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Project EVIS: An Example of an Innovative Capstone Process

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Abstract

Over the past five years, the Electronics and Telecommunications Engineering Technology programs have transformed a single semester senior project course into a two semester course sequence. In its original format, the capstone course was too short and did not afford the students time to truly demonstrate their capabilities. The new two course sequence now requires the students to:

- Create a student project team.
- Find a project and assemble a technical assistance team that includes sponsorship and faculty advisors.
- Develop a conceptual design, a project management plan, and a formal proposal,
- Take the design from paper to an implemented prototype product.
- Present the final prototype in a sales-type presentation.

The new format has elevated the level of student achievement in the capstone process and their final project implementation is now typically a professionally manufactured beta prototype that could easily lead to a commercial product.

This paper will use a recent capstone project, Project EVIS (Expandable Vehicle Information System), to lead the reader through the entire capstone process. This project was undertaken by a group of four students and was centered on the development of a Bluetooth-based automotive diagnostic system. As with the majority of our current senior projects, it involved both mechanical and electronic hardware design as well as software development. The paper will discuss all phases of the project and will emphasize mechanisms used by the faculty to gauge the technical merit of proposed projects and to maximize the productivity and success of the students.

Introduction

Most engineering technology programs culminate in a senior design course or sequence. The objective of this course/sequence is to have students demonstrate their understanding of the concepts they have learned throughout their degree program. Though the goal of these courses is the same, the quality of the end result varies substantially from program to program and from student group to student group. Some senior project courses result in a paper design while the outcome of others is a bread-boarded prototype. One survey of engineering senior design projects indicated that only 41% of senior design projects require any sort of hardware prototype and only 23% require a production grade prototype. [1]

Five years ago, the Electronics (EET) and Telecommunications (TET) Programs at Texas A&M used a single semester capstone model. In that course, the entire class met once a week in a standard lecture format so that each team could report on their progress over the previous week. The teams were then left to work on their projects. This methodology produced varied results with a few excellent teams completing their projects while most groups achieved varying degrees of success (or failure). Although there is something to be said for allowing students to pass or fail based on their own efforts, it is also true that for most students the capstone senior design course is their first attempt at a true open-ended design problem where they pose the question and develop the answer. A more real-world approach would be to have the student teams work with "senior engineers" and give them access to technical and project management support. With this in mind, EET/TET Programs set out to revise their capstone process.

It was also during this time period that members of the EET/TET Industrial Advisory Board began to stress the need and importance of project management tools and techniques for EET/TET graduates. These members communicated the growing need for these skill sets in entry-level employees and wanted the educational experience to be grounded in a "real-world" team project. In so doing, the student would learn by doing rather than just developing a vocabulary and general knowledge of the underlying concepts through a lecture-only based course. With the help of many private sector individuals, the EET/TET faculty redefined a new senior project course sequence that could incorporate many recommendations of our industrial partners while also reducing the negative aspects of the current single capstone course.

Over the past five years, a new approach to managing the capstone design sequence has been developed. The sequence is now divided into two courses. [2,3] The first course is titled "Project Management" and has three primary objectives. This course is taught by a single professor and the students are:

- taught the fundamentals of project management such as proposal writing, risk management, scheduling, financial management, etc…
- tasked with finding a real-world project and developing a preliminary design.
- required to identify a technical assistance team (TAT) that will be available as a resource as they implement their design. It is this team that will guide the students to a successful outcome in their second semester.

Upon completion of the first course, the Technical Assistance Team, or TAT team, takes over the management of the students through the second semester of the sequence. The TAT team is composed of three individuals: the instructor of the senior design course, a faculty advisor who has expertise germane to the project, and a "sponsor" who focuses on deliverables and the quality of the final product. Using weekly, thirty-minute TAT meetings the students report progress through the presentation of deliverables, discussion of issues and concerns, and creation of action items. The results of this new process have been excellent. Through the continued development, review, and improvement process, the new senior design project course sequence is exceeding initial expectations. The faculty is seeing a better investment in the education of the programs' young men and women; the students are obtaining a higher level of satisfaction in being able to deliver something of value; and the private sector is playing a more active role in the mentoring of the students. The quality and success of senior design projects has increased dramatically. The results of most of the projects are now professional prototypes of commercially viable products. In this paper, details of the new process will be given and example results will be discussed.

Current Course Structure

As discussed previously, the new capstone experience is now a two course sequence where the first course (15 weeks) teaches the students the basics of technical project management and also allows them to plan their project. In the second course (15 weeks), the student teams work to implement their design and develop a professional, working prototype. With the students now having almost eight months to complete their projects, the results have been excellent with many groups developing commercially viable products. Table 1 shows a timeline of the whole process. One can see that the students should have a complete design at Week 15 which leaves them with approximately four months to finish implementation. It should be noted that the better teams will have prototyped circuits and started working with hardware before Week 15. These teams will also use the Winter or Summer breaks effectively to being implementation before the start of the second semester.

Table 1 – Timeline of Capstone Sequence

Week	**Semester**	**Deliverable**
3	1	Find Ideas, Create Team
4	1	Final Idea, Find Technical Advisor
6	1	White Paper Presentation
7	1	Acceptance of White Paper
9-13	1	Memos on Problem Statement, Functional Design, Deliverables
14	1	Finalize Technical Assistance Team
15	1	Technical Merit, Final Proposal
16	2	Approval of Proposal/ Technical Merit, Schedule TAT Meetings
17	2	Begin Weekly TAT Meetings
23	2	Mid-Term Review of Project Implementation
27	2	Last Chance for Request of Extension
30	2	Final Deliverables Due, Final Presentation

In the following sections, examples from a recent senior project will be used to walk the reader through the senior design process. Project EVIS was started in the Fall of 2005 and completed in Spring 2006. EVIS, or Expandable Vehicle Information System was undertaken by a group of four students. The goal of EVIS was to create a self-contained vehicle monitoring computer (complete with user interface) that would then communicate via Bluetooth with various add-on modules designed to monitor and sense the condition of the automobile. For this project, the students chose to implement two add-on modules that included an OBDII interface that could monitor the vehicle's internal diagnostic interface and a rear bumper proximity sensor that could be used to monitor the presence of objects behind the vehicle. Each module was equipped with Bluetooth and reported status to the stand-alone computer in the cockpit. A diagram of the project can be seen in Figure 1.

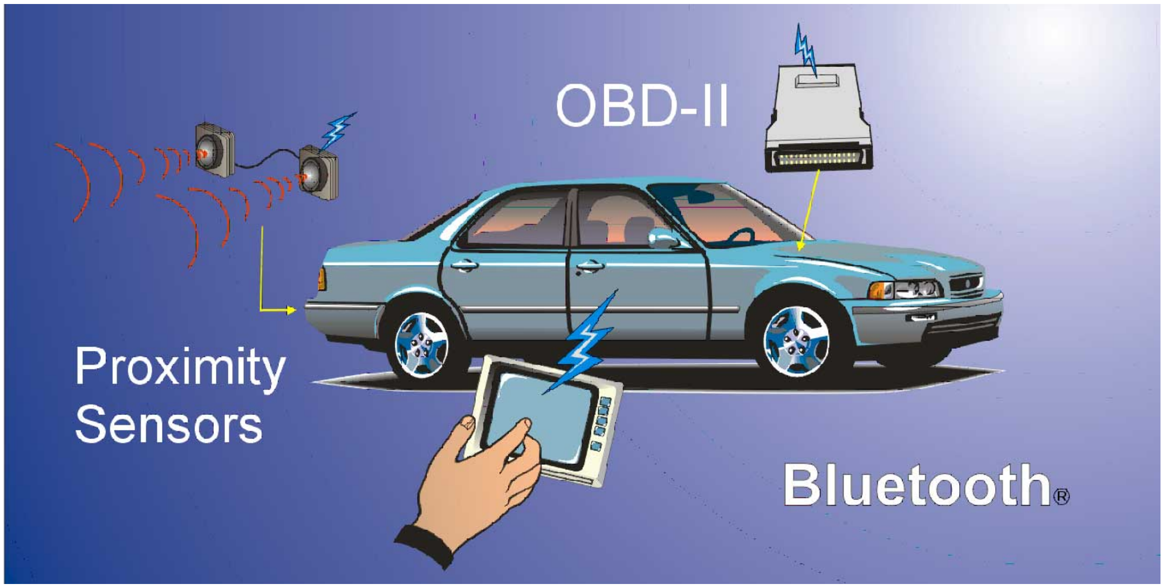


Figure 1 – Project EVIS (Expandable Vehicle Information System)

First Semester – Project Management

The overall goal of the ENTC 419, Technical Project Management course is to provide students with an understanding and appreciation of working effectively in a team environment to accomplish an open-ended design project. By effectively planning and communicating the scope of their project, a realistic assessment of project time and costs can be made. Successful completion of this course provides the student with the tools and knowledge necessary to plan, conduct, manage, and document a valuable and beneficial senior design project.

In parallel with the planning process of their own project, ENTC 419 students acquire basic knowledge of project management tools and techniques using the Project

Management Body of Knowledge 2000 [4] (PMBoK 2000). These include the Work Breakdown Structure, Responsibility Assignment Matrix, Network Logic Diagram, Gantt Chart, and Risk Management Cards. All of these tools are used in the planning and communications of the project's scope, time and costs. In addition, the teams will set up their projects to utilize Earned Value as the primary method to control and report the status of their projects during execution in the following semester to their Technical Assistance Team. The following sub-sections describe the steps taken by the students in during their first semester to plan their project.

Selecting Teams and Initial Ideas

During the first three weeks of the Project Management course, the students are expected to form their design team (typically 3-4 students) and begin brainstorming ideas. Because students have had several opportunities to work in groups throughout the EET/TET curriculum, team formation is typically a simple task. In fact, many students have chosen their teams before starting senior projects. Also, as an aside, the Project Management course stresses written communication skills. Therefore, as with most deliverables in this class, team formation is formalized with a written memo to the instructor. Once the team is formed, the students have a short period of time to identify a minimum of three project ideas. To help, potential sponsors including faculty and industry members are invited in during the second week to make idea presentations. The teams must then submit their ideas in the form of a Quad Chart. The Quad Chart for project EVIS can be seen in Figure 2. By formalizing their ideas in the form of a Quad Chart, the students often find that the process of selecting one for implementation is simplified.

Finding a Technical Advisor

Once the team has selected one of their ideas for implementation, they must select a technical advisor from the EET/TET faculty. This is sometimes the faculty member that originally presented the idea. However, quite often they have to sell their own idea to a faculty member. In any case, it is the team's responsibility to convince their potential advisor of the idea's merit, its feasibility, and of their ability to complete the project on time. Over time, the students have learned success often depends on selecting a faculty member that has interests and expertise in areas related to their project. In the case of Project EVIS, the team chose a faculty member with expertise in embedded systems and microcontroller interfacing.

Developing a White Paper

From the time the student teams selected an idea for implementation, they have approximately four weeks to further develop the idea into a white paper that can be used to sell their idea to a sponsor. This process of developing a white paper motivates the

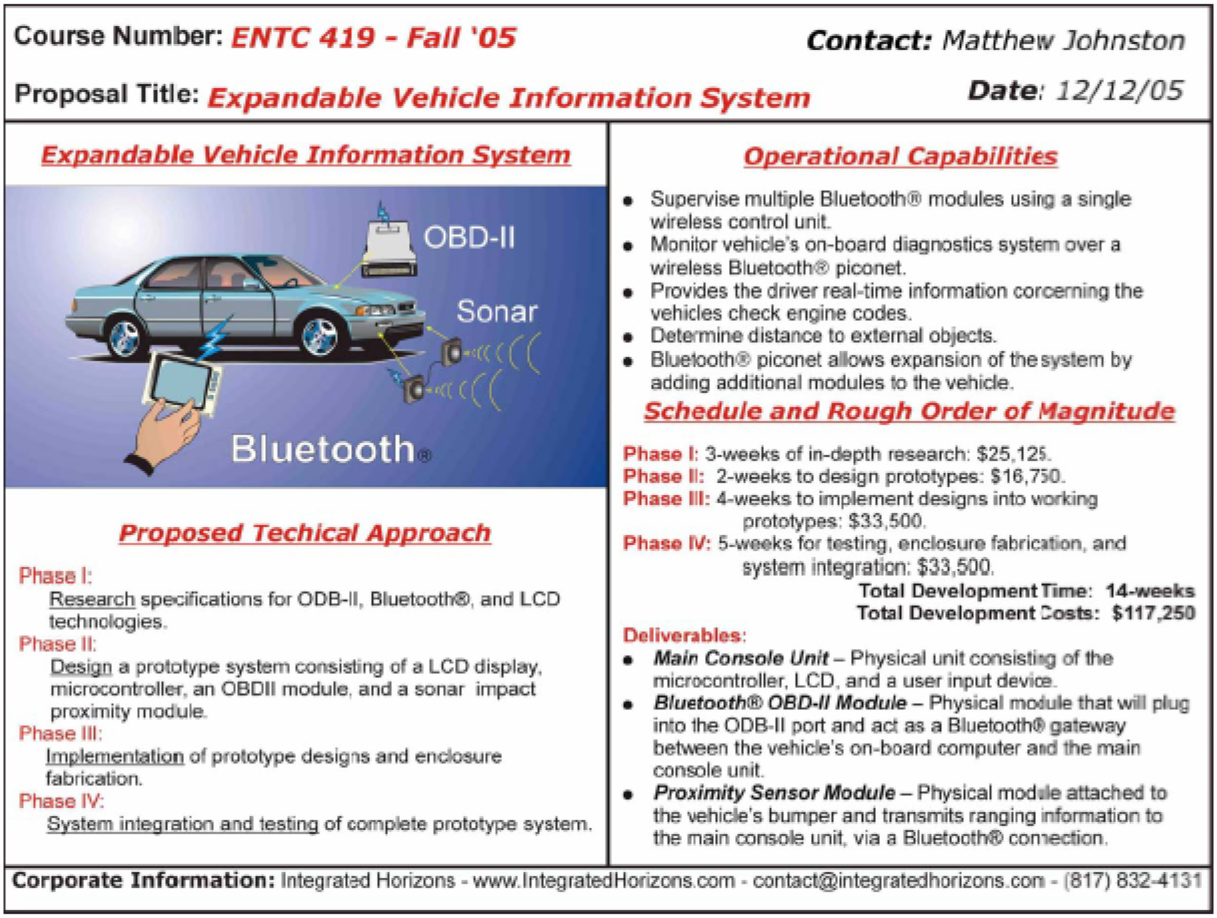
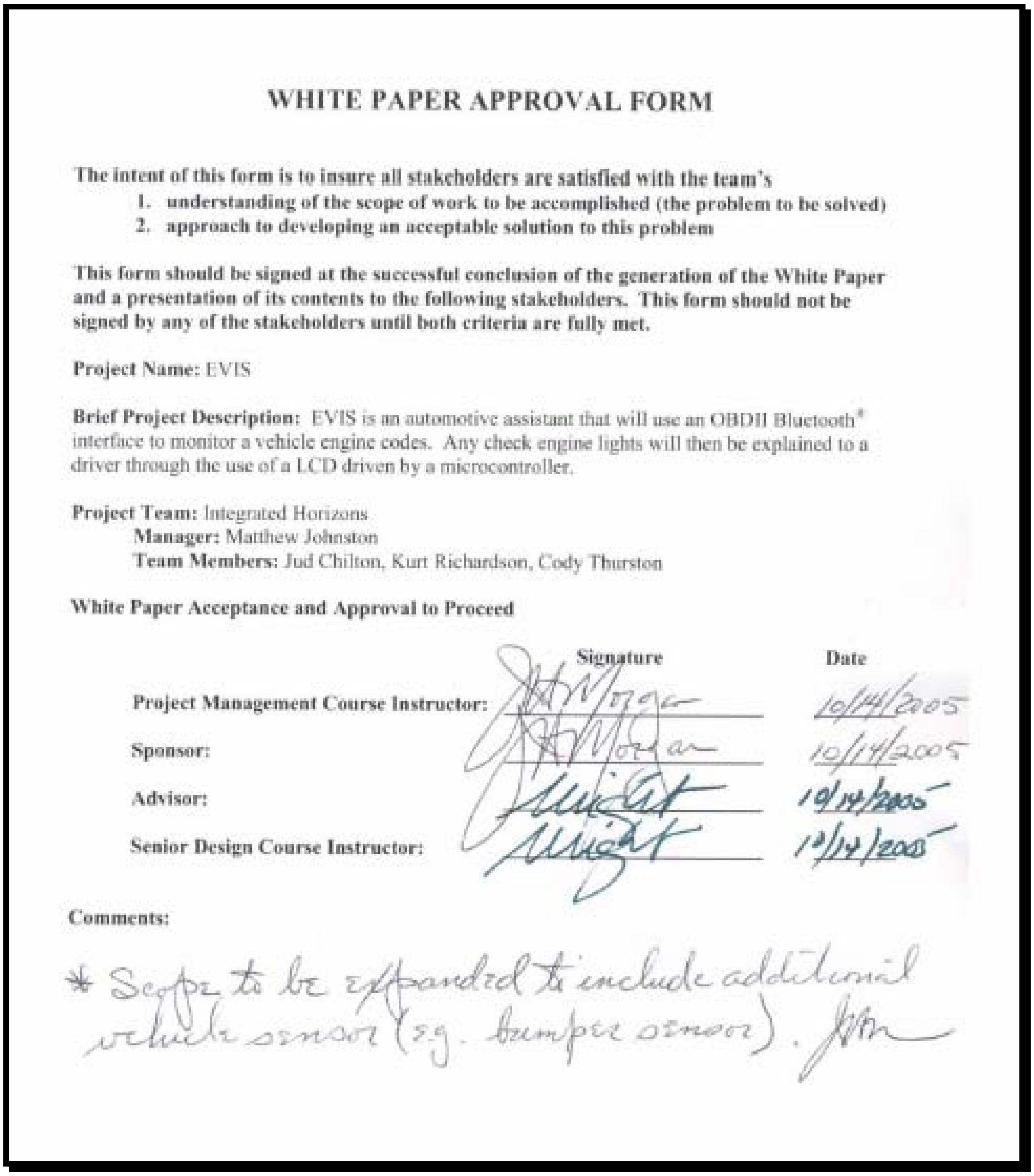


Figure 2 – Project EVIS Quad Chart

students to look at their idea in more detail. Specifically, they have to define the objectives of their project, create a work plan, do a preliminary assessment of the project's technical merit, determine resource needs and cost, and detail their final deliverables. The students present their white paper in Week 6 to the other students in the class, the faculty, and external evaluators. The review of their white paper determines whether they can proceed with their idea. Teams that have inadequate information are tasked with correcting problems and then repeating their presentation. By Week 7, most student teams have finished their white papers. However, the final document can not be submitted until the team has found a sponsor willing to provide the necessary resources to make the project successful. In most cases, the sponsor also acts as a customer and has a vested interest in the final deliverables. Figure 3 is the white paper approval form for project EVIS. One will note that the customer added requirements to the project as a condition of approval. Once this document is in place, both the sponsor and the team have committed to a set of final deliverables.



WHITE PAPER APPROVAL FORM

The intent of this form is to insure all stakeholders are satisfied with the team's

1. **understanding of the scope of work to be accomplished (the problem to be solved)**
2. **approach to developing an acceptable solution to this problem**

This form should be signed at the successful conclusion of the generation of the White Paper and a presentation of its contents to the following stakeholders. This form should not be signed by any of the stakeholders until both criteria are fully met.

Project Name: EVIS

Brief Project Description: EVIS is an automotive assistant that will use an OBDII Bluetooth® interface to monitor a vehicle engine codes. Any check engine lights will then be explained to a driver through the use of a LCD driven by a microcontroller.

Project Team: Integrated Horizons
Manager: Matthew Johnston
Team Members: Jud Chilton, Kurt Richardson, Cody Thurston

White Paper Acceptance and Approval to Proceed

	Signature	Date
Project Management Course Instructor:	[signature]	10/14/2005
Sponsor:	[signature]	10/14/2005
Advisor:	[signature]	10/14/2005
Senior Design Course Instructor:	[signature]	10/14/2005

Comments:

* Scope to be expanded to include additional vehicle sensor (e.g. bumper sensor). JHM

Figure 3 – Project EVIS White Paper Approval Form

Formalizing The Project

Starting in Week 9, the teams must begin to formalize their project work plan into a final proposal. This includes developing a Work Breakdown Structure, Responsibility Assignment Matrix, Network Logic Diagram, Gantt Chart, and Risk Management Cards. This material is reviewed by the Project Management course instructor as it is created. However, in parallel, the teams must continue working with their technical advisor to make certain that they are progressing on the technical aspects of their project. To motivate the students to maintain continued contact with their advisor, they are required to produce three written memos. The first is a detailed project statement. This ensures that the team and the advisor both understand the problem being solved. The second is a functional description of the project. Again, this helps the teams think through the different part of their system and the key issues that need to be addressed so that the final design functions as expected. Third, and most important, the students create a list of interim and final deliverables for their project. The interim deliverables are tangible items that the team will periodically present to demonstrate progress. The final deliverables spell out in detail what the final product will "look like." The following is the list of deliverables for Project EVIS:

Interim Deliverables

- Weekly Status Reports – Weekly status report presented during TAT meetings with the project coordinator, advisor, and sponsor.
- Circuit Schematics - Drafts of proposed circuits to be built.
- Fabricated PCB – Manufactured circuit boards that have been fully populated.
- Controlled Simulation of Bluetooth® - Demonstration of Bluetooth® communications between two modules.
- LCD Demonstration - Showing communication between the microcontroller and LCD.
- Proximity Sensor Demonstration – Showing proper operation and readings from a proximity sensor.
- OBDII Demonstration – Using the OBDII circuit to read codes off the car's communication port.
- Lookup Table Demonstration – Showing proper operation and displaying of information programmed in the lookup table.

Final Project Deliverables

<u>Reports</u>

- Circuit Schematics – Detailed technical engineering schematics of all fabricated circuits.
- Software Flow Diagrams – Document that explains the functional hierarchy of the microcontroller's software system.
- Test Plan – Document with detailed test procedures for the entire system and its
- subsystems.
- Test Results – Document containing the results gathered during the procedures found in the test plan.
- System Specifications – Document listing the physical and electric specifications of each device in the system.
- Installation Guide – Document containing suggested installation instructions for the main console unit, OBDII module, and proximity sensor module.
- User's Manual – Booklet describing basic setup and use of the system.
- OBDII Report- Document detailing the operation of the OBDII core technology..

<u>Hardware</u>

- Main Console Unit – Physical unit that consists of the microcontroller, LCD, and a user input device.

- Bluetooth® OBDII Module – Physical module that will plug into the ODBII port and act as a Bluetooth® gateway between the vehicle's on-board computer and the main console unit.
- Proximity Sensor Module – Physical module attached to the vehicle's bumper and transmits ranging information to the main console unit, via a Bluetooth® connection.

Forming the Technical Assistance Team

By Week 14, the teams must have finalized their Technical Assistance Team, or TAT for short. The TAT is one of the major improvements that has been implemented in the new course sequence. Gone are the days when one faculty member tried to provide overall leadership and technical guidance to large numbers of projects dealing with a wide range of hardware/software development efforts. As with many other programs, it was quickly realized that the workload of a senior design course was significantly higher than a normal lecture course. [5] For this reason, the EET/TET Programs have gone to a model where the students are responsible for establishing a Technical Assistance Team. This new methodology has resulted in much higher levels of success by the student teams. The TAT is composed of the ENTC 420 course director who provides consistency across all projects, the technical advisor who acts as the subject matter expert for the team, the project sponsor who acts as the customer/client, and other interested parties including the EET/TET Program Coordinator. In this way, the workload for senior design is distributed over all faculty members. The TAT has a vested interest in the overall success of the student team and performs a weekly review during the second semester of the capstone sequence to ensure that the team remains focused. They also provide needed support for all aspects of the project. Although the weekly status reports are intended to be a technical review of the previous week's accomplishments and to provide input on the upcoming week's activities, the meeting can also be used to brainstorm and evaluate solutions to problems or issues that have arisen. Technical review of software algorithms, hardware designs, circuit board layouts, test plans, etc. are also valuable to the teams. Finally, each week the teams are required to provide a quantitative assessment of their overall project status using Earned Value schedule and cost performance indices (SPI and CPI). For Project EVIS, they chose a faculty member with an interest in mobile computing applications as their project sponsor. This faculty member also provided work space, equipment, and funding for their project.

Assessing Technical Merit

With team sizes ranging from 2 to 4 members and with the increasing sponsorship by the private sector, the EET/TET faculty has found that a standardized methodology had to be created to assess the overall scope of the project in a quantitative manner so that variations could be taken into account. The Technical Merit assessment has been another major product of the program's continued improvement efforts. This assessment is now used by the students to guide their selection and scope definition for their projects. The assessment provides a “level playing field” that accounts for varying degrees of technical content and design from project to project.

Table 2 is an example of the technical merit assessment for Project EVIS. These criteria are used by the students to perform a self evaluation of their project’s merit at the white paper, formal technical proposal, Critical Design Review and final project documentation milestones. Teams are required to have a minimum technical merit of 1.0 in order to proceed to the implementation phase of their project. However, they are encouraged to have more than a 1.0 in case they do not receive all of the points in the final assessment. In the case of Project EVIS, one can see that the team requested (and received) 1.7 out of a maximum of 1.8 technical merit points. This approach to assessing final grades for ENTC 420 has been well received by all students. Understanding these criteria early in the planning phase allows the student to align the scope of their project so that it is consistent with the overall goals of the new course sequence.

Table 2 – Project EVIS Technical Merit Factors

	Technical Merit Factor	***Weight (Maximum)***	***Weight (Requested)***
1	Contains a clearly described and completely understood technical challenge	0.1	0.1
2	Contains a requirement for system integration	0.2	0.2
3	Contains a requirement for system testing	0.2	0.2
4	Contains a requirement for analysis	0.2	0.2
5	Contains hardware design, development and test	0.3	0.3
6	Contains software design, development and test	0.3	0.3
7	Contains a hardware fabrication requirement, typically a prototype	0.2	0.2
8	Contains a requirement for documentation other than the project report	0.2	0.2
9	Contains a requirement for intellectual property protection	0.1	0.0
	TOTAL	1.8	1.7

The Formal Proposal

Finally, by Week 15 the students must submit a formal technical proposal that demonstrates they have a well thought out solution for their project, a detailed work plan, a dated list of interim deliverables, a technical merit self-assessment, plans to mitigate risk (i.e., delayed parts, loss of a team member, …), and a cost analysis. This proposal must be signed by the members of the Technical Assistance Team and forms the basis for how the team is evaluated during the second semester of the capstone sequence. Examples of formal proposals including the proposal created for Project EVIS can be found on the Texas A&M’s capstone website. [6]

Second Semester – Senior Design Project Implementation

ENTC 420, Senior Project is the second course in the two-course sequence. Teams of students that have successfully completed the ENTC 419 course requirements will move on to this course the following semester. Where ENTC 419 focused on the planning of the project, ENTC 420 now focuses the student team's attention on the execution and control of their proposed project. Overall, the course has the following requirements:

1. Each team member contributes a minimum of 10 hours per week of productive work on the project. In the formal proposal, the team outlined the project down to the individual tasks and assigned lead responsibility for each of these work packages to a particular team member.
2. Coordinate and conduct a 30-minute project status review meeting each week with the team's Technical Assistance Team.
3. Provide a formal mid-term presentation (Critical Design Review) on the overall technical status of their project.
4. Conduct a final project presentation.
5. Deliver complete technical documentation including items such as:
    a. Test plan and report.
    b. Project report.
    c. User manual.
6. Demonstrate the level of project success through presentation of all project deliverables.

Approval of Final Proposal/ Technical Merit and TAT Meeting Scheduling

During the first week of ENTC 420 (Week 16), the first order of business is for each team to have their final proposal and technical merit approved by the course instructor. These documents are placed on file and serve as the baseline for the team's performance for the rest of the course. The teams also start a documentation binder that they will bring to all meetings during ENTC 420. The binder allows them to accumulate their project logs, schematics, memos, meeting minutes, etc. in a single place and have them available upon request of the TAT.

Finally, each student team must schedule a regular weekly meeting with all of the members of their Technical Assistance Team and it is up to the student teams to accommodate the schedules of everyone involved. This often means that TAT meetings will be held before 8 AM or after 5 PM. It is during these thirty minute meetings that the student team will present their weekly accomplishments, demonstrate deliverables, and request assistance from the TAT. The student team involved with Project EVIS chose to hold their meeting on Friday mornings at 7:30 AM.

Management by Deliverables

Another very important aspect of the new capstone sequence is the concept of managing by deliverables. As mentioned previously, the students must create a list of interim deliverables. These items are generally demonstrations of technology, schematics, circuits, PC boards, etc. and are used to show tangible evidence of progress by the team.

The student team must date each interim deliverable as part of their technical proposal. These deliverables are then presented at the appropriate TAT meeting based on their due date. This process has made a huge difference in how well the students stay on schedule. Having committed to dates for specific items typically gives them a reason to make continued progress and has, to a large extent, mitigated the problem of student teams that procrastinate until the last few weeks of the semester.

Mid-Term Presentation

During the seventh week of the semester (Week 23), all teams must participate in a consolidated Critical Design Review process. Throughout most of the course, the teams work independently of one another and have little knowledge of the overall status of the other projects. At the CDR, all teams are present and thus are able to assess their accomplishments in terms of what other teams have accomplished. This is again a motivating factor for most teams in that they work hard to stay ahead of the other groups. In addition, the CDR offers all team members another opportunity to prepare and deliver a formal verbal presentation which will receive critical review and feedback from a large number of individuals. Many students have communicated back to the EET/TET faculty that these "opportunities" for communication have served them well as they have advanced in their professional careers.

Requesting an Extension

One relatively new aspect of the course sequence is the "Request for Extension." In the twelfth week of ENTC 420 (Week 27), each team must decide whether they will need to request a time extension for their project. If so, they must formally request and justify this extension and state that a penalty of one letter grade "may" be imposed on the project (at the discretion of the TAT members) in granting the additional time. Appreciating the need to remain on schedule and the negative ramifications that falling behind on project milestones and deliverables can have is a new experience for most students. Typically one or two in ten teams request an extension.

Final Presentation and Hand-over of Final Deliverables

Under the previous senior project methodology, most student groups would have wasted substantial amounts of time "spinning their wheels" and the final project often would have been breadboards with very primitive, semi-functional circuits. In the new course sequence, with the required prep work and TAT interactions, the students were able to demonstrate a fully functional, professionally packaged prototype by the end of the semester. Their capstone experience culminates in a two hour presentation/demonstration. It is during this demonstration that all of the members of the team must show a technical understanding of their project and must demonstrate a working prototype. Also, each member of the student team must quantitatively evaluate the performance of his/her team members. These peer evaluations are then factored into each team member's final grade and it is possible to receive a failing grade for lack of technical understanding and/or participation.

For Project EVIS, the students demonstrated a completely functional system on time and under budget. Their final prototype was interfaced to a standard commercial vehicle and performed as expected. As a plus, the stand-alone computer had a built in diagnostic program which could interpret vehicle codes generated on the OBDII bus and suggest a course of action. As further proof of their success, the student team responsible for EVIS presented their project at Texas A&M Mays Business School's 2006 IDEAS Challenge, an annual competition hosted by the Center for New Ventures and Entrepreneurship where students present ideas for new products. Out of over 170 students, Project EVIS won first place and received a $3000 award.

Conclusion and Future Directions

The new two-semester senior project sequence has now been used for approximately four years. Over that time, a process of review and continuous improvement has been use and the new sequence is now consistently producing quality and successful senior projects. In fact, the last two semesters have generated several projects that could easily serve as beta prototypes for commercial products. Many factors can be attributed to this success.

First, the early identification of a project gives the students ample time to understand the problem and develop conceptual solutions. Also, requiring them to find an advisor gives them early opportunities to consult with a technical expert. Secondly, one of the major problems with the original capstone design course was that students did not take the time to truly define the problem they were trying to solve or to understand exactly what the final outcome of their work would be. Through three informal presentations to their technical advisor in the first semester, they are forced to develop a formal problem statement that includes requirements, a complete functional diagram of their proposed solution, and a list of deliverables that they will present over the course of the second semester. By committing themselves to an incremental list of deliverables, they are creating a self-regulating mechanism for keeping themselves on track. Third, the formal proposal due at the end of the first semester helps cement the faculty's expectations of their project. It also gives the students the opportunity to think through their approach and the risks associated with their project such as availability of parts, etc. Fourth**,** a rigorous and documented assessment of the technical merit of a student team's project allows the students to objectively assess the worthiness of their project. It has also made the level of effort more consistent between teams which had been a problem in the past. Fifth, management by deliverables allows the TAT to gauge the student team's progress more quantitatively and objectively. Previously, a group could simply say they were doing well and this was accepted at face value. Now, there are tangible results required for each team to demonstrate that they are on track. Finally, and probably the single most important addition affecting the quality and results of student projects has been the TAT. While it is important that the students manage their own projects, having access and oversight by an assistance team made up of "experts" allows the students to overcome roadblocks in their progress more rapidly. Also, having to report weekly to the TAT motivates the students to try and stay on schedule.

It is through these additions that the majority of student teams are able to complete the capstone design sequence successfully. As a by-product, most student teams are now generating products with commercial potential. As a result of this, the EET and TET Programs at Texas A&M University have recently undertaken a new initiative in entrepreneurship. While many institutions are adding entrepreneurship in the form of coursework and lectures [7,8], the Engineering Entrepreneurship Educational Experience (E4) initiative includes a partnership between the EET/TET Programs and a newly formed, locally-based company and defines a structure that allows students in the Electronics and Telecommunications Engineering Technology programs to transform a product idea into a proof-of-concept prototype as part of their undergraduate education. These same students will then participate in the potential transformation of their prototype into a profitable commercialized product. Once successful, the E4 partnership will:

- Create an entrepreneurial experience within the EET/TET curricula;
- Stimulate collaboration between public and private sectors;
- Produce new ideas that lead to new products;
- Generate opportunities to help start-up technology firms;
- Attract high-tech companies to the local area around the University; and
- Establish a leadership position for the University and the State in developing new strategies to secure job growth in high-tech industries.

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Biographies

JAY PORTER joined the Department of Engineering Technology and Industrial Distribution at Texas A&M University in 1998 and is currently the Program Coordinator for the Electronics and Telecommunications Programs. He received the BS degree in electrical engineering (1987), the MS degree in physics (1989), and the Ph.D. in electrical engineering (1993) from Texas A&M University.

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