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Incorporation of Significant Project Experiences within the Undergraduate Engineering Curriculum

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Work-in-Progress: Incorporation of Significant Project Experiences within the Undergraduate Engineering Curriculum

Abstract

This paper discusses the introduction and delivery of project experiences intended to create, strength, and sustain the professional growth of the undergraduate engineering degree student. The engineering industry in the 21st century is rapidly evolving with the numerous technological advances across the globe. The engineering programs at universities across the world must adapt to the ever-changing landscape by ensuring the preparation of the student to meet the demands and needs of the global workforce. Engineering project-based learning experiences go a long way toward training each engineering student to become an active, intentional, and goal-oriented learner.

The course, titled Project Experience, is offered as a one credit course to junior level students in the Electrical and Cyber Engineering (ECE) department at this institution. The primary goal of the course is to emulate the internship learning environment and experience for students. Students work on a supervised project and in a team setting to learn workplace fundamentals, teamwork, and project management skills. Topics include teamwork assessment, management versus leadership, critical thinking for design of experiments and project management techniques. The students proposed the design of the subsystems of the project and understood project management principles.

Introduction

The knowledge and training required and expected from the graduating engineering student preparing to join the global engineering workforce is significantly different in the 21st century than in the preceding timeframes. Engineering technology and the requirements from the global workforce are in constant evolution. This behooves engineering programs at universities across the world to adapt their curricula to prepare the graduates for the challenges in the engineering industry. The engineering curriculum which adopts integrated projects on a centralized engineering project platform [1] enables the student to become an active, intentional, and goal-oriented learner through *problem-solving* [2]-[3] in a *project-based* [4]-[6] and *project-enhanced learning* [7] environment. Traditionally, core lecture and laboratory courses have been taught in relative isolation of each other. This approach does not effectively deliver the broad and specific critical-thinking competencies that are required at the system, sub-system, and component level for the design and validation of engineering projects.

Project experiences on a centralized engineering platform create and foster the environment which mimics the engineering industry wherein senior-level students guide the junior-level students. This relationship shares some of the attributes observed in industry with senior, junior, and entry-level engineers. Collaboration and team work on projects promote leadership, communication, and technical skills across the four years of the curriculum, attributes that are crucial for future global engineers. The students learn to work on teams, assume leadership roles, and make decisions on how to work together by abiding by a set of rules that will help the team succeed. They inculcate discipline and take responsibility for actions and decisions, facets that would serve them well in their future professions and careers.

Section 2 overviews the course setup in terms of its description, outcomes, schedule, and assessment methods. Section 3 details the delivery of the course in the fall 2022 semester (fourteen weeks from late August to early December). Section 4 documents the learning outcomes assessment which comprises mapping to the ABET student outcomes. Conclusions and recommendations for the next steps appear in Section 5.

Section 2: Course Setup

This course emulates the internship learning environment and experience for students. Students work on a supervised project and in a team setting to learn workplace fundamentals, teamwork, and project management skills. Topics include teamwork assessment, management vs. leadership, critical thinking for design of experiments and project management techniques. The course is offered in the first semester of the junior year and is followed by the project seminar course in the second semester of the junior year. These two courses set the stage for the capstone senior design course (two semesters, fall and spring) in the final year of the undergraduate engineering program.

The course schedule is shown below in Table 1. There are fourteen sessions (one in each week) in the semester. Each session lasts three hours.

Table 1: Course Schedule

Topics	Week
Workplace fundamentals and applications	1& 2
Teamwork skills: Management vs leadership	3
Project management skills: Overview of planning – How to do planning	4
Project management skills: critical thinking for design of experiments and project management techniques – Agile Project Management	5
Apply project management process: initiating, planning, executing, monitoring, and controlling, closing – Scrum, Backlog Refinement, and Sprint Planning	6, 7 & 8
Know (1) integration, (2) scope, (3) time, (4) cost, (5) quality, (6) procurement, (7) human resources, (8) communications, (9) risk management, (10) stakeholder management – (Project implementation) Scrum Meeting and Sprint Review Meeting	9, 10 & 11
Project/team assignments: work on an assigned project and self-manage workflow, job scope, project timeline, targeted delivery – Sprint Retrospective Meeting	12 & 13
Project Report/Presentation	14 & 15

The course outcomes (COs) are listed as follows:

CO_1: Demonstrate the ability to work effectively in a team environment

CO_2: Apply appropriate project management skills

The assessment methods comprise weekly individual homework assignments and bi-weekly team project status reports which address specific components of project management.

Section 3: Course Delivery

Table 1 lists the topics covered in the course. Some of these topics are discussed in this section. The topics are organized from the basic knowledge expected of engineers in the industry to advanced project practices which adopt software development practices such as *agile*, *scrum* and *lean* [8]-[10]. *Agile* is based on iterative and incremental development, where requirements and solutions evolve through collaboration between self-organizing and cross-functional teams. *Agile* promotes adaptive planning, evolutionary development, and delivery, and encourages rapid and flexible response to change. *Scrum* is the software development method for managing projects and product or application development. Laboratory facilities with large open areas for *pairing* and *swarming*, whiteboard spaces and walls for post-its facilitate team collaboration and increase the efficiency of collaborating teams. Workplace basics comprising tips and fundamentals, and teamwork skills are assessed through the assignments which are described below.

Workplace fundamentals and applications

Each student must independently rank the items of workplace essentials, as shown in Table 2, in the order of importance/priority to you (i.e., 1: most important, 31: least important). Each statement in the Table relates to actions, reactions, and observations of the person operating in a workplace environment.

Table 2: Workplace fundamentals

Item	Description
1	Business is made up of ambiguous victories and nebulous defeats. Claim them all as victories
2	Be comfortable around senior managers, or learn to fake it
3	*Never bring your boss a problem without some solution. You are getting paid to think, not to whine*
4	Long hours don't mean anything; results count, not effort
5	*Always arrive at work 30 minutes before your boss*
6	Help other people network for jobs. What goes around comes around.
7	*Don't take sick days --- unless you are*
8	Assume no one can/will keep a secret
9	*Know when you do your best --- morning, night, under pressure, relaxed; schedule and prioritize your work accordingly*
10	Treat everyone in the organization with respect and dignity, whether it be the janitor or the president
11	When you get the entrepreneurial urge, visit someone who has his own business. It may cure you
12	*Never appear stressed in front of a client, a customer or your boss. Take a deep breath and ask yourself: in the course of human events, how important is this?*
13	Recognizing someone else's contribution will repay you doubly
14	*Career planning is an oxymoron. The most exciting opportunities tend to be unplanned*
15	Always choose to do what you'll remember 10 years from now
16	*The size of your office is not as important as the size of your paycheck*
17	Understand what finished work looks like, and deliver your work only when it is finished
18	*The person who spends all of his or her time at work is not hardworking; he or she is boring*
19	Never confuse a memo with reality. Most memos from the top are political fantasy
20	*Eliminate guilt. Don't cheat on expense reports, taxes, benefits or your colleagues*
21	People remember the end of the project. As they say in boxing, "Always finish stronger than you start."
22	Job security does not exist
23	*Always have an answer to the question "What would I do if I lost my job tomorrow?"*
24	Go to the company holiday
25	*Don't get drunk at the company holiday party*
26	Avoid working on the weekends. Work longer during the week if you have to.
27	*The most successful people in business are interesting*
28	Sometimes you'll be on a roll and everything will click; take maximum advantage. When the opposite is true, hold steady and wait it out.
29	*Never in your life say, "It's not my job."*
30	Be loyal to your career, your interests and yourself.
31	*Understand the skills and abilities that set you apart. Whenever you have an opportunity, use them.*

Teamwork skills
Each student must independently rank the leadership attributes and management attributes, as shown in Table 3, in the order of importance/priority (i.e., 1: most important, 14: least important).The attributes for each category represent the basic expectations of the individual assigned to function in the role of the category. For instance, a manager appears to push people to work while the leader guides the people in their work. The manager is focused on the work while the leader is concerned about the people performing the work.

Table 3: Management vs. Leadership attributes

Manager	Leader
Tells people what to do	Shows people and allows growth
Sticks to the plan	Visionary
They do not take risk	Takes risks to better the company
"Do what I said" attitude	Encouraging attitude
Done when mission is completed	A mission or goal is never done
Sees problems	Sees opportunity
Need to be in control	workes on trust
Cares about money	Cares about improvement and bettering others
Their job is just a job	Their job is their lifestyle
Organized	Charismatic
Authoritative	Captivating
Good communication skill	Inspirational
Goal-oriented	Motivational
Decisive	Socially adept
Pushes people	Leads people
Focused on Work	Focused on People
Directs	Modivates
Follows exactly	Willing to change
Reactive	Proactive
Oversees people	Looks after people
Physical	Psychological
Organized	Innovate
Plan	Visionary
Take responsibility	Seek responsibility
Control employees and functions	Creative
Set goals	Flexible
Minimize risk	Decision maker

Project management skills
The students are provided an overview of the chosen project. Aspects related to project planning, the critical thinking skills, and Agile are introduced. The project comprised the design of the centralized remote monitoring and surveillance platform [11]-[14] for classroom and laboratory sites in chosen buildings on the campus. Figure 1 illustrates the broad concept. There are tethered and wireless connections between specific laboratories and the intranet through routers and access points. Within each laboratory, each workstation, IoT device, and cyber-physical system/subsystem (CPS) is surveilled and monitored over a subnet which is connected to the intranet. Guidelines to ensure successful project planning and implementation are outlined [15].

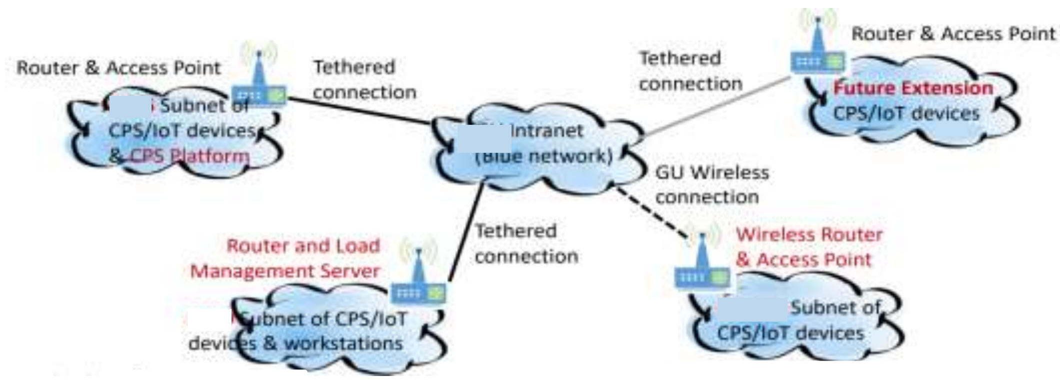


Figure 1: Remote monitoring and surveillance concept

Centralized Remote Monitoring and Surveillance System
The project to be managed is identified as a centralized remote monitoring and surveillance system. The system consists of the design of a command center to surveil and monitor the activity within laboratories which are identified as nodes on the network. Specifically, the project management process comprising the identification of the product vision and product requirements is as follows:

1. Command center: Node monitoring and diagnostics platform

Product Vision
Establish a centralized platform in the ECE course laboratory to surveil and monitor the activity in remote locations. The centralized platform will capture multimedia data (audio, video, text) from the two locations listed above for display and analysis on monitor(s) in the chosen location and will be used to store the data at regular intervals such as hourly, daily, and weekly records for future retrieval and analysis.

Product Requirements
The product requirements are:

1) Primary or main display monitor setup to provide (a) the overview of each remote location (b) key real-time multimedia data captured.
2) Secondary display of room-level, workbench-level, device-level status from each remote location.
3) Controls to navigate across primary and secondary displays at different visual resolutions/zoom features.
4) Include, features to provide streaming video on demand from each remote location.

2. Surveilled nodes: Multi-level monitoring

Product Vision
The surveillance data from each location will comprise (a) room monitoring information (b) workstation monitoring information (c) device monitoring information. The individual and collective data from each location is accessed from the centralized platform located in the laboratory. The router and access point setup at each remote location will have wireless/tethered connections to GU intranet.

Product Requirements

The product requirements are:

1) Identify all the hardware components required to monitor the activity within the location. This includes (a) cameras (b) IoT sensors (c) PCB-based electronic interfaces (d) routers and network switches.
2) Prepare the schematics for the layout of the equipment at each location.
3) Develop the secure software for communication with the hardware components at each location.

Project management processes

The project management and implementation processes comprise (a) identification of the product owner (b) functioning within a Scrum framework, (c) backlog refinement, and (d) sprint planning, progress, and retrospective meetings. The backlog items are in the categories of product backlog items (PBIs) and sprint backlog items (SBIs).

(a) Product Owner

The product owner is the individual responsible for maximizing the value of the product resulting from work of the project development team(s). In the context of the project discussed in this paper, the product owner is the faculty member(s) assigned as the course instructor. The product owner manages the Product Backlog Items (PBIs). Product backlog management includes (a) clearly expressing the PBIs (b) ordering the items in the product backlog to best achieve the visions (c) optimizing the value of the work the project development team(s) perform (d) ensuring that the product backlog is visible, transparent, and clear to all, and shows what the project development team(s) will work on next (e) ensuring the project development team(s) understand the PBIs to the extent required.

(b) Scrum framework

Scrum is a process framework to manage work on complex products which employ various processes and techniques. Scrum makes clear the relative efficacy of product management and work techniques so that one can continuously improve the product, the team, and the working environment. The scrum framework [16] consists of scrum teams and their associated roles, events, artifacts, and rules. Each scrum team identify the scrum master whose role is to lead and coordinate the functions of the scrum team. The scrum master is responsible for promoting and supporting scrum as well as assisting the scrum team members to understand scrum theory, practices, rules, and values. The scrum master helps those outside the scrum team understand which of their interactions with the scrum team are helpful and which are not. The rules of scrum bind together the roles, events, and artifacts, governing the relationships and interaction between them.

(c) Backlog refinement

The product backlog comprises the ordered list of the requirements of the intended product. It is the single source of the need for any changes to be made to the product. The product owner is responsible for the product backlog, which includes its content, availability, and ordering. Product backlog refinement is the process of adding detail, estimates, and order to items in the product backlog. This is an ongoing process in which the product owner and the project development team(s)/scrum team(s) collaborate on the details of PBIs. During product backlog refinement, items are reviewed and revised. The scrum team(s) decide how and when refinement is undertaken.

(d) Sprint planning, progress, and retrospective meetings

The heart of scrum is the Sprint, the time interval of one month or less during which significant product increments are generated. Sprints have consistent durations throughout the development effort. A new sprint starts immediately after the conclusion of the preceding sprint. Sprints contain and consist of the sprint planning based on the sprint goal, daily scrums, the sprint progress review, and the sprint retrospective meeting to determine the progress on sprint backlog items (SBIs). Sprint planning is the event whose time interval is limited to eight hours for a one-month sprint. For shorter sprints, the event is usually shorter. The scrum master ensures that the event takes place and that the participants understand its purpose. The scrum master instructs the scrum team(s) to accomplish the event within the specified time interval. The sprint goal is the objective set for the sprint that can be met through the implementation of product backlog. It provides guidance to the scrum team(s) on why it is creating the increment. The sprint goal is created during the sprint planning meeting. The sprint goal gives the scrum team(s) some flexibility regarding the functionality implemented within the sprint. The PBIs selected deliver one coherent function, which can be the sprint goal. The sprint goal can be any other coherence that causes the scrum team(s) to work together rather than on separate initiatives. The daily scrum is the short time interval (fifteen minutes or so) event for the scrum team(s). The daily scrum is conducted each day of the sprint. During the daily scrum, the scrum team(s) plan work for the next twenty-four hours. Team collaboration and performance is optimized by inspecting the work since the previous daily scrum and forecasting the upcoming sprint work. The daily scrum is conducted at the same time and place each day to reduce complexity.

Implementation of project management processes

The class comprised a total of eight students formed into two teams of four members apiece. For the PBI & SBIs, the Scrum Development Team members spent a total of 15 minutes (ideally, every day at the same time and place; practically in this course, twice a week) inspecting their progress toward the Sprint goal and creating a plan for the day (practically for a half of the week). Team members share with each other what they did the previous day to help meet the Sprint goal, what they plan to do daily, and what impediments they face. The sprint progress review was held at the end of the sprint to inspect the increment and adapt the product backlog if needed. During the sprint review, the scrum team(s) and stakeholders collaborated about what was done in the sprint. Based on that and any changes to the product backlog during the sprint, participants collaborate on the next set of tasks that could be undertaken to optimize value. This was an informal meeting and not a status meeting. The presentation of the increment was intended to elicit feedback and foster collaboration. Typically, the duration of the sprint review was at most four hours for the sprint of one month.

The sprint retrospective was the opportunity for the scrum team(s) to inspect itself and create the plan for improvements to be incorporated during the next sprint. The sprint retrospective occurred after the sprint progress review and prior to the next sprint planning. The duration of the sprint retrospective meeting was approximately three hours for the sprint of duration one month. The SBIs were the set of PBIs selected for the sprint and included the plan to deliver the product increment and the realization of the sprint goal. The sprint backlog was a forecast by the scrum team about what functionality will be in the next increment and the work required to deliver that functionality into the accomplishment of the increment. The sprint backlog makes visible all the work that the scrum team(s) identify as necessary to meet the sprint goal.

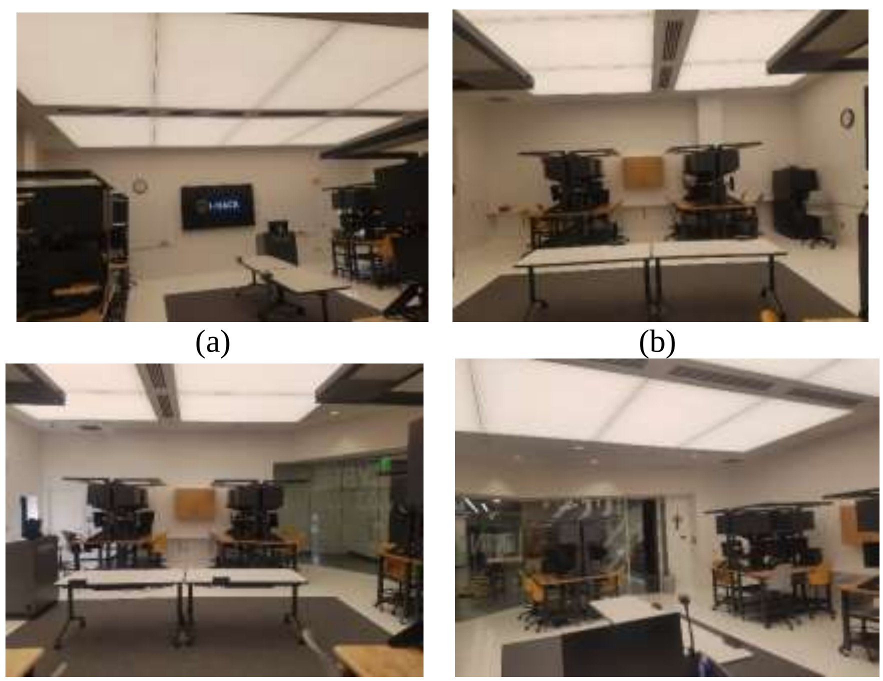
Formative project experiences/outcomes

At the start of the semester, the students formed scrum teams, appointed the scrum master for each team, and identified the PBIs of the product. Each scrum team identified the planned sites for surveillance. Multiple views of each surveilled site were captured. The pictures obtained by the scrum teams for two surveilled sites are shown in Figure 2 and Figure 3 respectively.

Each surveilled site is studied for the appropriate location of the equipment to capture the activity within the site. The scrum teams identified the placement of the equipment and the connections required to the tethered and wireless network interfaces as envisioned in Figure 1.

(a) (b) (c)

Figure 2: Surveilled site #1 (a) view 1 (b) view 2 (c) view 3



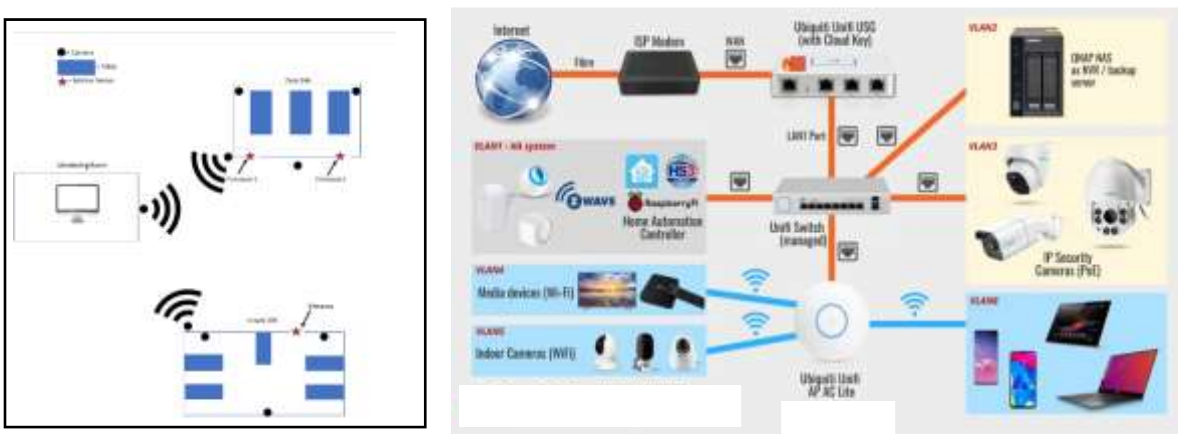
(a) (b)

(c) (d)

Figure 3: Surveilled site #2 (a) view 1 (b) view 2 (c) view 3 (d) view 4

Figure 4: Monitoring site

The site chosen for monitoring the surveilled sites is shown in Figure 4. The goal is to set up the command center and multimedia data collection system at this site.



(a) (b)

Figure 5: Proposed system models (a) top-level (b) equipment-level

The scrum teams developed models for the overall system implementation as shown in Figure 5. Each model comprises the top-level and the equipment-level design of the subsystem for surveillance and monitoring. The top-level design identified the position and units used to surveil and monitor the activity. The equipment-level design provided possible choices of the equipment and their interconnection.

Cumulative project experiences/outcomes

Each team comprising four members, led by the Scrum Master, produced the final report whose Table of Contents resembled that shown in Figure 6. Individual team members contributed to the documentation. Product architecture, hardware, and software requirements were determined based on product and sprint backlog items (PBI, SBI), the scrum process, and sprint review. The budget to set up and operate the surveillance and monitoring system was provided.

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Figure 6: Organization of the final report

Section 4: Learning Outcomes Assessment

The learning outcomes assessment is based on the mapping of the course outcomes (CO) to the ABET student outcomes (SO) through performance indicators (PI). Specific course activities called ‘Key Assignments’ measure the level of achievement of each student based the following scoring: Excellent (E) is scoring 90 or better of the total points possible, Adequate (A) is 75 or better, Minimal (M) is 60 or better, and Unsatisfactory (U) is anything below 60.

- **Demonstrate the ability to work effectively in a team environment (CO_1)**

  PI_5_1: *Demonstrate commitment to the work of the team and follow through with their agreed-upon roles and responsibilities*

  <u>Key Assignment</u>: Project status report

  <u>Justification</u>: This assignment requires the student to demonstrate commitment to the work of the team and follow through with their agreed-upon roles and responsibilities (PI_5_1). The assignment measures *the ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives* (SO_5).

  PI_5_2: *Demonstrate individual roles consistent with the team vision and goals*

Key Assignment: Project status report
Justification: This assignment requires the student to identify his/her role while working in a team environment (PI_5_2). The assignment measures *the ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives* (SO_5).

PI_5_3: *Implement the solutions to achieve the objectives of the project per customers' requirements*

Key Assignment: Project status report
Justification: This assignment requires the student to implement solutions which meet the objectives of the project (PI_5_3). The assignment measures *the ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives* (SO_5).

- **Apply appropriate project management skills (CO_2)**

PI_3_1: *Write clearly, concisely, and accurately, using appropriate language structure including grammar and punctuation*

Key Assignment: Final project report
Justification: This assignment requires the student to write clearly, concisely, and accurately, using appropriate language structure including grammar and punctuation (PI_3_1). The assignment measures *the ability to communicate effectively with a range of audience* (SO_3).

The course is offered in the first semester of the junior year and the class comprises electrical and cyber engineering students. The survey is completed by each student at the end of the semester and consists of the quantitative section and the qualitative section. The quantitative section consisted of specific questions related to the quality of the course, the performance of the faculty, and the quality of the learning experience.

Seven of the eight students enrolled in the class offered in the fall semester of 2022 completed the survey. Results in three categories of the quantitative section are documented below. The options for the responses fall in five subjective categories labeled 'Very Poor' to 'Very Good'. Each category is assigned a weight ranging from 1 for 'Very Poor' to 5 for 'Very Good'. The average score is computed from the weighted percent responses.

Course quality
Table 4 displays the responses of the students in the category of overall quality of the course. The students rated the overall quality as fair (28.57%), good (28.57%), and very good (42.86%).

Table 4: Overall quality of the course

30 - Overall quality of the course.				
Response Option	**Weight**	**Frequency**	**Percent**	**Means**
Very Poor	(1)	0	0.00%	4.14
Poor	(2)	0	0.00%	
Fair	(3)	2	28.57%	
Good	(4)	2	28.57%	
Very Good	(5)	3	42.86%	

Response Rate	Mean	STD	Median
7/8 (87.50%)	4.14	0.90	4.00

Faculty performance

Table 5 displays the survey responses in the category of overall performance of the faculty (instructor). The students are rated the performance of the faculty as fair (14.29%), good (28.57%), and very good (57.14%).

Table 5: Overall performance of the faculty

31 - Overall performance of the faculty.				
Ramakrishnan Sundaram				
Response Option	**Weight**	**Frequency**	**Percent**	**Means**
Very Poor	(1)	0	0.00%	4.43
Poor	(2)	0	0.00%	
Fair	(3)	1	14.29%	
Good	(4)	2	28.57%	
Very Good	(5)	4	57.14%	

Response Rate	Mean	STD	Median
7/8 (87.50%)	4.43	0.79	5.00

Quality of learning experience

Table 6 displays the survey responses in the category of quality of learning experience. The students are rated the performance of the faculty as poor (14.29%), fair (14.29%), good (14.29%), and very good (57.14%).

Table 6: Quality of learning experience

32 - The quality of your learning experience.				
Response Option	**Weight**	**Frequency**	**Percent**	**Means**
Very Poor	(1)	0	0.00%	4.14
Poor	(2)	1	14.29%	
Fair	(3)	1	14.29%	
Good	(4)	1	14.29%	
Very Good	(5)	4	57.14%	

Response Rate	Mean	STD	Median
7/8 (87.50%)	4.14	1.21	5.00

Qualitative section

The following comments were captured in the qualitative section of the survey. Two of the seven students made qualitative observations.

Comments:

- Useful precursor to the Capstone design course in the senior year
- Gained critical project management skills

Section 5: Conclusions and Recommendations for next steps

The introductory course in project experience is an effective approach to set the junior undergraduate engineering student along the path toward successfully accomplishing the goals of the senior capstone design project as well as gaining the crucial training necessary as an engineer in the workforce. The course emphasizes the role of the individual in an engineering team environment and the adoption of best practices such as agile, scrum, and lean project management skills. Clearly, these are extremely important for the student to understand and eventually fit into the chosen engineering industry. The goal is to allow faculty to offer the course with choices of engineering projects which require planning and implementation at the system and sub-system level.

The introductory course is the first in a sequence of courses offered by the Electrical and Cyber Engineering (ECE) department at this institution lending credibility to the fact that the department can take on the identity of an ECE organization. In this organization, the faculty members of the ECE department, besides being traditional classroom educators, assume the role of project managers. As the project manager, the faculty member delegates responsibilities to the student and coordinates the project activities of the student teams. The students in the ECE program can be viewed both as four-year employees of the ECE workforce and as customers who pay for value-adding educational experiences. In addition, the students become mentors for new trainees/interns as they progress through the ECE undergraduate program. The freshman class constitutes the new interns or entry-level trainees, the sophomore class form the mid-level trainees, the junior class represent the engineers with adequate basic training and working toward the required skills, and the senior class identified as the engineers who have acquired advanced training and deemed ready for real-world experiences.

Recommendations for the future include multi-year projects which enable senior level students to mentor and guide the junior level student through new designs and implementations of the project worked on by them in the past. This fulfills the perception of the department as an engineering organization and establishes continuity of the project management and implementation process across the four-year engineering curriculum.

Bibliography

[1] R. Sundaram, "Engineering Project Platform for Electrical and Computer Engineering Curriculum Integration," *Proceedings of the American Society for Engineering Education – North Central Section (ASEE-NCS) conference,* Morgantown, WV, March 27-28, 2020. https://peer.asee.org/35732

[2] J.E. Mitchell, B. Canavan, J. Smith, "Problem-based learning in communication systems: student perceptions and achievement," *IEEE Transactions on Education,* Vol. 53, Issue 4, pp. 587-594, Nov. 2010.

[3] N. Linge and D. Parsons, "Problem-based learning as an effective tool for teaching computer network design," *IEEE Transactions on Education*, Vol. 49, Issue 1, pp. 5-10, Feb. 2006.

[4] H.A. Hadim and S.K. Esche, "Enhancing the engineering curriculum through project-based learning," *Proceedings of the Frontiers in Education conference*, Session F3F, pp. 1-6, Oct. 2002.

[5] O. Pierrakos *et al*., "Special session - Not all problems are created equal: From problem-based learning theory to research on complex problem solving and implications for the engineering classroom," *Proceedings of the Frontiers in Education conference*, Session T3A, pp. 1-3, Oct. 2010.

[6] L. Kilmartin and E. McCarrick, "A case study of enhancing learning outcomes for undergraduate & computer engineering students through a service-learning based project module," *Proceedings of the 2010 IEEE conference on Transforming Engineering Education: Creating Interdisciplinary Skills for Complex Global Environments,* pp. 1-18, April 2010.

[7] Y.S.A. Dyer and J.L. Schmalzel, "Macro Systems: Adopting a coherent top-down framework in undergraduate engineering courses," *Proceedings of the 2007 IEEE Systems conference*, pp. 1-5, April 2007.

[8] V. Mahnic, "A Capstone Course on Agile Software Development Using Scrum," *IEEE Transactions on Education,* Vol. 55, Issue: 1, pp. 99-106, February 2012.

[9] D.F. Rico and H.H. Sayani, "Use of Agile Methods in Software Engineering Education," *Proceedings of the Agile Conference* (*AGILE '09*), pp. 174-179, August 2009.

[10] D. Damian *et al.*, "Teaching a globally distributed project course using Scrum practices," *Collaborative Teaching of Globally Distributed Software Development Workshop* (CTGDSD), Zurich, pp. 30-34, June 2012.

[11] A. Jain *et al*., "Smart surveillance monitoring system," *Proceedings of the 2017 International Conference on Data Management, Analytics, and Innovation* (*ICDMAI*), February 2017; DOI: 10.1109/ICDMAI.2017.8073523.

[12] Z. Luo *et al*., "Design of Computer Room Monitoring System with Remote Language Alarm Function," *Proceedings of the 2015 Fifth International Conference on Instrumentation and Measurement, Computer, Communication and Control* (*IMCCC*), September 2015; DOI: 10.1109/IMCCC.2015.10.

[13] E. Elbasi, "Reliable abnormal event detection from IoT surveillance systems," *Proceedings of the 2020 7th International Conference on Internet of Things: Systems, Management and Security* (*IoTSMS*), December 2020; DOI: 10.1109/IOTSMS52051.2020.9340162.

[14] Room Alert and Security equipment: https://www.security.org/security cameras/ https://avtech.com/Products/AVTECH_Environment_Temperature_Monitor_Model_Compare.html

[15] Planning: https://managementhelp.org/planning/index.htm#anchor1379314

[16] Scrum: https://scrummasterchecklist.org/pdf/ScrumMaster_Checklist_12_unbranded.pdf