Semester Long Projects in Electrical and Computer Engineering Laboratories

Micheal Parten
Department of Electrical and Computer Engineering
Texas Tech University

I Introduction

The Department of Electrical and Computer Engineering at Texas Tech University began stand-alone project laboratories in the early 1960s. The project lab structure has continued to evolve over the past 40 years.[1-9] Students take 5, 3-hour credit laboratories not directly associated with any lecture course. Although the laboratories have no directly associated lecture course, they do have pre and co-requisites. In addition, the first 3 labs have general areas of specialization. In the senior labs, a student may have only one project for 2 semesters. The objectives of the ECE laboratories include the ability to:

1. Identify, formulate, and solve practical electrical engineering problems. This includes the planning, specification, design, implementation, and operation of systems, components, and/or processes that meet performance, cost, time, safety, and quality requirements.
2. Communicate effectively through oral presentations and group discussions.
3. Communicate effectively through written reports and other documents.
4. Design and conduct scientific and engineering experiments, and to analyze and interpret the resulting data.
5. Function and communicate effectively within multidisciplinary teams.
6. Interact with other students, faculty and practicing professionals on professional and ethical responsibility issues.
7. Recognize the need for, and ability to engage in, perpetual learning by working on projects, both individually and within multidisciplinary teams, for which they have no prior experience and developing ways to learn.
8. Use statistical techniques to represent, analyze and interpret data.

A recent, new development for the first 3 labs is to have only one, comprehensive project over the whole semester. How this is done to effectively cover the many different objectives of the laboratories is the topic of this paper. Some specific projects used in the labs will be presented

Copyright © 2002, American Society for Engineering Education

along with results of the projects. Faculty and student evaluations will also be presented.

II Project Laboratory Structure

In all of the ECE labs, the student will be provided with the following information:
1) A basic statement of the project objective
2) The faculty advisor (technical advisor and evaluator)
3) The team members (if any)

The faculty advisor for the project is the Product Engineering manager and, as such, is the primary technical evaluator for the project. The ECE labs operate in a matrix style of management. The lab instructor, as the Development Engineering manager, is the primary supervisor and project director. The ECE undergraduate labs director and staff (including Teaching Assistants) are the resource and quality control managers. Whenever possible, at least two members of the management team will attend the lab sessions.

To properly manage a project it is necessary to develop a clear and thorough plan and carefully monitor the execution of the plan. In cooperation with the Product Engineering manager (faculty advisor), the Development Engineering manager (lab instructor) and the resource/quality manager (lab director or staff) and within one week after receiving the project, the project team must develop a detailed project plan. Although all projects and project plans are dynamic, it is imperative that a detailed plan be developed initially and continually examined to properly execute the project within time and budget constraints.

For all ECE laboratory projects, activities on the Gantt Chart must be broken down into time intervals no longer than one week in duration. Each task must have a specific deliverable (physical evidence) to indicate the task completion. Completion of the project within the given time and budget constraints is critical. Agreement between all parties (students, faculty advisors, lab instructors, lab director's staff) on acceptable deliverables is required. The project Gantt chart must indicate these weekly deliverables.

Most of the projects in the ECE labs are team projects. Although each team member will be assigned specific actions by the team, ALL team members are equally responsible for successful completion of the project. Team members will be measured for their contribution to the team by their advisor, lab instructor, lab director's staff and the team itself.

III Project Requirements

Throughout the semester, each ECE lab student must:

A) Submit a weekly progress report

A written progress report must be submitted weekly by each student identifying the task that was to be completed that week. Evidence of the completed task (the deliverable) is

Copyright © 2002, American Society for Engineering Education

required as an attachment. An updated project plan along with the specific task to be completed the next week must also be included. Any problems encountered should also be included.

B) Meet weekly with the faculty advisor.

Student groups are required to meet with their project advisor to discuss their weekly progress reports and the advisor will sign the report indicating that the group has briefed him/her. The weekly report must be signed by the faculty advisor or his/her appointed representative. The faculty advisor will assign a grade for each individual representing the individual's weekly performance.

C) Provide oral progress reports

For all projects each student will give periodic oral progress reports. These oral reports will be presented by the project group or team with each student reporting on the portion of the project for which they are responsible. Oral progress reports must include:

1) restate what task was to be completed for this week and indicate the status of each individual member's weekly tasks,
2) technical details on the project and verification of the tasks' completion (diagrams, flow charts, schematics, design decisions, parts selection, etc.),
3) updated project schedule with changes indicated,
4) tasks to be completed for the upcoming week,
5) identification of problems,
6) updated budget with changes indicated,
7) indication that project advisor has approved the progress report.

All oral presentations should be well organized and include visual aids. Each member of the project team is required to speak during each oral presentation. These presentations should be organized so that each student has approximately the same amount of presentation time. These presentations are mini-design reviews and must contain enough technical information for the other students, the lab instructor and the lab director's staff to fully understand the direction of the project. The presenter should be prepared to answer ANY questions concerning the project. Although each team member will have specific deliverables, ALL team members are equally responsible for successful completion of the project and ALL team members should be prepared to answer questions on the whole project.

Copyright © 2002, American Society for Engineering Education

The oral presentations provide a focal point for the project and the project team. Each individual team member will be measured on their ability to meet the designated deliverables, to clearly present information on the project, to demonstrate an understanding of the technical aspects of the project and to work effectively with their team. The first three items will be measured by the lab instructor, the lab assistant and the other students in the class (excluding the team members). The last item will be measured by the team members themselves.

Each individual's oral presentation style and effectiveness will be evaluated and the results will be returned to the student before the next week's class so that improvements can be made. Periodically, through out the semester, the presentations will be video taped. Each student will be asked to evaluate their own presentations and develop plans, with the lab instructor and staff, for improvement. The written plans will be used later in the semester to assess improvement.

D) Read assigned material

Each student should read the assigned material, be prepared to discuss the material in class and take a test over the material.

E) Maintain a lab notebook to record day-to-day lab activities.

Each project team member must keep a project notebook. This notebook must be turned in at the completion of the project. All notebooks, for continuing projects, will be retained by the Electrical Engineering Department for future use in the laboratory. It should be a loose-leaf, three ring binder. All project related written work should be kept in this notebook as far as practical.

F) Update Gantt Chart and Budget.

The Gantt chart and budget should be updated on a weekly basis clearly indicating changes from the previous week and from the original plan.

IV Project Evaluation

Interim Project Reviews

Laboratory groups will meet at their scheduled time each week in the assigned location for oral progress reports. Approximately half way through the course, interim project reviews with individual project groups will be held in lieu of oral progress reports. These interim project reviews will consist of an in–depth presentation on the project by the group with interactive critique from course instructors, faculty advisors and other invited guests. Interim project reviews will include both written and oral presentations. For the oral presentations, individual students will have 15 minutes to present their part of the overall project. For the interim project review students should be prepared to defend their concepts and approach. Oral progress reporting will

Copyright © 2002, American Society for Engineering Education

resume after all groups have completed their interim project review. The written interim project review should serve as a major portion of the final project report.

Project Demonstration

Each project team must demonstrate their completed project to their faculty advisor and their lab instructor. Measurements are required for each project and must be included in the student's final report and demonstrated during the final demonstration. Statistical analysis of data is also required.

Final Presentations

Each student is required to make a final, formal oral presentation on each lab project to the other lab students, the lab instructor, TA, faculty advisor and other invited guests. The formal presentation should be well organized and should include visual aids. The presenter should be prepared to answer ANY questions concerning the project. If for some reason your faculty advisor or his representative is unavailable, you must schedule a separate presentation to your advisor. The project team is responsible for scheduling and completing the advisor presentations by the posted due date.

Written Reports

A formal technical paper by each student is required at the completion of each laboratory class. Each student is required to write an individual or group Formal Technical Report for each project. The particular form depends on the specific project and will be indicated when the project is assigned. All reports are due on the designated date.

All written reports should follow a format described in the Electrical Engineering Reports document. Reports should have NO grammatical or spelling errors. All information obtained from other sources must be referenced. This includes figures and tables. The other sources also include other people. If a lab partner draws a schematic, it must be referenced.

V Projects

As an example of the type of semester long projects, the following is the project statement for the second project lab (first semester junior year).

EE 3332 Fall 2001

You work for an engineering company, ECE, Inc. The Systems Engineering group has determined that there is a market for a remote data acquisition system. The transducer inputs are low frequency, 0 – 100Hz. The amplitude of the transducer outputs can be adjusted. The Systems Engineering group has determined that a modern digital communication system is necessary to beat the competition. However, they are not sure which specific type would be best.

Copyright © 2002, American Society for Engineering Education

The Development Engineering group, your group, has been given the task of developing prototype systems using different modulation schemes and evaluating the systems. The System Engineering group has recommended that as much of the system as possible be implemented in a digital signal processor (DSP). The performance, cost and manufacturability are all important in determining which, if any, system is to be manufactured and sold by the company.

Each system has the same basic form, as shown in Figure 1. The carrier modulation blocks are all different.

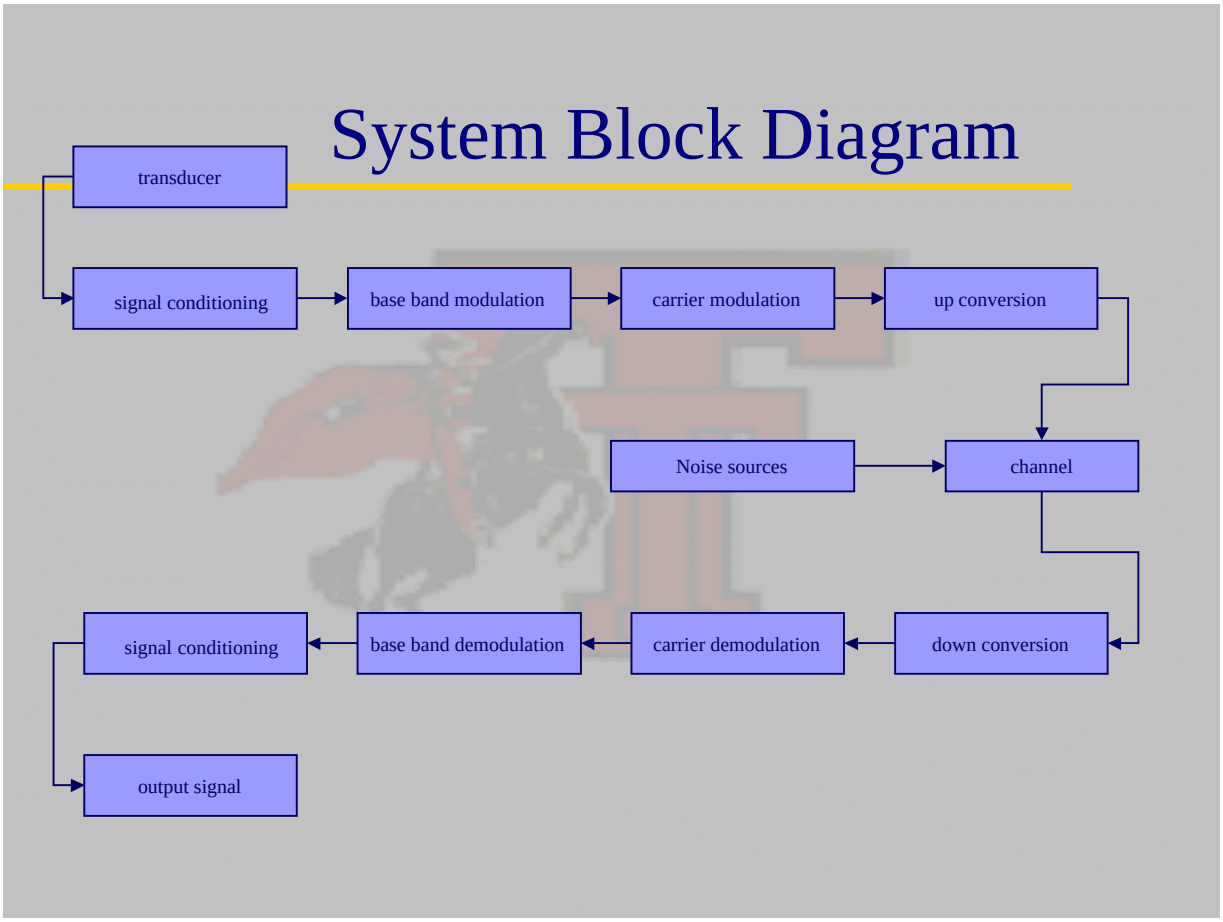

Figure 1 Remote Data Acquisition System

The different systems to be evaluated are:

- ***Pulse Amplitude Modulation (PAM)***
- ***Phase Shift Keying (PSK)***
- ***Frequency Shift Keying (FSK)***
- ***Quadrature Amplitude Modulation (QAM)***

Copyright © 2002, American Society for Engineering Education

- ***Generic I/Q Modulation (IQ)***

Each system is a potential product and is assigned to a different Engineering Development team. Each product has a separate Product Engineering manager to oversee the development of the product. An additional project team is required to develop test facilities for all of the other products. Testing must take place at all product development levels. The procedure for the development of the projects should include conceptual designs and simulations using MATLAB.

The over all goals for the project are to develop and evaluate the remote data acquisition system. The evaluating process must involve quantitative measures. The ability of the system to work in a noisy environment is of particular concern. The system should be designed, simulated, built and tested at each block level of the transmitter and corresponding receiver.

VI Results

These are relatively large and complex projects. As to be expected, a number of problems occur through out the project and are addressed. This can mean modifications to the overall objective, if all parties agree. There is a lot of interaction between the student teams in helping and learning together, which is encouraged. Naturally, the final result varies quite a bit for the different projects. However, the student evaluations of the outcomes from the laboratories are high. In addition, graduating seniors and alumni indicated that these types of long-term projects are good preparation for the industrial world.

References

1. M. E. Parten, D. L. Vines, T. T. Maxwell and J. C. Jones, "A Combined Electrical and Mechanical Engineering Senior Design Laboratory," Proceedings of ASEE 1999 Annual Conference, Charolette, North Carolina, June 1999
2. M. E. Parten, D. L. Vines, T. T. Maxwell and J. C. Jones, "Advanced Vehicle Research in a Multidisciplinary Project Laboratory," Proceedings of ASEE 1998 Annual Conference, Seattle, Wa., June 1998
3. M. E. Parten, D. L. Vines, A. Ertas and J. C. Jones, "Multidisciplinary Engineering Project Program," Proceedings Frontiers in Education, November 1996, Salt Lake City, Utah
4. M. E. Parten, "Project Management in the Laboratory," Proceedings of ASEE 1995 Annual Conference, Anaheim, Calif., June 1995
5. M. E. Parten, "A Different Approach to Engineering Laboratory Instruction," Proceedings Frontiers in Education, November 1994, San Jose, Calif.
6. M. E. Parten, "Progressive Design for Instrumentation Development in Project Laboratories," 1993 ASEE Gulf-Southwest Annual Meeting, Austin, TX, April 1-2, 1993.
7. M. E. Parten, "Digital Signal Processing in a Junior Electrical Engineering Design Laboratory," Proceedings of ASEE 1992 Annual Conference, Toledo, Ohio, June 1992.
8. M. E. Parten, "Design and Research in Project Laboratories," Proceedings of Engineering Education: Curriculum Innovation and Integration, Engineering Foundation Conference, Santa Barbara, CA, January 1992.

Copyright © 2002, American Society for Engineering Education

9. M. E. Parten, "Design in the Electrical Engineering Laboratory," 1988 ASEE Gulf-Southwest Annual Meeting, San Antonio, TX, March 17-18, 1988

Micheal E. Parten

Micheal E. Parten is a Professor of Electrical Engineering at Texas Tech University. Dr. Parten has conducted research and published in the areas of instrumentation, control, modeling and simulation of a variety of systems, including hybrid electric vehicles. Dr. Parten has served for over sixteen years as the Director of the Undergraduate Laboratories in Electrical Engineering.

Copyright © 2002, American Society for Engineering Education