.cs.umd.edu/~sharip/swebook/>

SupplementalResources:
<http://www.cs.umd.edu/~sharip/swebook/>

Examinations: Two, midterm and final, open book "online" for all format courses. "What is the future of: Cleanroom? Xtreme Programming? Explain."

Assignments: Per Instructor's Manual, using two text cases.

Term Team Project: Loan Arranger Case from text.

Course Schedule:

(wk1) Why Software Engineering and this course?

(wk2) Modeling SE process, Life Cycles.

(wk3) Planning, Managing SE Project(s).

(wk4) Capturing Requirements

(wk5) Designing System(s)

(wk6) Concerning Objects: OOAD

(wk7) Writing Programs

(wk8) Testing Program(s)

(wk9) Testing System(s)

(wk10) System Fielding/Delivery

(wk11) Maintenance

(wk12) Integration of COTS

(wk13) Process Improvement and SE

(wk14) Issues and Trends in SE and FINAL

8. COURSE B: IT Program/project management, CSMN.

Text: Software Management, IEEE, edited by Don Reifer, 5th edition.

Supplemental online references: Include but are not limited to:

<http://www.threesl.com/reference.htm>

Guidelines for Successful Acquisition and Management of Software Intensive Systems, (GSAM) V 3.0, May 2000.

<HTTP://www.stsc.hill.af.mil/gsam/guid.asp>

<http://www.dacs.dtic.mil/databases/>

<http://www.dacs.dtic.mil/databases/url/key.hts?keycode=120>

<http://www.tech.purdue.edu/textbooks/sadm/>

<ftp://ftp.oi.com/pub/oi/playground>

"Chaos" and "Unfinished Voyages"

<http://www.standishgroup.com/visitor/chaos.htm>

<http://www.standishgroup.com/visitor/voyages.htm>

SPMN Project Analyzer [aka guidelines for PM's]

http://www.spmn.com/pdf_download.html

SPMN"16BestPractices"

<http://www.spmn.com/16CSP.html>

<http://www.stsc.hill.af.mil/crosstalk/1999/feb/reifer.asp>

<http://ayna.hun.edu.tr/~sencer/objectp.html>

<http://c2.com/doc/oopsla89/paper.html>

<http://www.softstarsystems.com/Default.htm>

<http://www.extremeprogramming.org>,

http://www.xprogramming.com/what_is_xp.htm

<http://www.sei.cmu.edu/cmm/cmms/cmms.html>

<http://www.sei.cmu.edu/cmml/products/models.html>

<http://web1.ssg.gunter.af.mil>

<http://www.software.org/quagmire/>

Examinations: Students take both a midterm (open book) and final (open book) with both being application essay. Exams are designed to take 2-3 hours for the proficient student.

Assignments: Students either (1) **prepare three plans**, for an organization for which I provide a scenario, or (2) **critique three plans** that I provide and I associate with a case scenario. Which option clearly is an instructor decision before course start.

The three plans are:

- (1) Risk management plan,
- (2) Software metrics plan, and
- (3) Software quality assurance/testing plan.

Write three plans: seems easier for all, but it has a major downside risk. Students with commercial employment connections have access to commercial firm libraries, and their plans, and they can, and do, "lift" these, despite stern warnings about original work. I have offset this advantage by providing access to government sites that have many plan templates, but the point of the assignment can quickly be shifted or lost. So much is available online today, "white paper URL's" as one example, and organizations are making their corporate experience available to employees, that keeping the course a level playing field is difficult.

Students working for Booz Allen, or equivalent, have a gold mine of resources. Others don't.

Critique three plans: When the professor provides a case, and sample plans, and asks students to evaluate/critique, the workload to keep materials updated and original, term after term, is considerable, but classroom results are quite good. Students report that while they write less, they think more.

Course Schedule and linked Resources:

(wk 1) Course introduction, overview

Overview of course materials and structure, purpose, deliverables and evaluation.

Methodology Overview (tools and techniques)

<http://www.threesl.com/reference.htm>

Guidelines for Successful Acquisition and Management of Software Intensive Systems, (GSAM)V3.0, May, 2000.

<HTTP://www.stsc.hill.af.mil/gsam/guid.asp>

<http://www.dacs.dtic.mil/databases/>

<http://www.dacs.dtic.mil/databases/url/key.hts?keycode=120>

<http://www.tech.purdue.edu/textbooks/sam/>

<ftp://ftp.oi.com/pub/oi/playground>

(wk 2) Requirement Management

"Chaos" and "Unfinished Voyages"

<http://www.standishgroup.com/visitor/chaos.htm>

<http://www.standishgroup.com/visitor/voyages.htm>

DM, C 1

SPMN Project Analyzer

http://www.spmn.com/pdf_download.html

(wk 3) Best Practices: Role(s) of PM

SPMN "16 Best Practices"

<http://www.spmn.com/16CSP.html>

GSAM C 11

DM, C 5,6

(wk 4) Program Estimation and Scheduling

Reading "Cocoma II" by B. Boehm;

[SOFTSTAR or REVIC software]

GSAM C-11 GSAM II-N

<http://www.stsc.hill.af.mil/crosstalk/1999/feb/reifer.asp>

<http://ayna.hun.edu.tr/~sencer/objectp.html>

<http://c2.com/doc/oopsla89/paper.html>

<http://www.softstarsystems.com/Default.htm>

(wk 5) Risk Management

David Walker, "Defense Acquisition: Employing Best Practices Can Shape Better Weapon System Decisions," GAO Report, April 27, 2000.

GSAM C 6

<http://www.dacs.dtic.mil/databases/url/key.hts?keycode=270>

(wk 6) Program Structure and Staff Issues.

DM C 4

GSAM C 14

Best Practices: DOD Teaming Practices Not Achieving Potential Results. GAO-01-510,

<http://www.gao.gov/cgi-bin/getrpt?gao-01-510>

(wk 7) LIFECYCLES-I

GSAM C 5

NASA JPL on "spiral development"

http://www.wisds.jpl.nasa.gov/cwo/cwo_23/handbook/spiral.htm

(wk 8) LIFECYCLES-II

[FIRST DELIVERABLE DUE]

GSAM C 5 (review.)

<http://web1.ssg.gunter.af.mil/> [Find SEP under

"products and service"]

(wk 9) MIDTERM IN-CLASS OPEN BOOK

All references to date: lecture notes, readings, handouts. Short (half page) essay application questions.

(wk 10) Measurement and Metrics

[SECOND DELIVERABLE DUE]

PSM, [from DAD or WWW]

<http://www.psmc.com/>

GSAM C 13, II-N

(wk 11) Quality Processes

DM, C 5

GSAM C 2, 10, GSAM Vol II Appendix G,H,K,L,M

<http://www.extremeprogramming.org>,

http://www.xprogramming.com/what_is_xp.htm

<http://www.sei.cmu.edu/cmm/cmms/cmms.html>

<http://www.sei.cmu.edu/cmmi/products/models.html>

<http://web1.ssg.gunter.af.mil>

<http://www.software.org/quagmire/>

(wk 12) System Tradeoffs: C, S, P

[THIRD DELIVERABLE DUE]

Student papers: tradeoffs in cost, schedule and performance....

(wk 13) RFP's, Contracting, "Incentives for success"

GSAM C 8 GSAM II-S

http://www.arnet.gov/References/Policy_Letters/pbscsdc.html

(wk 14) FINAL IN-CLASS OPEN-BOOK ESSAY

All course references, readings, and student individual projects (you have to know your own!).

Sample questions: "What would your methodology be to estimate, from the beginning, the actual cost to complete this task, from analysis through to fielding? Explain your methodology and give a [rough] estimate of what you think it would take in time, manpower, dollars." **OR**

"What would your major CSCI's be on this project if done for real? What would the plan of execution be for the system development? What would your milestone review points have as (individual) exit criteria?"

OR

"What uses would you have for the three basic project requirement baselines if you did this task for real? What would your plan for configuration management be? Explain."

9. COURSE C: Strategic IT Management

Text: The basic text in this course is Kerzner's Project Management, 7th edition. It is a "desk reference."

Supplemental Resources: Substantial reading is required from HBR and online sources such as WWW.ITPOLICY.GSA.GOV. Students read excerpts from books or white papers by Parker and Benson on Information Economics, industry and government resources on business modeling and activity based accounting, OMB and GSA references on Functional Economic Analysis, a variety of resources on source selection and (performance based) contracting, classic sources such as SEI and SPMN on risk management and best practices.

ASSIGNMENTS:

Paper: Each student writes one paper on a topic relevant to one of the course modules. A list of topics is presented before the class and students can "negotiate" to take topics. The list is professor generated and changes each term. The student constructs a proposed outline for the paper which is reviewed by the professor. The list of papers guarantees "spread" and currency in the topics and is carefully scoped to give the students a sense of direction. This guidance leads to a quilt of student-generated material covering the entire course, which is a significant part of the overall student course learning resource. Student papers are posted to the University DE website for all to read and/or download. Paper writing is as old as teaching. Creating a student-generated course reference library online is new.

HBR Case: Each student is assigned to a team which does one HBR business case/presentation. This paper and presentation is likewise posted to the DE website for all to read and/or download. In both cases class discussion refers to these DE postings after they have been posted.

Examinations: Students take two open book examinations. Student materials in the DE environment are subject to questions on the final examination: team projects and individual classmates' papers

Course Schedule:

(wk 1) Overview Information Technology Acquisition

Paper topics assigned, Teams formed.

(wk 2) Aligning IT with Strategic Goals

Teams meet online and organize.

(wk3) Understanding Requirements: Business Modeling

One-page outline on assigned topic

(wk4) Understanding True Costs: Activity Based Costing

(wk5) IT Capital Planning: Information Economics

(wk6) Assessing Competing Investments

(wk7) Solicitation Preparation, Source Selection

Student individual papers posted online.

(wk 8) Mid-term Examination (open book)

(wk9) Project Management overview

(wk10) Teams, Team building, Change management

(wk11) Risk ID, measurement, management

Team projects posted to WWW.

(wk12) Contract Management

(wk13) Best Practices: Integrating IT Acquisition

(wk14) Implementation Issues and Final Exam

10. CONCLUSIONS

It is possible to have anywhere from one to three courses within a program at the Masters level in the general area of "IT management" which deal with, respectively, (a) software engineering issues, (b) program or project management issues, and (c) institutional resource management issues. This paper presents courses which achieve such goals for one campus. At the Masters level, there is reason to believe that more topically focused narrow courses might not offer the same integrative "real world" breadth experience required of real managers.

COURSE C: Executive/Institutional CIO Decisions
COURSE B: Hands On IT Project Management
COURSE A: Hands On Software Development

Hierarchically Represented: The Three Courses

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