

# Using Systems Engineering to Create and Guide a Successful Student Software Engineering Project Class when the Instructor is Half-Way around the World

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**Abstract.** The software engineering project class (MSWE617) is the capstone subject in the Master of Software Engineering program at University of Maryland University College. It may be considered as a comprehensive examination covering the application of the tools, skills and techniques the students have acquired in the course of their studies. This subject provides experience in applying software-engineering techniques by giving the students an opportunity to produce software working in teams under the schedule constraints commonly experienced in industry. The instructor emulates the vagueness shown by typical customers in describing requirements and serves as a guide and mentor, not as a traditional teacher.

This paper describes the experience of converting the traditional face to face synchronous class into a format to allow the instructor to guide the class into producing useable software within the 14-week semester from a location half way around the world. The paper also summarizes a number of lessons learned that are applicable to other classes in engineering management, systems and software engineering, using distance education techniques.

**Keywords.** Distance learning, software engineering, collaborative working environments, collaborative learning.

## 1 INTRODUCTION<sup>1</sup>

University of Maryland University College (UMUC) inaugurated its Master of Software Engineering (MSWE) degree in 1999. However, from the beginning, its success was contingent on having all subjects available via web based distance learning. This factor was taken into account when creating the degree. The subjects which covered the systems and software lifecycle,

were configured such that the students<sup>2</sup> would be able to perform any “laboratory” work on their own personal computers. The only risk to the web-based degree was the final project class (MSWE 617).

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<sup>1</sup> This work was partially funded by the DSTO Centre of Expertise Contract

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<sup>2</sup> These students were employed in the workforce and earned their degree by studying part time, mostly in the evenings. Their employment positions ranged from programmers to project managers. Some also had up to 20 years of experience in their respective fields.

## 2 THE FINAL PROJECT CLASS

This subject is the capstone class in the Master of Software Engineering program at UMUC. It may be considered as a comprehensive examination covering the application of the tools, skills and techniques the students have acquired in the course of their studies. This subject provides experience in applying software-engineering techniques by giving the students an opportunity to produce software working in teams under the schedule constraints commonly experienced in industry.

The class is a collaborative learning environment. The instructor is not present in a teaching role, but is only supposed to emulate the vagueness shown by typical customers in describing requirements and serves as a guide and mentor. The students are expected to have acquired the knowledge of what to do and how to do it from the prerequisite subjects. It is up to the students to form their own teams (organization) and schedule their work to meet the deadlines imposed by the contract (syllabus).

The subject was designed so that the class would only meet at the formal design reviews

- Operations Concept Review.
- Systems Requirements Review.
- Preliminary Design Review.
- Critical Design Review.
- Delivery Readiness Review.

However, the students were free to meet in between times, as and when they decided to do so.

The students also had to produce the appropriate documentation for the Software Development Life Cycle.

The operations concept for the distance education version of the class

The operations concept for the distance education version of MSWE 617 contained the following scenarios

1. The class would be taking place in UMUC's web based distance learning environment (WebTycho).
2. An effective web-based collaborative learning environment for the students.
3. Audio lectures by the instructor using PowerPoint graphics.
4. Public (class-wide) and private communications between the instructor and the students.
5. Students presenting PowerPoint presentations.
6. Transfer of documents between the instructor and students.
7. Students sharing documents.

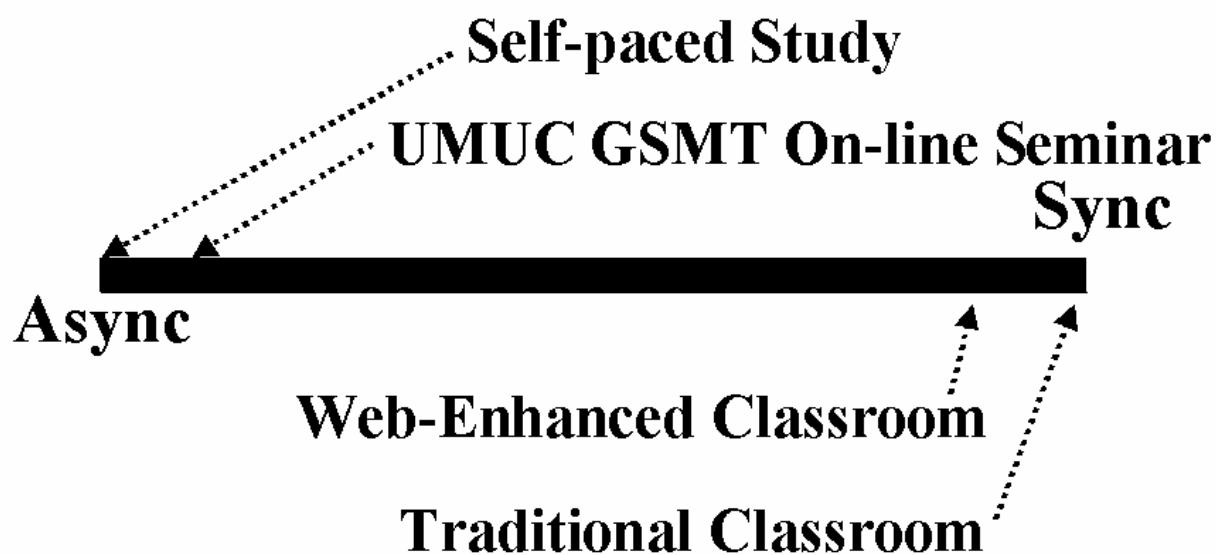
## 3 THE SYNCHRONICITY SPECTRUM

Postgraduate seminar classes are spread out along the synchronicity spectrum shown in Figure 1. The traditional face to face (f2f) classroom lies at the synchronous end of the spectrum. The f2f class can be augmented with a web page, a Listserver, and other asynchronous techniques. When web augmentation takes place, the web augmented traditional classroom moves away from the edge of the synchronous end of the spectrum towards the center.

At the other end of the spectrum is the totally asynchronous classroom. This represents the self-paced studies, correspondence schools and other techniques in which there is no synchronous contact between anyone in the class. The graduate school seminar that is mostly asynchronous does allow for synchronous student to instructor and student to student communications. Therefore, while the graduate seminar is not 100% asynchronous, it has so many of the characteristics of an asynchronous class that it will be referred to as an asynchronous class for the remainder of this paper.

## 4 SYNCHRONOUS AND ASYNCHRONOUS CLASSES

The difference between teaching in the synchronous (f2f) style of the traditional classroom and



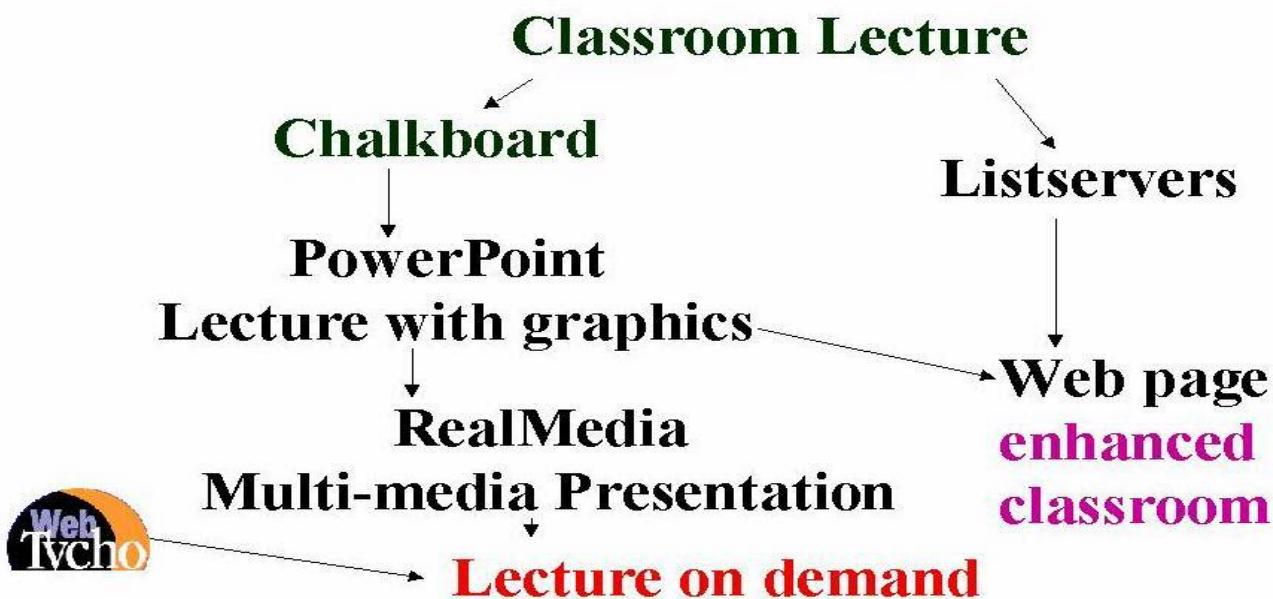
**Figure 1 The spectrum of synchronicity**

the asynchronous web classroom may be as great at the difference between the theater and television in the entertainment industry. This means that techniques that work in the synchronous classroom may not work, or may have to be modified to work, in the asynchronous classroom. Consider some of the differences

- **Dialogue** – unlike the f2f classroom, the asynchronous classroom has to use non-visual and non-verbal dialogue. Mechanisms such as the requirement for regular task completion, evaluation of frequency and depth of interaction (i.e. making it ‘count’) and hooks such as regular postings requiring student response, can be used effectively in classes where dialogue constitutes a significant learning resource.
- **Attendance** – unlike the f2f classroom with its fixed meeting times, the asynchronous classroom is available for longer periods of time in which both the student and instructor appear at sporadic or periodic time intervals. This requires specific time management skills.
- **Lecturing** – unlike the f2f classroom where lectures are interspersed with question and answer discussions, the asynchronous classroom is multi-threaded not single-threaded as

shown in Figure 2. The instructor cannot wait for a few days before continuing the lecture. Asynchronous pauses can, however, be advantageous to the learner who (depending on learning disposition and language proficiency) can benefit from the time available for reflection before responding to or asking questions.

- **Technical limitations** - there are things that can be done in the f2f classroom that as of the moment cannot be done in the on-line classroom. Designing the optimal asynchronous classroom requires that the capabilities and limitations of entire communications link between the students and the instructor be considered using a systems engineering approach.
- **Team building** - unlike the face-to-face classroom in which a team can begin to form in a few minutes as the prospective team members sit and talk, forming successful teams in the asynchronous on-line class requires a completely different approach. However, once developed, this approach can be retrofitted to the synchronous classroom to facilitate team building in that environment.

**Figure 2 The transition process**

## 5 THE PROTOTYPING APPROACH

The approach taken was a prototyping method following the transition from the synchronous to the asynchronous classroom methodology.

The plan was that the first and second iterations of the MSWE class would be traditional f2f-sections in the classroom; and the WebTycho class be designed using the lessons learned in those iterations. However, by the time the second iteration ran, several students in the programme had moved out of the area and needed the class to graduate. Had the plan been followed, those students would have had to delay their graduation by a year while waiting for the class to run. To avoid this situation, the second iteration was modified into a hybrid class.

## 6 THE REQUIREMENTS FOR THE CLASS

The requirements for the class were derived from the operations concept and the spectrum of synchronicity. Consider each scenario mentioned above.

1. The class would be taking place in UMUC's web based distance learning environment (WebTycho). This is a constraint imposed by the institution and sets the scope of the project.
2. An effective web-based collaborative learning environment for the students. This was the highest risk. Students were already collaborating on simpler projects in WebTycho to produce single documents but with what appeared to be the usual mixed results of students working in teams. MSWE 617 would require that the students produce a suite of documents as well as a working software product.
3. Audio lectures by the instructor using PowerPoint graphics. This wasn't a problem. The technology had been used in other Web-Tycho based subjects in the program (Kasser and Kerby 1999).
4. Public (class-wide) and private communications between the instructor and the students. This wasn't a problem. The technology had been used in other WebTycho based subjects in the program. The rule of thumb for these communications had been as follows. If it was

- A question - that in the classroom would be asked aloud in front of others, or others in the class would benefit by the reply, then post it in the appropriate thread or on the Listserver.
  - Personal - as in asides after class, or during the break in the classroom, use E-mail, fax, voicemail or synchronous communications (telephone or Internet voice).
5. Students presenting PowerPoint presentations. The technology had been used in other WebTycho based subjects in the program.
  6. Transfer of documents between the instructor and students. This capability was built into WebTycho.
  7. Students sharing documents. This capability was built into WebTycho.

Thus, the reuse of techniques from other WebTycho classes provided most of the capability needed for the WebTycho version of MSWE 617. The only risk remaining was to determine if the project could be completed in the WebTycho environment.

## 7 THE HYBRID CLASS

### 7.1 The design

The hybrid class proved to be an excellent way to mitigate the risk invoked by a totally WebTycho based class as it provided an opportunity for a side-by-side experiment. The class was designed as follows.

- There would be several teams of four to five students, depending on the enrollment. At least one team would be a WebTycho team
- Each milestone review would be presented using a mixture of synchronous and asynchronous techniques. The formal presentations would be done asynchronously, via WebTycho. This approach would allow all the teams to preview the presentations before the reviews
- The discussions would be f2f and via WebTycho. This, and the asynchronous reviews

for all teams, would allow the WebTycho teams to feel part of the entire class.

- The f2f teams had the choice of meeting f2f or using WebTycho and other non-f2f techniques. The WebTycho teams were prohibited from meeting f2f even though some team members would be in the local UMUC service area.

All students enrolling in the subject that semester were offered the opportunity to select between the WebTycho and f2f sections and were assured that there would be no assessment penalty if the experiment failed. While there were really too few distant students to make up a viable team, enough local students chose the WebTycho option to form one WebTycho team.

After the plan had been finalised the instructor decided to relocate half way around the world. This meant that not only would there be distance-students, there would also be a distance-instructor. While distance-instructors were commonplace in the WebTycho classes, there hadn't been a distance-instructor in a f2f class – a major risk to the success of the class.

Drawing on the results of ongoing research mitigated the risk. While in the process of converting subjects in the MSWE programme from f2f to WebTycho and employing asynchronous PowerPoint enhanced audio lectures, it had been recognised, that there was very little difference between a classroom and a conference session. Distance mode presentations had been made with the aid of the session chair (Kasser 2000). Thus if the instructor was considered as a distance mode presenter, all that was required was a session chair to be present in the classroom to facilitate the f2f milestone meetings. Ms Kimberly David-Chung undertook the role of session chair in the guise of a teaching assistant acting in two areas of activity associated with the class. The first area was in the running of the hybrid classroom. The second area is in the continual development of the subject to make it function entirely in the WebTycho environment. In particular, she had the following duties

- Help develop the student project ideas by interviewing potential clients within the University.
- Act as single customer interface between students and university staff to minimize impact on staff workload while students were developing the software.
- Assist with audio word processing of student presentations as necessary.
- Represent the instructor in f2f meetings as appropriate.
- Monitor the class with the goal of being able to assume the role of (back-up) instructor in the following iteration.
- Assist in developing and testing techniques for use in WebTycho classes in conjunction with UMUC grant applications.
- Assist in developing model for future instructor/teaching assistant roles in the hybrid classroom.

The modified plan for the hybrid class was that the instructor would “lecture” in the asynchronous mode as planned. However, instead of attending the f2f meeting in person, he would do it via distance mode, either using voice over the Internet, or the telephone. He would phone in at a prearranged time and talk to the students.

## 8 THE RESULTS

The results exceeded expectations. After some early equipment problems with the communication links at UMUC, the class was a success. The project products were produced on schedule just as in the prior section of the class. There was little difference between the performance of the WebTycho team and the other teams.

Kimberly did a great job as an “IT Technician”. We both put in many hours to make the class work, some planned, and many not planned. After an initial high volume of e-mail to clarify the situation to all concerned, the volume settled down to a thin trickle and the pressure was off both Kimberly and myself.

With respect to the milestone review meetings, my feelings after the first one were that I was not needed, Kimberly had everything well in hand. After the second one, I really was not needed. When I telephoned in, the main question the stu-

dents had was deciding when the class would meet next. I stayed on-line at the end of the PhoneFree (2001) link for a while, but was not needed. The lesson to be learned here is that preparation and team work works wonders.

Since it was a hybrid class, the WebTycho team were asked if they wanted the Milestone reviews to be live on-line (synchronous) using chat room technology. Their response, in the main, was negative. They preferred the asynchronous approach, in which questions and points raised at the f2f meeting, were posted in WebTycho after the meeting had ended. There became no need for me to “attend” the meetings, and the when technology failed my absence didn’t seem to make any difference.

## 9 CONCLUSIONS

Distance mode can be used in the classroom in a hybrid style. This opens up opportunities for remote guest speakers and instructors.

The hybrid section of MSWE 617 pushed the envelope, not only in the teaching area, but also in the area of on-line collaborative working in geographically distributed groups. The success of the experiment resulted in a template for a WebTycho only section of MSWE 617, as well as a potential solution to UMUC and other post-graduate institution’s universal staffing problem in the area of software engineering.

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