# TEAM BUILDING AS THE FOCUS IN A COURSE ON ELECTRONIC PROJECT ENGINEERING

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*The paper presents the teaching methodology of a new course in Electronic Project Engineering in the Bachelor degree program of the Electrical Engineering Technology. This course is a precursor to the course in Senior Design Project. The course contains two components: (1) Introducing the principles and concepts of project planning and engineering and (2) the execution of a demonstrable project that is run very close to the principles learned. The first component is conducted through a regular lecture and the second component through an interactive session.*

## INTRODUCTION

Senior Design Project is the capstone course in the Bachelor degree program of Electrical Engineering Technology. The primary focus of the course is on the planning and the execution of a demonstrable project. There is very little time to learn and practice the principles of sound project engineering and management. A course to address these needs is being felt for quite some time in the technology program. An effort is made[1] in this direction but no experiences have been reported. However, in addition to above issues, we should also consider that most of the real-life projects in the industry are executed by a team rather than a single individual. Hence team building and team dynamics become an overwhelming issue in project execution. This paper presents a new course EET 397, Electronic Project Engineering, which is designed to teach project engineering techniques with a focus on team-building. The students in this course actually practice the learned techniques through executing an electronic project.

This paper presents the teaching methodology of the proposed course. The course is comprised of three components: (1) introduction of the principles and concepts of project planning and engineering, (2) the execution of a demonstrable project that utilizes the well tried project management techniques and (3) the critical evaluation of the project and the techniques. The first component is delivered through regular lectures. The second component involves interactive laboratory sessions. The third component is the most important component. The evaluation is a continuous in the form of regular oral reports, written progress reports and maintaining a log book entries by each student in the class.

## COURSE DESCRIPTION

**EET 397 ELECTRONIC PROJECT ENGINEERING**

**Catalog Data**:

Introduction to electronic project engineering principles and techniques. Topics include technical feasibility studies, project specification, scheduling, testing, validation and cost estimating. Focus is on team work. These principles and techniques are emphasized through the design and execution of an electronic project.

class 2, laboratory 3 credit 3

Prerequisite: Junior standing

**Course Organization**

| | | |
|---|---|---|
| Three components: | (I) | Lecture on project management/engineering topics |
| | (II) | Project execution in a team-environment |
| | (III) | Critical evaluation |

The class meets for five hours per week. Four hours in each week for the first eight weeks are devoted to lecturing on project management topics. Two hours in the first eight weeks are reserved for oral reporting, information gathering, trouble-shooting and problem analysis in component specifications and procurement.

Five hours in each week in the final eight weeks are exclusively reserved for laboratory sessions. The laboratory sessions comprise of closely supervised activities of testing, interfacing of subsystems and trouble-shooting.

Lecture Topics:

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|---|---|
| Project engineering and the nature of project management | 1 hour |
| Feasibility study and project specification | 1 hour |
| Learning curves | 2 hours |
| Scheduling | 4 hours |
| Component procurement and project inventory techniques | 4 hours |
| Design review and reliability analysis | 2 hours |
| Value engineering and ergonomic issues | 2 hours |
| Costing | 4 hours |
| Project ethics | 2 hours |
| Total quality control | 4 hours |
| Report writing | 2 hours |
| Electrical technology topics | 4 hours |

**TEXTBOOK**

Project Management, Engineering, Technology and Implementation

-Avraham Shtub, Jonathan F. Bard and Shlomo Globerson

Prentice-Hall, 1994 (ISBN )

The book presents a concise treatment of most of the topics of the course. It supplements the subject matter with case studies. The principles are reinforced through problems and exercises at the end of the chapters.

**PROJECT**

The project selected was an electric bicycle with commercial specifications. It is essentially an electromagnetic project that involves multi-disciplinary design and interfacing of subsystems.

**ELECTRIC BICYCLE**

Target specifications

| | |
|---|---|
| Maximum speed: | 20 mph |
| Range : | 20 miles, (70 Kg. Without pedaling) |
| Battery Charging time: | 4 hours |
| Peak power : | 1400 Watts |
| Safety limit output power : | 720 Watts |
| Battery : | 12 V, 17 Ah x2 |
| Motor : | DC motor |
| Charger : | 110 V ac, 60 Hz. |

## COURSE PEDAGOGY

In this course, the class is divided into groups of four or five students. All groups are assigned the same project. The project requires a major design in electrical or electronics but includes design in mechanical and other necessary disciplines. All teams compete and are expected to complete the project by the end of the semester. The student teams are required to do the feasibility study, develop the specifications that either meet or surpass the similar commercially available products. The teams are allowed to have variations in the specifications to achieve niche in the market.

The teams are asked to divide work into smaller segments, draw detail specifications for compatibility in assembly of segments, select components, plan schedule for procurement, prototype design etc. Team building is the very essential aspect of this course. They are asked to use Internet and e-mail services for information search and networking among themselves and with the instructor.

Weekly report presentation and bi-weekly written report are required. All teams engage in active exchange of information in the class room setting within the framework set by the instructors. The teams present their weekly progress and tell what they are going to report in the next weekly session. Seminars by industry managers and a visit to a company are also parts of this course. Maintaining log-books is mandatory. The team members evaluate each other in addition to the evaluation by the instructor.

## TEAM BUILDING

### TEAM CHEMISTRY

A project team should be comprised of members who share common views, can meet often and have easy access to communication. All three objectives are very difficult to achieve when the class is comprised mostly of the part-time students. Students, being busy as they are with job and family, have hard time in knowing, leave alone developing understanding of, fellow student’s views. Hence, the group is initially formed by the students with physical proximity in the class room. A few modifications in team chemistry may have to be allowed but limited to the first week of the semester.

Weekly meeting of all team members is absolutely essential in building the group chemistry. The scheduled laboratory meetings can be used for this purpose. Attendance in the group meetings should be rewarded by allocating some grading points. The group leader must be required to maintain the group meetings in his or her log-book.

## DIVISION OF WORK

The division of work among the group members is the key to the success of the team building. A detail work plan (schedule) must be developed which consists of sequential and parallel activities. The instructor must provide help in this process. Division of work may have to be revised in first couple of weeks due to realignment and drop-out of students. The group is also required to designate a reporter who would log the meetings and prepare the oral and written reports. The group should be told to prepare alternate plans for realignment of work. It is advisable to assign two students to a single activity.

The dissentions and complaints in the group must be addressed immediately by the instructor. Typical complaints are abstention and lack of communication. Internet access or listserve email communication would be of great help in removing the complaints.

## DOCUMENTATION

Division of work must be accompanied by detailed documentation of activities and assignments. The documentation must also be shared among the team members so that all team members are aware of each others work. In the event of personal emergencies or absenteeism, this documentation would be very helpful in keeping the schedule on time.

## EXECUTION PHASE

All the three teams in the class decided on a modular design that would be retro-fitted on the commercially available bicycles. The project design was divided into three parts:

(i) Mechanical design of the retro-fit unit
(ii) Motor drive circuit design
(iii) Battery charger design

Each team divided work internally. A project leader emerged in each team automatically. An individual responsible for an activity was also responsible for the research in components, for exploring the state-of-art technology and the implementation aspects. Component costs are shared among the team members. Each team is required to present an oral report every week and a written report bi-weekly. Every student is required to maintain a log-book.

The teams were advised to make judicious choices between purchasing the sub-assemblies or build them in-house by taking into account the time and money constraints. Emphasis was laid on obtaining the state-of-art components and sub-assemblies even if meant more waiting time. The students were also advised to draw up the list of long-lead items and plan their procurement as early as possible.

## EVALUATION

Careful and continuous evaluation is the most important component of the course. The evaluation is comprised of two components: (i) team evaluation and (ii) individual evaluation. The team evaluation constitutes about fifty percent of the total grade to reflect the importance and emphasis of team-building and co-operation. The remaining fifty percent of the grade is based on the performance in two written tests, individual contribution, the critical self evaluation, the evaluation of the project by a team of one or more faculty member, and the suggestions by the team for improvements.

Course Evaluation:

| | | |
|---|---|---|
| Mid-term test I | 50 points | (individual evaluation) |
| Mid-term test II | 50 points | (individual evaluation) |
| Project execution | 100 points | **(group evaluation)** |
| Final project report | 20 points | **(group evaluation)** |
| Oral and visual presentation | 20 points | **(group evaluation)** |
| Peer evaluation | 20 points | (individual evaluation) |
| log-book | 20 points | (individual evaluation) |
| Attendance in group meetings (2 points per meeting) | 20 points | (individual evaluation) |
| Critical self-evaluation, individual assessment of the project and suggestions for improvements | 50 points | (individual evaluation) |
| **Total** | **350 points** | |

Division of the evaluation of oral and visual presentation project points (20 points)

| | |
|---|---|
| Organization | 5 points |
| Visual communication | 5 points |
| Oral communication | 5 points |
| Interaction (Question/Answer) | 5 points |

Division of project report evaluation points (20 points)

| | |
|---|---|
| Quality of project idea | 5 points |
| Amount of technical content | 5 points |
| Amount of work done | 10 points |

Division of the peer evaluation points(20 points)

| | |
|---|---|
| Contribution | 10 points |
| Co-operation | 10 points |

Project report format (20 points)

Table of Contents with page numbers,

Introduction,

Specifications (electrical and mechanical),

Feasibility study

Division of responsibilities

Original schedule

Component list with resources and costs

Schematics, and mechanical drawings

References

<u>Division of critical evaluation and project assessment points (50 points)</u>

| | |
|---|---|
| analysis of mistakes | 20 points |
| project assessment | 10 points |
| suggestions for improvement | 10 points |
| self-evaluation | 10 points |

## OBSERVATIONS AND IMPRESSIONS

The feasibility study consisted of both the technical and commercial feasibility aspects. The study showed that the project was not attractive commercially due to two reasons:

(1) The added weight of a 24 volts battery and the dc motor alone adds a weight of 25 pounds on the bicycle. The added weight would cause balancing problems and may require a third wheel.

(2) The sale price of an electric bicycle would not be less than one thousand US Dollars.

The use of the electric bicycle may be limited only to sports. High cost will put the bicycle beyond the reach of common persons. The project was still given a go-ahead since it was meant to be a learning exercise.

There were serious problems in obtaining electric motor. The teams' selection of the dc motor in preference to a light weight ac induction motor was because of the complexity of designing an ac drive system. The dc motor was further narrowed down to a low dc voltage version in comparison to easily available 90 Vdc motors because an additional step up dc-dc converter would have been required. The waiting time for the low-voltage dc motor turned out to be very long. It was realized, although late, that a 90 volts dc motor would have been an appropriate choice.

The mechanical design of the three competing teams were completed by the time the semester came to a close. The teams procured the electrical components for the dc motor controller and the battery charger, but the time for testing and trouble shooting of the circuits was not sufficient. One of the teams obtained a controller sub-assembly but they also ran out of time for an actual trial on the bicycle.

**FAILURE-ANALYSIS**

Most of the problems can be traced to the failure in visualizing the extent of effort and time of various activities of the project. This is the classical problem of scheduling. The work division was satisfactory but the alternate plans were not developed.

The follow-up of the details of the schedule became difficult in general report taking sessions. The group reporting sessions should have been a combination of an open reporting and a closeting with an individual team. As a consequence,

Documentation of each member's activity were not emphasized which lead to other members waiting for the absent member to show up in the class or to establish contact with the team members. Another handicap was that the listserve service could not be established.

Teams spent excessive time in searching and obtaining components for sub-assemblies. The time for testing and interfacing sub-assemblies was grossly inadequate. Unfortunately, group could not apprehend the seriousness of this problem inspite of several warnings by the instructors.

## SUGGESTIONS FOR IMPROVEMENTS

Team-building was the most difficult task considering that almost all students were evening students. However, the use of Internet for mailing by some students was very helpful. Later on we intend to create a “listserv” e-mail platform for reports and message transfer and information sharing among the teams. Physical meetings became necessary towards the end of the semester for interfacing sub-assemblies. More laboratory time was needed at the end of the course. Hence, a gradual increase in laboratory time with advancing weeks is recommended. The lecture content of the course may be delivered at an intense pace in the beginning of the course. The laboratory content of the course may be heavy towards the end.

The course has the tendency to drift into a execution-intensive mode. The slackness must be avoided very skillfully by setting an elaborate road-map and setting warning flags and presenting the bottleneck scenarios. Teams must be continuously engaged in the brain-storming sessions. The instructors must conduct themselves like managers in these report taking sessions.

## SUMMARY

A new course in Electronic Project Engineering was designed to introduce the principles and practices of project management in the Bachelor degree program of the Electrical Engineering Technology. This course is a precursor to the course in Senior Design Project. The course contains two components: (1) introduction of the principles and concepts of project planning and engineering and (2) execution of a demonstrable project that is run methodically in a team environment. The first component is conducted through a regular lecture and the second component through an interactive laboratory session.

Team-building was the most important though difficult task because the students were evening-time students. The use of “listserv” Internet environment for report submitting, message transfer and information sharing among the teams would help greatly. Physical meetings, however, become necessary towards the end of the semester when the interfacing of sub-assemblies and testing are required.

The course has been found to have a tendency to drift into a project-only course if the lecture part is slackened and the goal of finishing the project is over emphasized. It must be avoided very skillfully by setting an elaborate road-map, setting warning flags and presenting the bottleneck scenarios. The failures were analyzed and the suggestions were invited. Most of the problems can be traced to the lack of visualization of the extent of effort and time of various activities of the project. Overall, it was a worthwhile experience. The course instructors are required to conduct themselves as the managers in a real-life industrial setup.

Overall, it was a worthwhile experience. We expect to pick the threads from where the class left this project, improve and complete the electrical and safety measures of the design in the next time this course is offered.

**REFERENCES**

[1] "Curriculum 2000 for EET", the new study plan for EET students in B.S. Program at Purdue University, West Lafayette, IN.

[2] The new study plan for EET students in B.S. Program at Purdue University Calumet, Hammond, IN.

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