

# REFLECTIONS ON A DISTANCE EDUCATION EXPERIMENT IN DSP

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## ABSTRACT

Distance Education is becoming an increasingly important means of reaching a wider variety of traditional and non-traditional students and of developing unique educational partnerships between universities. In an effort to assist engineering departments just beginning to pursue distance education, the authors reflect on an innovative four year experiment in Internet based distance education involving students and faculty from the University of Colorado at Boulder, George Mason University, Rice University, Cornell University, and Sandia National Labs. The educational and research benefits to both the students and faculty will be discussed in detail. In addition, the weaknesses and limitations of this experiment will also be addressed. It is hoped that these comments and observations will benefit other institutions beginning to pursue similar distance education programs.

## 1. DISTANCE EDUCATION

With the advent of digital media, distance education is becoming an increasingly large part of many university's educational portfolios. The Internet, together with advanced computing resources, will continue to lead to many important innovations in educational delivery and course content. This new resource, along with teleconferencing utilities, are opening up exciting (and somewhat revolutionary) opportunities for partnerships between universities and industry. In the near future, these technologies will be widely used for synchronous and asynchronous delivery of course lectures to remotely situated students at many educational institutions around the globe.

To offer some insights (both good and bad) into these growing trends, this paper describes a four year experiment in distance education between the Univer-

sity of Colorado at Boulder, George Mason University, Rice University, Cornell University, and Sandia National Labs. The overarching intent of this effort was to develop new methodologies for the teaching of undergraduate digital signal processing through the use of various Internet based technologies and a common signal processing language (Matlab). However, in addition to this, the instructors were also interested in developing and experimenting with innovative student-student and student-faculty interactions. The details of the courses and the various forms of interactions have been well document in both journal articles [8, 7] and conference proceedings [4, 5, 2, 1, 6, 3]. Thus, rather than rehash these issues, in this short paper we stand back from the work and assess it's implications for other distance education experiments and projects.

## 2. A CHANGING VIEW

Traditionally, universities and faculty have viewed themselves as the center of the educational hub. This was particularly evident in the earliest designs in distance education where the overriding paradigm was that of distributing in various forms traditional courses to remote locations via technology. First, via the traveling faculty, then by videotape or microwave, and now by Powerpoint slides, web documents, digital video, etc. This paradigm was the natural extension of years of experience by the local institutions in delivering education to their local students (see figure 1).

Unfortunately, this model failed to anticipate how the next generation of students would begin to view themselves with regard to technology and learning. With the emergence of a new Web culture, students began to see themselves not as passive learners of "canned" lectures by faculty, but rather as active surveyors and

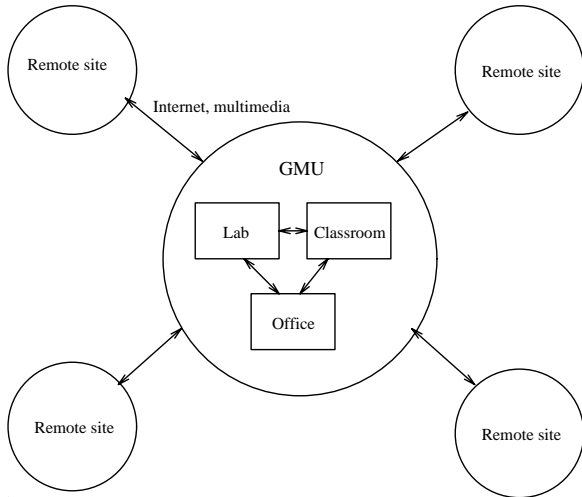


Figure 1: Institutional centered view of Distance Education. In this graphic “GMU” represents a faculty located at George Mason University.

nomads of knowledge bases<sup>1</sup>. These new students have little patience for what they view as irrelevant and uninteresting material, no matter how fascinating it might be to us. In their own ways, they design their own course and integrate their own material through web surfing.

This new reality led us to reconsider the basic architecture of distance education when designing our experiment. The fundamental shift which we chose to pursue was to put the student at the center of the learning hub rather than the faculty (see figure 2 for an example of a GMU student).

However, during the early stages of our design (1995), we were not entirely clear on what the implications of this shift would be on us or the course. Yet one thing was evident: putting the student at the center would remove much of the control from the faculty. In a “senior design” oriented sequence of courses such as those we were conducting, we did not see this as necessarily a bad thing.

### 3. IMPLICATIONS

The first implication of the student-centered view was that the local professor was not going to be the only source of knowledge for the student (and in some cases may not be the primary source of knowledge for certain course subjects.) The second was that the student project teams no longer had to be composed to stu-

<sup>1</sup>This is best confirmed by watching any child (or adult) surf the WWW.

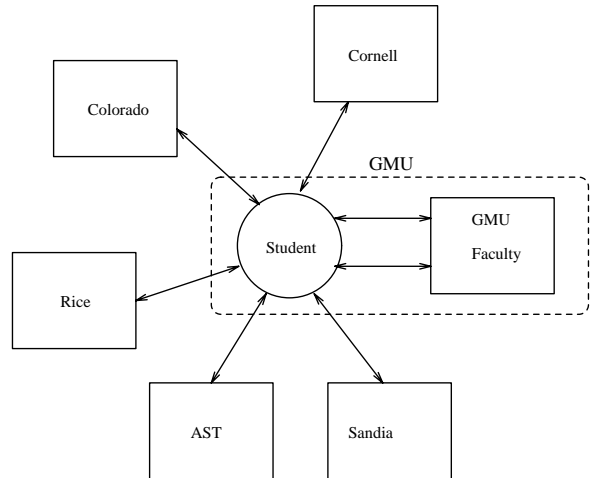


Figure 2: Student-centric view of Distance Education.

dents within regional proximity to one another, i.e., all at the same university. The technology which allowed for students to access other faculty, also allowed for students to have direct contact with remote students.

This opportunity meant that we could also experiment with “distance teaming” as well as distance teaching. To pursue this opportunity, we intentionally teamed students from the various participating institutions together to undertake the course projects (see figure 3). This was an important component of our efforts since leading industry was just beginning to do similar things with their personnel resources. We approached this component of the experiment with the belief that well coordinated groups of diverse individuals would be able to accomplish more than the “sum of their parts,” and thus lead to a more productive learning experience for each of the students.

### 4. OBSERVATIONS

**Course Objectives:** The fundamental objective of our courses was to teach students how to solve real practical problems using DSP rather than to teach them basic “DSP theory.” This meant that the material would be largely self-motivating and interconnected with their other courses through the selected projects.

Because we were tackling real problems, students gained tremendously from working with real data. Constantly dealing with these concrete data sets helped them understand immediately that the simplifying assumptions offered in the lectures often didn’t hold up in practice. Furthermore, we continuously stressed that the DSP algorithms

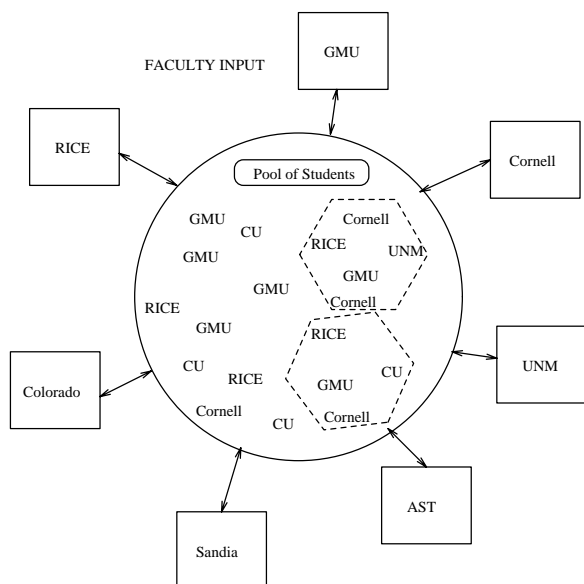


Figure 3: Architecture of distance teaming.

discussed in lecture were only a means to a solution, and not a solution unto themselves.

**Distance Teaming:** The teaming of students from the various institutions initially excited everyone. The students were thrilled to know that their participation in these new courses might have some national implication one day. Through the experience of distance teaming, they also recognized that they were getting to see first hand the earliest stages of a new wave in industry design.

However, actually coordinating the activities of these students turned out to be far more difficult than anticipated. Student work patterns varied tremendously, which often led to scheduling conflicts. The typical student style of last minute work is not tolerated well at all by any group based approach, and adding the extra dimension of having the groups geographically distributed served only to exacerbate the problem. To address these challenges, we instituted several directives:

- Students would immediately publish on the WWW a initial schedule (time table) for completing their lab with individual assignments. At the end of the project, we required an accurate final schedule for the project. Having the students compare these two schedules helped everyone understand the difficulties of coordinating groups, particularly

those which never sat down at the same table.

- Students would grade each other on their individual contributions. Of course, this would only help if students were willing to be honest and accurate about each others efforts. In our observations, it was often the case that they were much harsher on their remote partners than their local partners (they had to see there local partners around campus after the course.)

**The World Wide Web:** Placing course material on the WWW was absolutely necessary for the execution of our distance education experiment. Having anytime access to data, homework assignments, course notes was extremely beneficial to everyone including the participating faculty. For example, if the GMU faculty was not teaching a particular subject to his students, he could follow what the remote instructors were covering directly (rather than having to rely on the students for this information.) This was particularly beneficial for coordinating lectures across technical topics and for linking projects.

The student team's use of the WWW for the publication of their lab reports appeared to be the most beneficial dimension in the use of web. Since these students were working with others from different locations, their use of the WWW as a virtual central repository for programs, plots, notes, lab schedules was absolutely critical in allowing students to follow the team progress in completing the project. This repository would subsequently be turned into the final lab report which would contain multi-media data such as audio/video to enhance to presentation of the final report. As an aside, industry could also use these easily accessible reports to assess the quality of a potential employee's work for themselves.

Furthermore, students in the course would be able to see the quality of their classmate's work from a technical perspective and a presentation design perspective. Knowing that your friends would see first hand your work served as a great motivator for improving the quality of work and the level of effort. As a consequence, we would typically see lab reports progress in quality as the semester advanced since students could borrow good ideas from their colleagues (i.e., learn from each other). Overall, we felt that this dimension of the project was probably the single most successful element of the of the entire experiment.

Matlab: The adoption of Matlab as a common “language” for both classroom discussions of algorithms and as a DSP solution environment was an important unifying decision made early on in the project. Students were very comfortable discussing results with remote faculty and remote students using this language. It greatly assisted in joint projects where one programming module might have been written by a GMU student and the driver might have been written by a CU student.

Technology: This project began in 1995. The technology purchased to support our efforts was also circa 1995. We invested exclusively in SGI workstations as our common platform since these machines were ideal for working with the digital media and doing web development. In addition, they came with state of the art video-conferencing tools to support our remote interactions.

This being said, in our assessment, the technology at the time (computing and networking) was not quite advanced enough to completely support our project. The limited bandwidth of the internet was the leading cause of frustration for the students and faculty involved. It is our belief that with Internet 2, there will be substantial gains in “free” bandwidth for American universities and as such, the limitations with the video-conferencing based interactions should be significantly reduced.

Student Reaction: Because of the high faculty focus on this course, students taking these courses genuinely felt that they were part of something important. This external focus seemed to drive the students to excel.

This was also true for the faculty: knowing that one’s colleagues would be relying on you to teach their students in their course really improved the level of instruction and innovation found in the course lectures.

## 5. CONCLUSIONS

This project has been very rewarding for the faculty involved and has hopefully played some small role in determining good ways in applying technology to education. While it has been extremely time intensive for both students and faculty – the benefits of this effort have been clear and dramatic: better learning by the students and better instruction by the faculty. In the final analysis, these are the only important measures of success of any education project.

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