Dr. Ken Jungling (EECE), Mark Harty (CIRT), and I (ME) traveled to Rensselaer Polytechnic Institute in Troy, New York and to the University of Illinois in Champaign to observe their work with computer assisted, interactive teaching. Both universities have been developing their curriculum in this area for several years and are doing very innovative work. The report from that trip follows.

I. RPI

At RPI we talked to instructors and observed the use of computers in electrical engineering and physics. We also toured the campus and saw the room layout for chemistry classes. All three areas use approximately the same techniques for teaching but the studios (classrooms) in electrical engineering and chemistry seemed to be more thoughtfully laid out.

In Engineering, I was very impressed with the detail that went into developing the learning studios and the planning for and use of non-computer equipment by different engineering departments. I was also very impressed with how RPI has carried this interactive learning model to all of their classes. We observed essentially the same model being used in Engineering, Physics, and Chemistry. It is remarkable to see a university set goals for teaching and carry them throughout the university with the level of detail and consistency seen at RPI.

A. Electrical Engineering

Our tour in electrical engineering was guided by Dr. Ed Maby. He designed the interactive studios we saw in electrical engineering and is one of the avid promoters of the interactive learning program used in RPI’s electrical engineering.

The studios in electrical engineering followed two basic shapes. The rooms used for the studios were created by removing a wall separating two conventionally shaped classrooms. In one case, this produced a rectangular room much longer than it was wide and the other case, it produced a classroom that was approximately square. A layout

![Figure 1 - Typical studio layout in the RPI engineering building.](image-url)
of the rectangular room is shown below. The square room is similar in basic construction except that the computers and note desks are laid out in the round.

There are two rows of computers and desks for student work. The number of rows was limited to two in all of the engineering studios to prevent students from hiding on the back rows. The back row of computers and desks are raised about 18 inches to give the students using these desks a better view of the room. The tables used for note taking and general paper and pencil work face the instructor. The computers face the other way so that when the students are using the computers, they are facing away from the instructor. This allows the instructor to see all of the computer screens in the class. The student chairs are swivel chairs with casters that allow the students to move easily from the lecture desk facing the instructor to the computer desk facing away from the instructor. The desk-chair-computer arrangement is shown in Figure 2.

The rooms contained computers and other equipment that students could use in their lab work. The equipment in the rooms seemed was shared by all classes needing that equipment. The room with oscilloscopes and other electronic measuring devices was used by both electrical engineering and mechanical engineering controls classes.

In the rectangular shaped rooms shown in Figure 1, the instructor stands at the front of the room. There are two projection screens on either side of the lecture desk. The same images are shown on both the left and right sides of the classroom making it easy for students on both sides of the classroom to see the projected material. The pairing of the screens allows the instructor to display different information from different sources. The information on the screens could be projected from a overhead camera or from a computer in the instructors desk. A picture of the desk is shown in Figure 4. A switch box on the desk allows the lecturer to select the source of information to be displayed.

The round classroom that we visited did not have large projection screens in the center of the room because the shape and size of the room would not facilitate this arrangement. Instead, they had flat screen panels on the note desks. This is shown in Figure 5.

Near the center of the round classroom, is
a track for testing robotic cars that follow a white tape. Students program these cars in one of their classes. This attention to detail and the multiple uses of the classrooms was evident throughout.

The classes at RPI all seem to be 4 hour classes. Originally they were designed to be three hours of lecture and one hour of lab with three hours of contact for the lecture and three hours of contact for the lab. With the start of the interactive classrooms, the lecture and the labs were combined. In engineering the resulting classes meet for two hours three times a week resulting in the same six hours of contact time. We noted that physics went through the same change from conventional lecture and lab classes but reduced their total contact time to four hours for a three hour class and one hour lab.

Engineering refers to these classrooms as interactive studios. They are termed interactive not because they have computers in them but because of the way the class is conducted. In engineering the instructor seemed to lecture for 15 to 20 minutes then let the students work a problem based upon the lecture material for the next 15 to 20 minutes. The students work in groups of two to four students and share the computer and other equipment in the class. Groups having difficulties with the material are assisted by two TAs in the classroom.

The students did not necessarily work on the computers during the problem solving phase of the class. The work could involve pencil and calculator work or work with the oscilloscopes or other instruments. During the problem solving phase, music is played over the classroom audio system. The instructor we talked to felt this is very important because the music breaks up the formality of the lecture and facilitates students discussion of the problem. It also serves to divide the class into two distinct phases, lecture with no music and group problem solving with music.

B. Chemistry

We were not able to sit in on a chemistry class or interview any of the chemistry instructors but we did get a look at their interactive classrooms. They do not follow the same arrangement used in engineering but the arrangement seemed to be very usable. The chemistry classrooms were much larger than the rooms in engineering and the students sat at table large enough to accommodate two students on each side. The tables are radially arranged in the room so that a line through the center of the table points to the instructor. The students on both sides of the table can turn and see the instructor by looking to their side. In practice, this may not work as well as one would hope because half of the students sit on one side of the table and half on the other. The population is not equally divided between left and right handed people and sitting on the wrong side of the table could make note taking difficult.

The end of the table away from the instructor meets another table to form a TEE. The computer monitor sits on this table (see Figure 6). All of the students at the table can reach and use the keyboard.

The tables are generously spaced allowing the instructor and TAs to walk around the room assisting groups having trouble with their work.
C. Physics

The arrangement of the physics classrooms is not nearly so well thought out as in engineering or chemistry but they seem to work. Basically the physics rooms consist of rows of tables with students sitting on both sides. The instructor’s desk is at one end of the room but there did not seem to be any consistency to the orientation of the student desk to the instructor’s desk. Different classrooms seemed to use different arrangements. A typical arrangement of the desk is shown in Figure 7 and a typical layout of the instructor’s desk is shown in Figure 8.

RPI has mandated that all entering freshmen buy a laptop computer. The students can purchase a computer through the university or purchase an approved computer through a vendor of their choice. The university sets the minimum standards for the computers.

The students bring these laptops to each of their classes and use them instead of university supplied computers. The desks have plugs for the network and for power.

The method for presenting material in the physics lectures is more uniform than in engineering. Each physics lecture starts with the presentation of a problem. After the presentation, the students guess at the outcome. From a pedagogical point of view, this is valuable because it forces the students to relate this new problem with knowledge they have gained in the past. It builds a framework for the problem and relates it to knowledge the students already have.

After a discussion of the guesses, an experiment is run to see what actually happens. The classroom has a bench setup for running these experiments and the equipment necessary to run the experiment is brought into the classroom by the instructor and/or a lab assistant. The class discusses the results of the experiment.

The instructor then presents the theory behind the experiment and discusses it from a mathematical theoretical point of view. This is followed by more experimentation where data is collected. The data may be collected centrally using the demonstration equipment at the front of the room or by the students using lab equipment at their desks. The students then solve the problem using the theory presented in the lecture and compare the results of their calculations to the real data collected by the instrumentation. This is followed by more discussion of the problem and the differences between the measured and calculated results.

The students use their computers to solve the problems and to access background information from the web. The students can prepare for class by looking at the web information prior to coming to class.

The instructor is assisted by a TA. In the class we observed, the TA helped students who were having problems with the material and presented some of the lecture.

II University Of Illinois

At the University of Illinois, we looked at a software product called Mallard, the teaching of math using
Mathematica, and the teaching of chemistry using Web CT. The classroom interactivity at UIUC seemed to be on an instructor by instructor basis and was not organized throughout a college as it was at RPI.

A. Mallard

We visited with Donna Brown who is one of the developers of Mallard. Mallard is a software product used to support classes on the web. It allows the instructor to define true/false, multiple choice, and fill in the blank quizzes that are automatically graded. The instructor can define multiple questions for each problem on the quiz and the program will randomly select the question so that each student sees a different version of the quiz. The program also has the ability to vary numerical values used in defining a problem over a specified range so that each student sees a slightly different problem.

The program also keeps a grade book and can incorporate grades from the online quizzes and grades from conventional quizzes and exams. The grade book will presents statistics on the class grades in many different forms. Students can log into the system and see their grades. They cannot see the grades of other students but can see aggregate class grades and statistics.

Mallard also provides a hanger for web based instructional materials. These can be protected so that only students enrolled in the class can view the materials. The materials are instructor written in html.

Mallard is very similar to Web CT which is available at UNM. We did not see any significant difference between the two systems other than Mallard runs on an UNIX server and Web CT runs on a Microsoft Windows NT server. Web CT seems to be more commercially developed than Mallard but Ms. Brown is hoping that Mallard will continue to be developed as a commercial product.

B. Mathematica in Math Teaching

Dr. Jerry Uhl has been using Mathematica for the last 10 years to teach calculus, differential equations, and linear algebra at the University of Illinois. He and several colleagues have developed extensive course work to go along with these classes and that course work is currently being published by Wolfram, the company that developed Mathematica.

The materials consist of Mathematica notebooks containing instructional material. The student can go through the notebook based lessons and view the graphics presented by the program. They can change equations and values in the notebooks to explore the impact these make on the graphical and numerical displays.

In addition to the Mathematica notebooks, there is a problem book called a Literacy book of problems for the students to solve without the aid of the computer. Homework is assigned from this Literacy book.

The exams in the class are conventional requiring the students to solve problems without the aid of a computer. A successful student must be able to solve problems manually and with Mathematica. The use of Mathematica allows students to explore various solutions and to display the results graphically in hopes of achieving a better understanding of the underlying math.

We observed a demonstration of the lessons and I was very impressed with the capabilities of the software and the instructional materials. The system may not work for every student, but it appears to provide a significant pedagogical advantage over conventional approaches to teaching calculus and other courses in mathematics.

The Wolfram materials are supplied on a CD. The CD contains the Mathematica notebooks and a PDF file of the Literacy book. The software can be run on both Windows and Macintosh machines. The computer lab at UIUC which has a heterogeneous combination of machines and operating systems.

The UIUC calculus class we observed did not have the structure we saw at RPI. At UIUC, the students go
through the class materials individually. There is an instructor and a TA available during the class time to help them with their problems. Exams and quizzes are given in a separate room.

C. Chemistry

The Chemistry Department at the University of Illinois uses Web CT for both local and remote classes. Web CT is used for quizzes, keeping of grades, and presentation of instructional materials. I did not see anything here that is not currently going on at UNM. They have been using Web CT for a little longer than we have and the course materials for chemistry seemed to be well developed.

The students use Web CT and other programs needed for their chemistry classes in a rather conventional computer lab setting. There was an individual available to answer questions but for the most part, the exercises are done as an individual exercise.