Professional Partners as Adjunct Instructors in Emerging Technology Courses

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1. Introduction

Like every other electrical and computer engineering program across the country, Valparaiso University's ECE department is faced with two great challenges. The first is to continually seek input from key stakeholders to determine the skills and knowledge expected of our graduates and to update our curriculum and courses to reflect these changing expectations. Many engineering educators have recognized the importance of a close relationship with industrial constituents and the benefits that such a relationship can have on student outcomes.[1-4] The second challenge is to continually develop new laboratory facilities and faculty expertise necessary to teach courses in the emerging areas.

As part of the extensive assessment efforts required by the Accreditation Board of Engineering and Technology[5], Valparaiso has established a close relationship with a number of key stakeholders and routinely seeks their suggestions for revisions to the curriculum and the program learning objectives. However, in a relatively small department such as ours, it can be very difficult to recruit faculty members whose expertise is diverse enough to cover every area of emerging technology. Due to the geographic location of the university, it can also be difficult to hire adjunct and visiting faculty to teach part-time while continuing to pursue their engineering careers full-time. Thus, we have occasionally found ourselves in the position of knowing what needs to be taught but not having anyone who can teach it with the level of authority necessary to prepare students for a professional career in that field.

2. The Genesis of a New Course

In Spring 2003, as part of the preparation of a departmental strategic plan, the department faculty and its Technical Advisory Committee (TAC) identified "wireless communications" as a key field in which our graduates are likely to pursue professional careers. As part of this process, the members of the TAC were asked whether they knew of any qualified tenure-track faculty candidates in that area. Although no likely candidates for a full-time position were identified, TAC member Dave Wangrow, Senior Director in Motorola's Global Telecom Solution Sector and a member of the Valparaiso University ECE class of 1984, offered to commute to campus once a week to teach the course in Fall 2003.

After receiving approval for this project from the departmental faculty, the Dean of Engineering, and the Provost, the ECE department chair began to work with Mr. Wangrow to design the new course. It was decided that the most beneficial strategy would be to present an overview of the field, since Mr. Wangrow's professional experience spanned many aspects of the design of cellular phone infrastructure. Also, because of his extensive business background and the importance of economic constraints in the cellular phone industry, it was decided that the business aspects of the industry would be integrated throughout the course. This decision also embraces the recommendations of engineering educators who urge the integration of real-world problems and non-technical design constraints throughout the engineering curriculum.[6,7]

3. Development of the New Course Materials

Since the decision to offer the course was made in the spring of 2003, Mr. Wangrow was able to prepare more than half of the course materials during the summer of 2003 before the course began. As each lecture was prepared, he sent it electronically to the department chair, who reviewed the material and suggested any necessary revisions to reflect the length of the lesson, the level of preparation of the students, and generally accepted pedagogical methods.

Through this collaborative process, the course schedule and lecture notes were developed. The course outline is summarized below in table 1.

Lesson	Topics
1	An Overview of the Wireless Industry and Basic Technical Features
2	The Business of Wireless Networks
3	Signal Propagation
4	Antenna Design and Deployment
5	Cellular Geometry and Frequency Reuse
6	Mobility Management
7	RF Channel Assignment, Performance, and Capacity
8	Core Network Design
9	Core Network Capacity Engineering
10	Network Management
11	Call Processing
12	GSM Networks
13	IDEN Networks
14	CDMA Networks
15	Next Generation Networks and the Future

Table 1. The course outline developed as part of this project.

Although the initial maximum capacity of the course was set to twenty students, strong interest in the course prompted its movement to a larger classroom that could support a higher capacity. With an enrollment of thirty students, this course was the largest elective course taught in the department for the last several years.

4. Administration of the Course

In order to balance the need to have the instructor present on campus two hours away from home with his need to continue to excel in a time-demanding career while still maintaining a healthy family life, the decision was made that this course would be taught one evening a week for 150 minutes per night. In this way, the course would meet for the same total amount of time as a conventional class that meets three times a week for fifty minutes apiece.

Going into the course, the instructor and department chair had two main concerns. The first was that the longer, less frequent evening course meetings would be less effective than a conventional course at maintaining student attention and focus. The second was that the instructor would be physically inaccessible to students at almost all times but class meetings. Although the students were given several alternative methods to contact him electronically, the importance of accessibility to positive student perceptions of the course must not be underestimated.[8]

In order to help alleviate the concern of an uninterrupted 150-minute lecture, the instructor worked hard to integrate interactive learning exercises into the more traditional lecture presentations. Even in a conventional 50-minute course, such active learning exercises have been shown to improve student learning[9], but in a longer class meeting they were absolutely essential.

The course required the students to complete weekly homework assignments, three course projects, two take-home exams, and one in-class exam. The department chair attended the class meetings, both to observe the course and also to learn the material being taught. The workload expected of students in this course was approximately equal to or slightly higher than that of other comparable ECE elective courses. Students responded well to the course structure, and the instructor was generally very pleased with the quality of the assignments, projects, and exams they completed.

5. Evaluation of Course Effectiveness and Outcomes

The course evaluation at the end of this course provided many useful measurements of the course's success. The evaluation consisted of a series of questions with a Likert response scale in which students responded on a scale from 1 to 5. Their responses were then combined to determine a mean score for each question.

Students were asked to assess their own ability to perform each of the seven course learning objectives. The results are shown in table 2, with a score of 1 indicating that they could not perform the learning objective at all while a 5 indicates that they could definitely perform it.

Determine predicted coverage for a single site used in a cellular network	**4.40/5.0**
Design a single cell and a network of cells to meet capacity demanded by existing and projected users in a cellular network	**4.33/5.0**
Explain the differences between the three main digital cellular RF technologies (GSM, iDEN, and CDMA)	**4.07/5.0**
Apply the business issues involved in building an expanding cellular network	**4.27/5.0**
Explain the architecture of the core networks for cellular systems and explain the functional roles that each core network component serves	**3.33/5.0**
Correctly assign RF channels to sites within a cellular network, applying rules and design criteria for any of the digital RF technologies student in the course	**4.03/5.0**
Describe call-processing flows for voice and data calls in a cellular network	**3.40/5.0**

Table 2. Student self-assessments of achieving course learning objectives.

The average of these seven student self-assessments was 3.98/5.0. This result is comparable to the departmental average of 4.24/5.0, which represents the best efforts of full-time faculty who have spent their entire careers honing their teaching skills. It is also very close to the departmental goal of 4.0/5.0 in every course.

In addition to the learning objectives, students were also asked to evaluate several aspects of the course. The results are summarized in table 3, in which a score of 5 corresponds to the best possible score and 1.0 is the worst possible score.

Course organization	4.17/5.0
Usefulness of homework assignments	4.07/5.0
Overall course quality (compared to 3.89 for all ECE courses)	4.00/5.0
Instructor's knowledge	4.50/5.0
Instructor's presentation method	4.00/5.0
Overall quality of instructor (compared to 4.16 for all ECE faculty)	4.10/5.0

Table 3. Student evaluations of specific aspects of the course.

Three special questions were asked of students in this course in an effort to determine their perceptions of the special nature of this course. The results are summarized in table 4, where 1 represents "Not at all" and 5 represents "Yes, definitely."

Was it helpful to have the course taught by a professional in the cellular phone industry?	4.23/5.0
Was your learning in this course negatively affected by the once-a-week evening schedule?	3.43/5.0
Did the instructor's commuting schedule and lack of physical accessibility negatively affect your learning?	2.45/5.0

Table 4. Student responses to course-specific questions.

Sixteen of the thirty students felt that the schedule did negatively affect their learning, eight were neutral, and six did not feel that it affected them. Seven students felt that the instructor's commuting schedule did negatively affect them, six were neutral, and sixteen did not feel that it affected them.

6. Lessons Learned and Future Course Revisions

Although this course was largely successful, there were two important lessons learned that can be applied in many circumstances. First, since this course had never been taught at Valparaiso University before, some students in the course misunderstood its focus. Only having access to the title of the course, "Wireless Communications," they expected to learn about wireless computer networking technologies such as IEEE 802.11. Since the course was designed to focus on the cellular phone industry, those students were disappointed. Although the instructor and the department had clearly identified the learning objectives for the course, these were not broadly advertised to students when they were registering for the course. In the future, learning objectives will be broadcast for special topics courses to help students clearly understand the material to be covered in the course.

The second important lesson learned is that it is frequently difficult to identify excellent and authoritative textbooks in emerging fields such as this one. Due to the fact that the lecture notes were designed to be very detailed and almost comprehensive on their own, many students chose to ignore the reading assignments in the syllabus. This decision naturally led them to conclude that the textbooks chosen were not valuable and should not have been purchased. This perception was reflected by their 2.10/5.0 rating of the textbooks in this course. In the future, it will be more effective to either have no textbook in a course such as this one or, more likely, to require the students to read the assignments by carefully designing the assignments, projects, and exams to reflect at least some material in the textbooks that is not given in the lectures.

7. Future Delivery of the Wireless Networks Course

One of Mr. Wangrow's course creation objectives was to complete a comprehensive package that Valparaiso University could use for future delivery of the course. This package included fifteen slide presentations of 25-60 slides each, eight homework assignments, three projects, and three exams. The department chair and Mr. Wangrow both feel that future delivery of this course will continue to require the active involvement in course delivery by an individual with significant wireless industry experience in order to keep the course material relevant. As noted in the student evaluations, the course was considered valuable by the students, but the 150-minute class period impaired the learning of some students. A variety of options are being considered for future delivery of this course. These options range from Mr. Wangrow "guest lecturing" while the majority of the content is delivered by a full time faculty member in a more traditional 50 minute format to repeating the format used in the initial delivery (with Mr. Wangrow instructing).

8. Conclusions

Creating, developing, and implementing this special elective course was a very rewarding experience for the instructor, the students, and the other faculty involved. It was a great deal of work and required a tremendous commitment from the instructor, who made many professional and personal sacrifices to teach the course. Overall, it is clear that the experiment was a success, although one that hinged primarily on the dedication and talent of the instructor. It is difficult to imagine that the department will be able to staff many of its

courses by recruiting one of its professional partners to teach the course, but if we are fortunate enough to find ourselves with a similar opportunity, we will no doubt embrace it.

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