Instructional Electronics Laboratory (RVR 3017) and Projects Laboratory (RVR 3013)

During the spring 2001 semester, the Department formulated a laboratory development plan with the following goals:

1. to create an infrastructure including new instructional technology that will serve our present and projected needs
2. to create a new teaching laboratory with state-of-the-art equipment and an enhanced learning environment
3. to replace equipment that has reached the end of its useful life
4. to expand and update the capabilities of our laboratory facilities

Comments from recent program reviews provided motivation for the laboratory development plan. The most recent ABET review occurred during the fall 1997 semester. The review was very positive about the curriculum, the faculty, and the quality of our program and our graduates. One of the areas that drew comments was the support and funding for laboratory development. The following is an excerpt from our ABET Review Statement to the Institution:

> "Laboratory facilities for instruction appear to be very good and plans are in place to continue to modernize and upgrade laboratories over the next several years. Although university funding has not been sufficient for laboratory development, the Department has sought and obtained donations from industry to meet past needs. With the recent growth of electronics firms in the area this is expected to continue in the future but a stronger commitment by the University is needed to ensure that laboratory development plans are met."

In order to obtain support for achieving its laboratory development goals, Dr. Matthews from the E&EE Department applied for and received funding from the Strategic Workforce Initiative (SWI), a State of California one-time program. This funding of approximately $130,000, helped cover the costs of infrastructure improvements, including instructional technology equipment and new furnishings. With the addition of the equipment from Dr. Matthews' successful $98,000 Agilent grant proposal in 2002, we were able to implement the entire plan.

The laboratory development plan helped us create two new facilities: a teaching laboratory and an advanced projects laboratory. All items from the Agilent grant proposal have been allocated to one of these two laboratories. Equipment presently owned by the Department was also used in the new plan. In fact, the Department used its own resources to obtain some items to match its older equipment rather than request all new ones from Agilent.

The new teaching laboratory is dedicated to the instruction of beginning and intermediate laboratory courses. In 2001 the equipment used by the Department for beginning laboratory classes was practically at the end of its useful life and needed to be replaced. However, the objectives to be met included more than just replacing the equipment. The new teaching laboratory also includes new instructional technology. A video projection system enables all of the students to see the instructor's computer display, demonstration circuit, or oscilloscope display. The furnishings and floor plan are conducive to this mode of instruction, allowing students to follow along with demonstrations. Funding already obtained through the SWI was used for the new furnishings and instructional technology in the teaching laboratory.

The Advanced Projects Laboratory is accessible to all qualified students. The Department's objective for this laboratory is to provide a facility with multiple workstations, each one having expanded capabilities in some particular area. In this way, students will have increased access to equipment appropriate to their needs. Some of the Agilent equipment (e.g., mixed-signal oscilloscopes and high-speed function generators) helped add new capabilities that were not available at CSUS until 2001. The projects laboratory is also equipped with video projection capabilities (with funding already obtained from the SWI) to support project presentations.

The two laboratory facilities described above complement each other; they are both part of a unified plan. The teaching laboratory meets the need for a modern, structured laboratory in a learning environment supported by instructional technology. The projects laboratory supports simultaneous work on a number of diverse projects at specialized workstations. The capabilities of each laboratory can be fully developed because each has its assigned role.

Hands-on instruction has always been considered an important dimension of an engineering education at CSUS. Laboratory work requires the student to think critically about circuit theory, about the operation of the test equipment, and about the meaning of whatever data they gather. This experience helps the students to consolidate the abstract concepts they see in lecture settings and empowers them to use what they have learned.

The teaching laboratory supports instruction of EEE117L, EEE108L and EEE109L. These laboratory courses focus on basic networks and basic or intermediate electronic circuits, as well as teach the correct use of the test equipment itself. Measurements made by students include: signal amplitudes, bandwidths, clipping levels, and bias voltages. The exercises also specifically require students to use oscilloscope functions such as waveform math, external triggering, and display averaging. Students are required to use a computer interface (GPIB) to obtain characteristic curves of non-linear devices.

Another use of the teaching laboratory is to support an educational outreach effort of the College of Engineering and Computer Science. The College has organized and conducted free interactive workshops for high school teachers who are interested in developing pre-engineering curricula. Last year, the workshop was co-sponsored by SETRC (Sacramento Engineering and Technology Regional Consortium) and the Capital Center MESA program (Math, Engineering Science, and Achievement) and held on September 27-28, 2002. 50 high school teachers from 35 high schools participated. The workshop also attracted over 80 middle school teachers. The high school teachers were divided into teams and rotated through five laboratory stations on robotics, digital circuits, signal processing, optical engineering, and structures and materials. Faculty and students from CSUS served as facilitators and worked closely with the teams.

The projects laboratory supports instruction of EEE193A and EEE193B, the senior product design sequence, and other advanced laboratories. Although the senior design class does have scheduled periods of laboratory time, it would be difficult to estimate the number of hours these students actually spend in the laboratory completing their projects. Because the new projects laboratory offers a variety of equipment with expanded capabilities, students will be more productive when they work.

In senior product design students design, construct, and test a number of circuitry blocks that must function together to accomplish some purpose. This is the ultimate hands-on experience in the undergraduate curriculum. The Agilent equipment in the projects laboratory helps support students in this endeavor. The students learn to rely on the test equipment as the main source of useful information when things (at first) don't work as planned, and subsequently as the indicator of performance when they do.

Other courses using the projects laboratory include the relatively new course in analog and mixed-signal integrated circuit (IC) design, EEE111. Undergraduate students in this course design their own IC's and have them fabricated through the MOSIS service (a MOS prototyping service). A number of such projects have already been completed, but the present equipment does not completely support work in the emerging technology of mixed-signal IC design. A new course comprising experiments in analog and mixed-signal circuitry and testing will also be developed.

The Department's overall plan to establish two laboratories with complementary roles is a creative plan for the use of technology to improve laboratory teaching. For each laboratory, the array of test equipment, instructional technology, floor plan, security and access control, storage, and scheduling are optimized for its intended purpose.

The teaching laboratory makes extensive use of instructional technology. Plans are already in place to provide assistance to faculty in using the new equipment and to provide a forum for collaborative exchange of ideas relevant to its use. Work on new laboratory exercises and formats to make the best use of the instructional technology was completed during summer 2001. It should be noted that this same facility is used for all beginning laboratory courses (and appropriate intermediate ones); hence the collaborative effort has an impact across the curriculum.

Both laboratories make use of computer-interfaced laboratory equipment. This capability can be viewed as instructional technology because students can view results of repetitive measurements more quickly than if done by hand. Laboratory exercises requiring the use of the GPIB are already part of beginning laboratories, and this capability has also been incorporated into the projects laboratory.

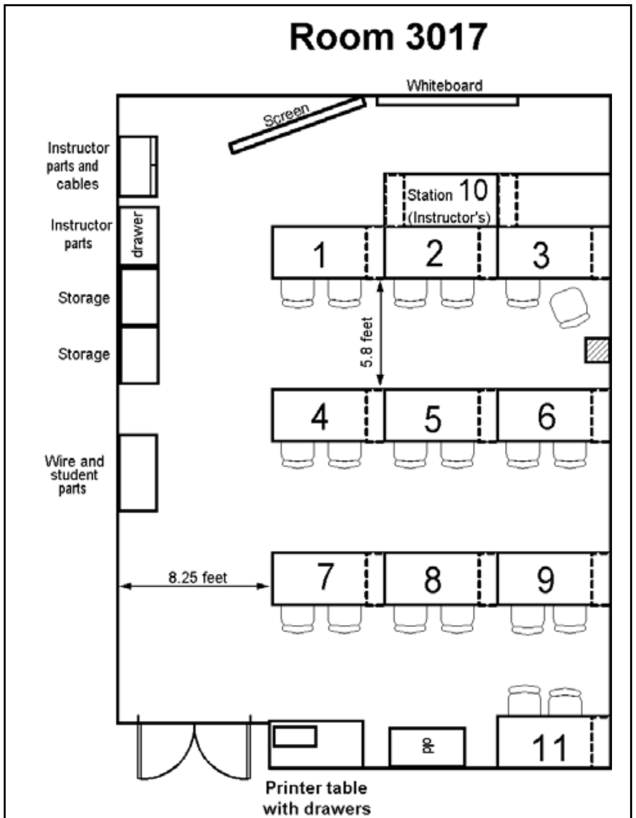
The advanced projects laboratory contains a variety of test equipment. In senior design, each project will have more than one disciplinary component and students will need to assess which particular workstation is best suited for their type of work. Because the different workstations are located in the same laboratory, collaboration within and among groups is facilitated.

As part of the Departmental course-embedded assessment plan, regular assessment of laboratory courses EEE117 and EEE108 began in 1997-98. Hence, it will be possible to compare assessment data from before and after the proposed upgrade of the teaching laboratory. Student evaluations are not the only method of assessment used; students are interviewed and their reports are read by designated evaluators. The impact of the laboratory upgrades will be specifically addressed in the assessment plan.

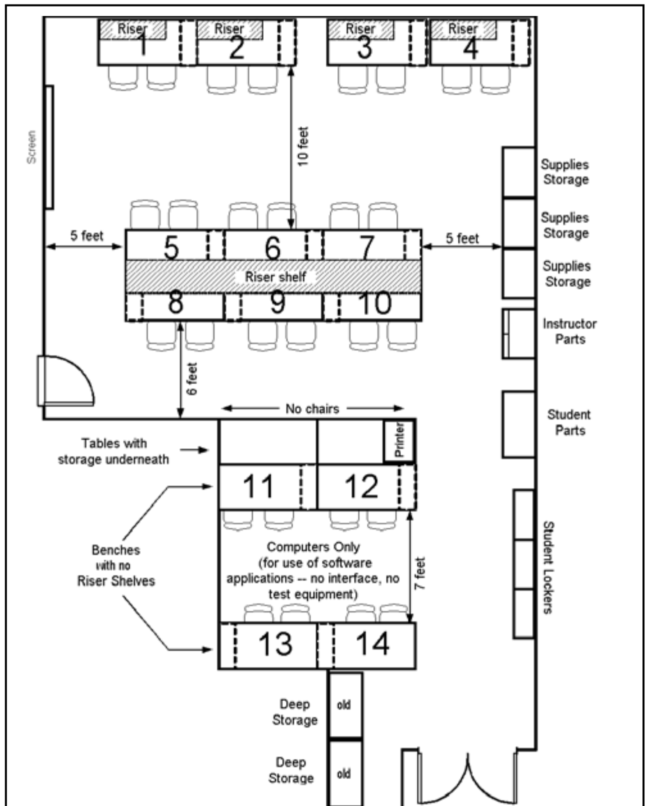
One indicator of the success of the projects laboratory will be its impact on the senior design sequence. This course is also designated for assessment, and data relevant to the equipment grant can be extracted. Also, it will be significant that the new equipment is used to support analog and mixed-signal design classes. If these new laboratory courses are successful, much of the credit will be attributable to the new equipment.

More subjective indicators are an important adjunct to the objective procedures described above. The major questions are: 1) Does the new teaching laboratory have an environment conducive to learning and is instruction more effective there? 2) What creative uses of the instructional technology have been developed? 3) Do more students have improved access to the equipment they need? 4) What is the hands-on experience level of our graduates? The responses to these questions from various faculty, students, and employers will be included in the Departmental plan for outcomes assessment. Preliminary results were presented at the IEEE Frontiers in Education Conference in Boston in 2002.

The layout for the remodeled laboratories is shown in the diagram below.



Room 3017



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