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Capstone Design Experience at Southern Arkansas University (SAU)-The Model, Implementation, and Relevance in ABET Accreditation Process.

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Abstract

Capstone Design is a critical course in Bachelor of Science (BS) engineering degree programs. Since the introduction of the course in the 1980s, it has become an integral part of engineering programs not only in the United States (US) but also in foreign nations. The Accreditation Board for Engineering and Technology (ABET) places a heavy emphasis on Capstone Design experience in its program evaluation because this course helps students transfer from school to the industry environment smoothly. In this course, the students bring together knowledge from previous courses, supplement it with new learning through self-studies plus applications, and produce design solutions to industry level problems by observing engineering and regulatory standards. This paper discusses the Capstone Design model used at Southern Arkansas University with reference to its implementation and relevance to the ABET accreditation process, to share our experience with the academic community.

Key Words: Capstone Design, Senior Design, ABET

Introduction

Since the introduction of Capstone Design to engineering programs, the course has evolved significantly to provide a major design experience to engineering undergraduates. The Accreditation Board for Engineering and Technology (ABET) describes the engineering design process as follows [1].

> "Engineering design is a process of devising a system, component, or process to meet desired needs and specifications within constraints. It is an iterative, creative, decision-making process in which the basic sciences, mathematics, and engineering sciences are applied to convert resources into solutions. Engineering design involves identifying opportunities, developing requirements, performing analysis and synthesis, generating multiple solutions, evaluating solutions against requirements, considering risks, and making trade-offs, for the purpose of obtaining a high-quality solution under the given circumstances. For illustrative purposes only, examples of possible constraints include accessibility, esthetics, codes, constructability, cost, ergonomics, extensibility, functionality, interoperability, legal considerations, maintainability, manufacturability, marketability, policy, regulations, schedule, standards, sustainability, or usability".

ABET also emphasizes that the above process should be carried out in a team environment allowing students to learn how to work with people of different backgrounds and skills. Because of the importance of capstone design in the ABET accreditation process, engineering programs strive to follow a capstone design model that addresses ABET concerns. It is important to note that ABET does not dictate a particular model, and it is the responsibility of engineering programs to use models that are effective in addressing ABET concerns related to engineering design.

Since the revision of the 11 “a-k” outcomes into the currently used seven outcomes, Alex Sczatmary [2] argues that a change is required to assessment tools as well. The assessment tools are mainly evaluation rubrics, and he discusses them in detail for each outcome.

In order to provide industry level design experience through capstone design, most engineering programs seek design projects from the industry. Susannah Howe of Smith college [3] noticed that there was a decided shift towards external project sourcing from engineering programs.

In an interesting research study conducted by Mary Perrati et al; [4], the transition of 120 engineering students to industry from two different years at four institutions has been tracked to learn the influence of capstone design on their professional work. Approximately, 85% of the participants attributed their self-learning abilities to capstone design experience, and 74% of them related their team work and communication skills to capstone work. Self-learning, team work, and communication skills are essential to succeeding in engineering practice. Therefore, the above findings are a recognition of the capstone design contribution to entry level engineers’ career development. The authors of the study also noted that the capstone design experience could prepare those engineering graduates who are entering the industry from school for a smooth transition.

It is clear from the above-mentioned work that capstone design is important in preparing students for their impending entry into the industrial workforce. Capstone design is also important for engineering programs because the program accreditation by ABET is dependent upon the course. At least, four student outcomes, out of seven, are assessed using the capstone design course. Those outcomes require assessing students on individual basis even though the capstone work is carried out in a team environment. Assigning the team performance assessment to every team member for a given task may violate the very purpose of measuring student outcomes and should be avoided. Carrying out capstone work in design phases, integrating industry/engineering standards at each design step, paying attention to health and safety of the public, maintaining ethical standards, and proper documentation of the capstone design process must be critical components of any capstone design model. Missing or inadequacy of addressing those critical components may result in negative evaluation by ABET program evaluators (PEV s). Therefore, it is important for any engineering program to adopt a proper capstone model to satisfy ABET program assessment requirements.

In view of these contexts, this paper discusses the capstone model used by the engineering program at the Southern Arkansas University (SAU). The model has been developed to provide an industry level design experience in academic environment while addressing ABET requirements. In the following sections, the SAU capstone/senior design model is presented with reference to its content, implementation, and its relevance to program accreditation.

The Capstone Design Model at Southern Arkansas University

The Capstone Design course at the SAU was a one-semester course with three credit hours. The course was reorganized in 2018 and is now offered as a two-semester course with three credit hours in each semester. Recently, the course was revised to improve the content and facilitate a better implementation. The course utilizes previous knowledge acquired in other courses of the program as shown in figure 1. The SAU capstone model recognizes that the capstone design work is iterative and follows the process given in figure 2. The current capstone design model emphasizes students taking initiatives and the instructor playing a supporting role with necessary instructions. These instructions are given in lectures, and in meetings with design teams. Lecture topics are primarily to help students complete activities undertaken in each design phase. Students also take a multiple-choice exam based on design activities and hypothetical engineering situations. The exam is a measure of students' understanding of the design process and is used to obtain data for ABET outcomes as well.

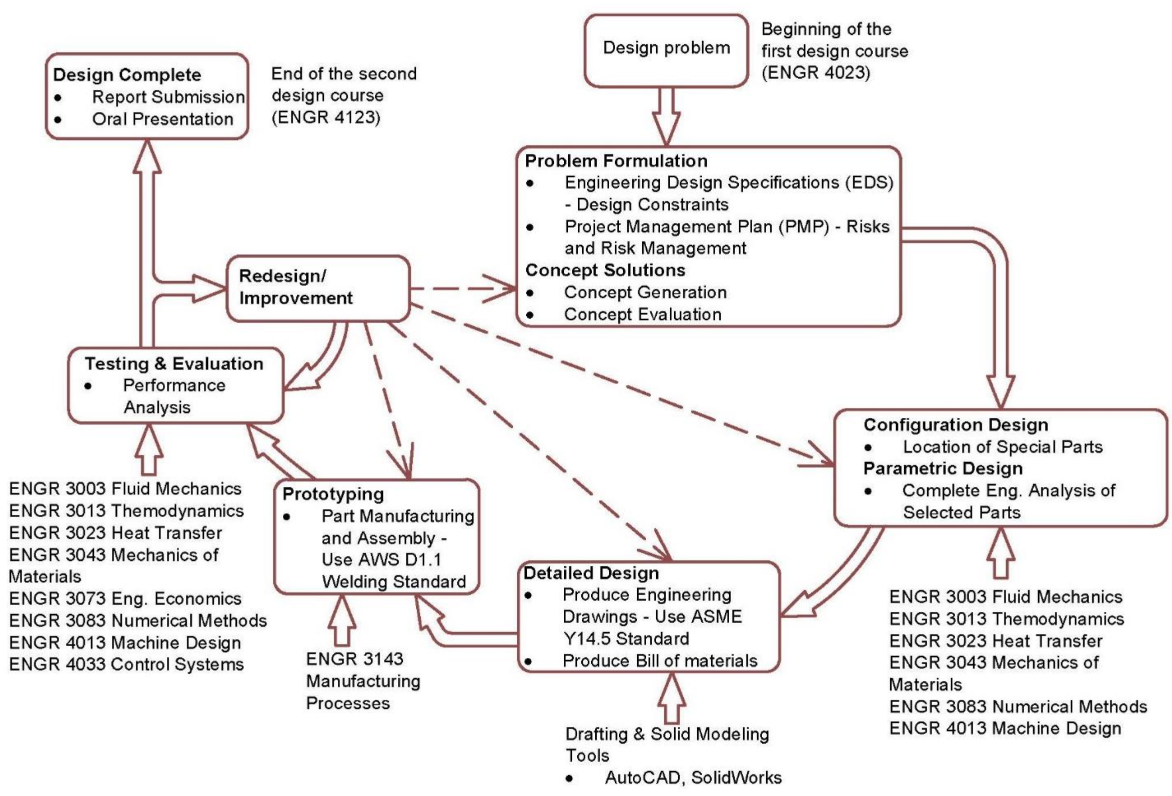

Figure 1: Use of knowledge from previous courses in capstone design at the SAU

The first semester work starts in fall and the design work is completed in the following spring semester. The first semester wok concentrates on completing the design on paper by going through design phases, and the activities include, literature survey, preparation of the project management plan (PMP), development of engineering design specifications (EDS) that includes multiple design constraints, proposing multiple concepts as design solutions and selection of the

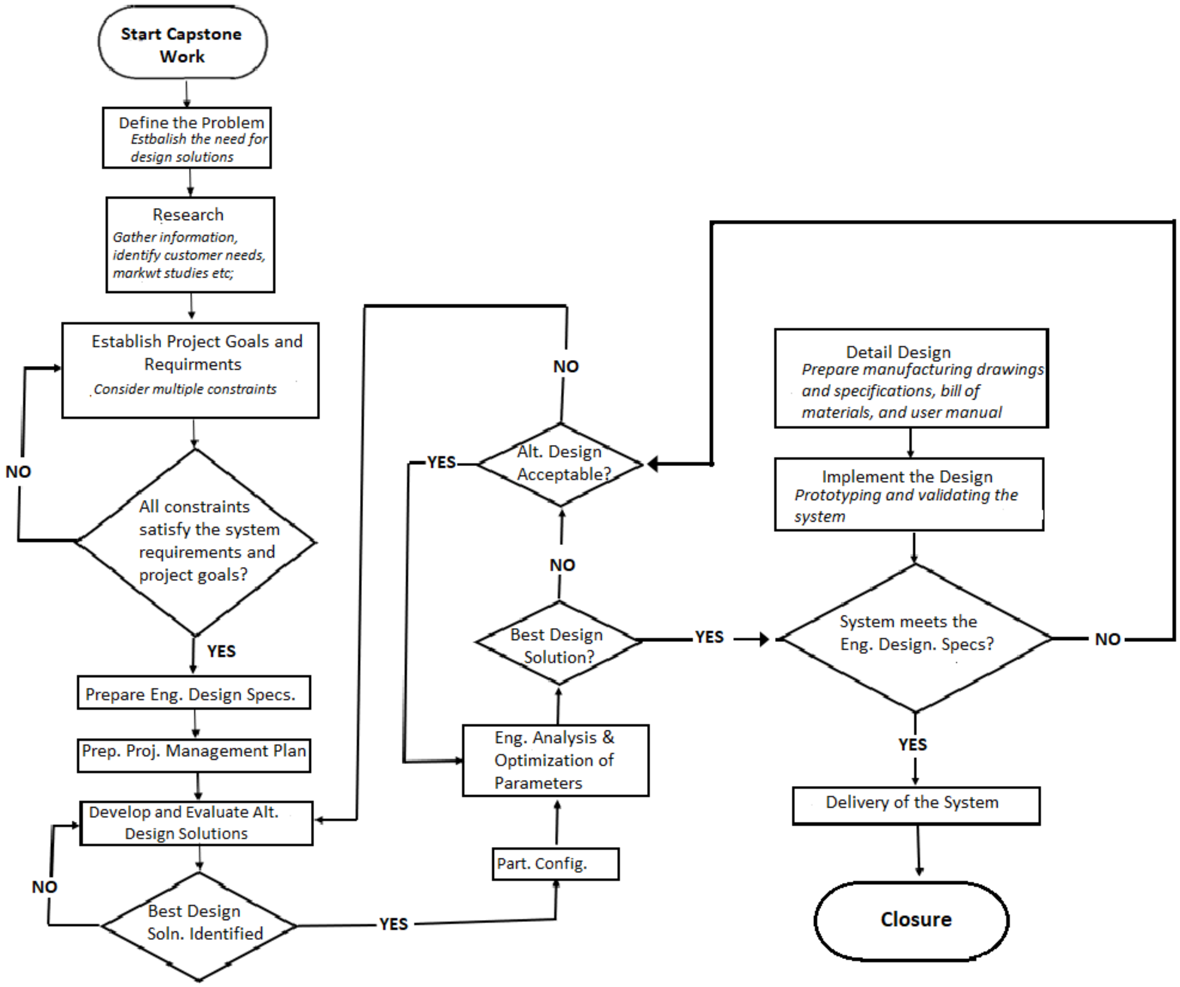

Figure 2: The iterative design process used in the SAU capstone model

most appropriate concept, engineering analysis of the selected concept, and preparation of the engineering drawings for prototyping. In addition, students also complete several specially designed machine shop exercises, which are unique components in the capstone model implemented at the SAU. The shop exercises include flat plate welding, T-joint welding, pipe welding of different geometrical joint configurations, and machining of bolts. These exercises supplement what students learned in the manufacturing course (ENGR 3143) and are designed to improve their fabrication skills, make them appreciate practical issues, and consider such issues when they design a component or a system. It has been observed that these exercises improve students' fabrication skills significantly allowing them to be less dependent on machine shop personnel.

The second semester (spring semester) work is mainly the prototyping, testing, evaluation, making refinements to the design, and documenting those activities to be included in the final report. Additionally, each design team defends the design solution in a public oral presentation, showcase the final product to general public, and complete the final design report. Students also

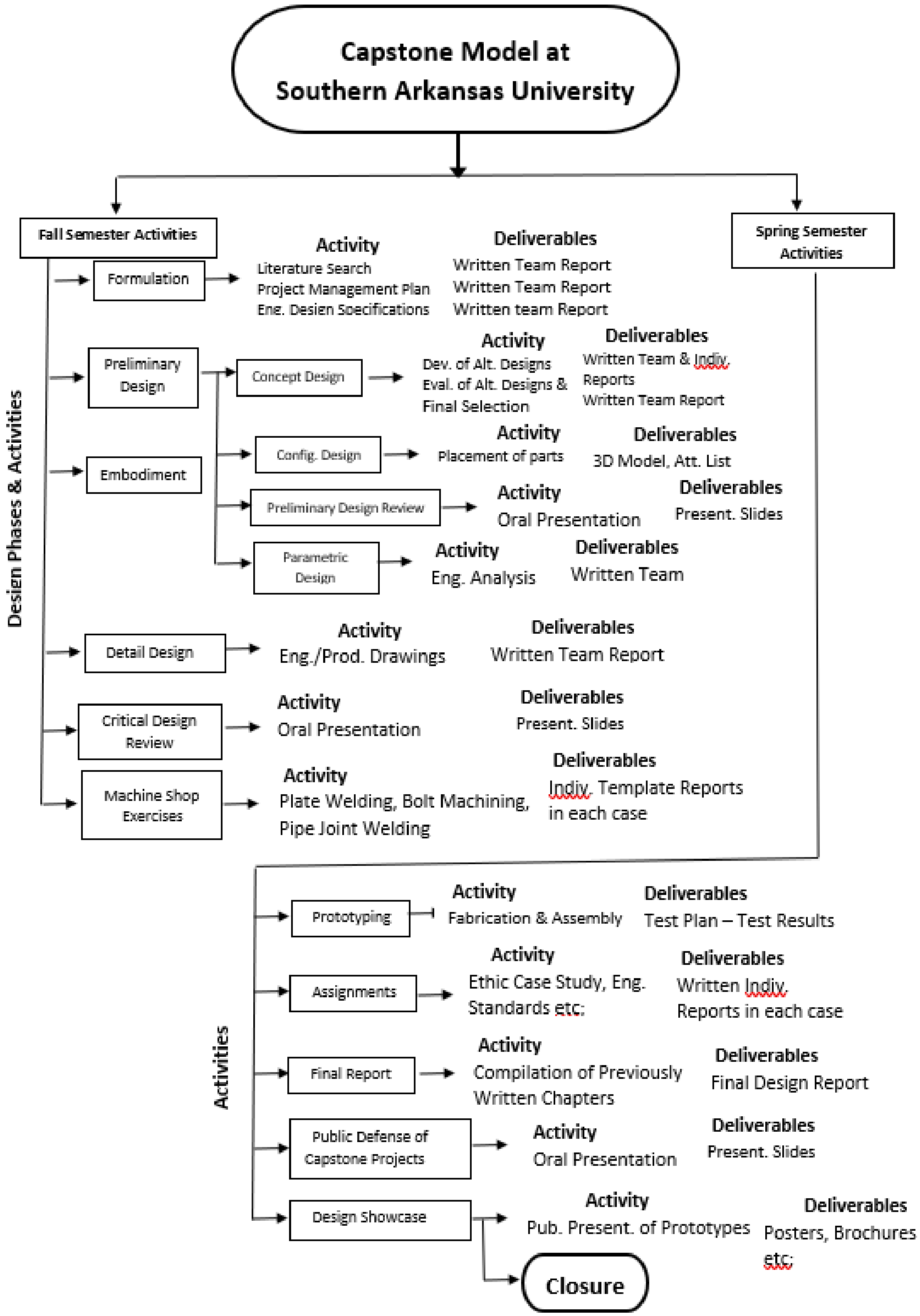

Figure 3: Design phases and activities undertaken in each design phase

undertake several individual assignments related to ethics and impact of design solutions on society.

According to Eggert [5] a product design evolves over time in design phases. This evolvement of capstone design at the SAU is illustrated in figure 3.

Formulation (of the design problem) is important because the successful design solution depends on the sound formulation of the design problem [5]. Gathering information on customer requirements, company requirements, identifying bench mark products, developing the project management plan (PMP), and establishing engineering design specifications (EDS) are completed in this phase. EDS is the guiding document of the design activities. It includes multiple constraints and specifies industrial design codes such as ASME and ASTM that must be used in the design process. During concept design phase, alternative design concepts are developed, evaluated and the final selection is made. In configuration design, the connectivity of components and location of sub components are identified. In parametric design phase, engineering calculations and simulation work using engineering software are carried out to optimize the design solution. In the detail design phase, students prepare a bill of materials, material and manufacturing specifications for each sub system, and manufacturing drawings. Manufacturing drawings are prepared according to ASMY Y14.5 standard. In the prototyping stage, fabrications are completed according to relevant industry standards. For example, steel welding work is completed according to American Welding Society (AWS) code 1.1 and aluminum welding is carried out according to AWS 1.2.

As mentioned previously, design solution is completed on paper in semester 1(fall semester). Students are required to document each design phase activity according to the final report format as they complete the activity so that, at the end of the first semester, most of the final report work is complete. This requirement helps save valuable time otherwise spent in the second semester enabling more time for prototyping, testing, and evaluation. The requirement also allows the instructor to review documented chapters of the final report very early without waiting to do so at the end of the second semester. Full activities undertaken in each semester are shown in table 1 and 2.

Monitoring of Students' Work

Monitoring of students' work in design work is important to ensure the quality of their work and completion of work as scheduled. The team lead turns in a weekly report (Appendix A) that provides comprehensive information about design activities undertaken as a team, and each team member's contribution to the activities. In addition, each team member maintains an individual log book that records the individual contribution to design activities on weekly basis. The team lead maintains a team log book that records the team meetings, work assigned to each team member, and the progress of completion of assigned work. These log books are also turned in on

Table 1: Major design activities in semester I (fall semester)

Major Exercise	Activity	Relevance
Library Training	Students will undergo a training provided by the university library staff on literature search.	The training helps students carry out library research and locate relevant information quickly.
Formulation of the Design Problem	1. Students undertake comprehensive literature search related to their design projects. 2. Students prepare Engineering Design specification (EDS).	Help students learn about competing products and benchmark products. EDS is the guiding document of the design, and it lists design constraints and other requirements. Chapter 2 – final report
Project Management Plan (PMP)	Students prepare a comprehensive document that describes the management of the design project.	Include risks, risk management, Gantt chart etc. Chapter 3 – final report
Concept Designs and Evaluation	Students develop multiple design concepts for the design solution and evaluate them using the Weighted Rated method.	Chapter 4 – final report
Parametric Design Calculation and Optimization	Students will complete a comprehensive engineering analysis of the selected concept design.	Chapter 5- final report
Detail Design	Students prepare engineering drawings (shop drawings) using Solid Works software.	Engineering Drawings meet ASME Y14.5 standard in Solid Works. Solid Works support ASME Y14.5. Chapter 6-final report
Critical Design Review (CDR) Presentation	Students will make oral presentation of ENGR 4023 work to the instructor.	The design on paper is complete and moves to prototyping phase. Oral presentations are evaluated by the instructor.

a weekly basis to the course instructor allowing proper monitoring of teams' activities. The course instructor provides feedback on those reports during the weekly meetings with design teams.

Assessment of Students' Work

Assessment of students' design work includes preliminary design review (PDR) and the critical design review (CDR) in the first semester. In the second semester, design work is evaluated through the final report, final oral presentation, and prototype evaluation in the design showcase, which is a mass display of the prototypes of design teams. Appendices 'B' through 'E' provide the evaluation instruments. It should be noted here that final oral presentation and the prototype evaluation are done by independent evaluators, and the course instructor does not participate in those evaluations. Even though students complete design work as a team, individual contribution and performance are monitored and evaluated within the team environment. Each student is entrusted with, a certain research section in literature search, an alternative design concept, a selected section of PMP, a selected section of EDS, a selected section of engineering analysis, and a certain part of the manufacturing drawings. Each student also submits a peer review

Table 2: Major design activities in semester II (spring semester)

Major Exercise	Activity	Relevance
Prototyping	Student teams begin fabrication and assembly of their final designs. The fabrication may involve drilling, machining, welding, and 3D printing that will span over a period of seven to ten weeks.	The prototyping work improves the hands-on skills of students and exposes them to practical problems unforeseen during early design stages. Such exposure will help them improve their design skills in future work. Engineers may not work on the shop floor but shop skills will help them guide technologists, machinists, and fabricators in future professional level design work.
Continuation of final report work from semester I	Student teams will complete remaining chapters of their final reports. Those are; Introduction (chapter 1), Manufacturing and Construction (chapter 7), Testing and Evaluation (chapter 8), Budget Control and Management (chapter 9), Results (chapter 10), Discussion (chapter 11), Recommendations (chapter 12), Conclusion (chapter 13), Statement of Ethics (chapter 14), References (chapter 15, and Appendices.	The completion of remaining chapters is undertaken as a team effort and carried out in parallel to prototyping work. The contribution each student in report completion work is recoded in his/her “peer review” s for grading and assessment purposes.
Other course assignments	Ethical practice in engineering. Students are given a case study topic related to engineering practice to examine if ethical violations have occurred or been committed by the parties involved. This individual assignment requires the submission of a report.	The purpose of the assignment is to stress the importance of ethics and ethical work in engineering practice. The assignment is also used in individual performance grading and to collect data for ABET outcome 4, which the assessment rubric is given for with the assignment.
	The impact of engineering solutions in global context. An individual assignment that requires students to turn in an investigative report on the given topic.	The assignment underscores the impact of design solutions on society and its wellbeing. The report is also used to collect data for ABET outcome 2.
	Industrial Design Codes An individual assignment based on questions designed by the instructor	The assignment tests the ability of students to identify the industrial design code/s for a given engineering task, and how to apply satisfy the identified code/s requirements.
Oral Presentation	Design teams make oral presentations to educators, professionals, peers, and the general public.	An oral presentation is the public defense of design work by a team. The team performance and the individual performance are evaluated and for grading purposes and assessed for data collection for ABET outcome 3.
Design Showcase	Design teams showcase their final products to the general public.	The event emulates marketing campaigns and product displays by commercial companies. The event marks the close out of capstone work.

evaluating the performance of each team member in each team activity. The course instructor evaluates individual contributions in each design activity according to evaluating rubrics. Such evaluations, along with peer reviews are used for data collection for ABET accreditation and course grading purposes.

The Relevance to ABET Accreditation Process

The capstone design course plays a critical role in ABET accreditation process in all engineering programs in the United States (U.S.) and North America. In the engineering program at the SAU, the capstone design course is used to obtain data for minimum of four student outcomes every semester. The table 3 shows the student outcome and the data collection method. Each outcome must be measurable, and the data collection instruments must be designed accordingly. Direct methods (exercises, exams, reports etc.) are used whenever possible for data collection because they are preferable to indirect methods such as surveys.

Table 3: Data collection for ABET accreditation from capstone design at the SAU

ABET Outcome	Outcome measurement
2. an ability to apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare as well as global, cultural, social, environmental, and economic factors.	Direct measurement Individual assignments Final report – EDS, and the Relevant chapters of the final report
3. an ability to communicate effectively with a range of audiences.	Direct measurement Written – Final report Literature Survey Oral – CDR and final Oral presentations
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	Direct Measurement Exam questions based on hypothetical Engineering situations Case study problem – second semester
5. an 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.	Direct measurement Weekly reports, PMP, Peer review. The course instructor reviews above reports and rate each student on the expectations of the outcome.

Discussion

The above sections provide a sensible description of the capstone design model used in the engineering program at the SAU. The model emphasizes students taking initiatives rather than the course instructor instructing students what to do at every step of the design process. The course instructor provides helpful lectures, monitors student activities on weekly basis, supervises the final report completion. Obviously, workload of the capstone design course is far greater than in any other course in engineering for both the instructor and the students. Therefore, proper management of the design work is essential to ensure successful conclusions to design projects.

As mentioned previously, capstone design course is critical to getting ABET accreditation or re-accreditation. This course provides data for at least four student outcomes. If ABET program evaluators (PEV s) identify any weakness in the capstone design course, the accreditation or re-accreditation of the engineering program might be in jeopardy.

Documenting the design process is important because PEV s evaluate the final design reports for what the ABET places emphasis on. The use of multiple constraints, alternative designs, adhering to ethical standards, working in team environment, and the impact of the design solution in global, economic, environmental, and societal contexts should be well documented. It is also important to integrate applicable industry/engineering standards in the final report. It is not sufficient to mention the industry/engineering standards merely in the final report. In each design phase activity, relevant engineering standard/code requirements should be discussed and how the requirements are met should be clearly stated. Therefore, it is advisable to include written chapters describing the integration of industry/engineering standards in design work and how student outcomes are addressed in the design work and the solutions.

Conclusion

The capstone design model and its implementation in the engineering program of southern Arkansas University has been presented. The model has been designed to provide a major design experience satisfying the ABET requirements. The model emphasizes the use of design phases in evolving the design. The importance of integrating industry/engineering standards and documenting the design work are stressed in the discussion part of this paper and may be useful to engineering programs that are preparing for ABET accreditation or re-accreditation.

References

[1] Criteria for Accreditation of Engineering Programs, 2023-2024. Publication by the Board for Accreditation of Engineering and Technology programs (ABET).

[2] A. Szatmary, "Tools for Comprehensive Assessment of the 7 ABET Student Outcomes in Mechanical Engineering, with Application to Capstone Design", ASEE-2023 annual conference and exposition, Baltimore, MD. 2023.

[3] S. Howe, "Where Are We Now? Statistics on Capstone Courses Nationwide"-Advances in Engineering Education, Spring 2010.

[4] M. C. Paretti, J. D. Ford, S. Howe, and D. Kotys-Schwartz, "Engineering Capstone Course Help Transition from School to Work", https://researchoutreach.org/articles/engineering-capstone-courses-help-students-transition-school-work/

[5] R.J. Eggert, *Engineering Design*. Meridian, Idaho: High Peak Press, 2010.

Appendix 'A'

Weekly Report

Project Name : ____ Report#:____

Faculty Advisor:___________Reporting Period:________ Submission Date: ________

Team Members: 1. ------------------------------ 2. ---------------------------------
3. ------------------------------ 4. ---------------------------------
5. -------------------------------

Time Sheet (Starting Date – Ending Date)

- Time spent on the project/work: date, start time and end time, summary of activities

Student	Reporting Period (start date-ending date)	Activity (in two to three sentences)	Hours For Reportin Week	Total hrs for the semester	Initial

Team Total hours for this week =
Team Cumulative hours for the semester =

Progress of Previous Activities

Student	Assigned Work (List current week, previous week 1, previous week 2)	Percentage of Completion	Plan for completing the assigned work	Initial
John Doe	Current	75%	Spend additional hours	JD
	PW 1	100%		JD
	PW2	100%		JD

Progress of Previous Activities –continuing table

Student	Assigned Work (List each week separately until up to the current week)	Percentage of Completion		Initial

Gantt Chart of Work Completion

Student	Completion of Work Reporting Week					Completion of Work Previous Week 1			
	<10%	10-30%	30-50%	50-75%	75-100%	<25%	25-50%	50-75%	75-100%
e.g. John Doe									

Color Code: Green – Completed Red – Not Completed

Work in progress is considered not complete

Team Meeting#: Date:

Student	In person/Virtual	Work Assigned

Ethic Statement:

The work and the hours logged in this report are true, accurate, and devoid of any exaggerations.

Each student certifies the above statement by signing below.

1. ………………………… (Team Lead) 2.---------------------------- 3. --------------------------

4. -------------------------------- 5. ----------------------------

Appendix 'B'

Final Report Evaluation

Report Title:

Section	Excellent Rating 4	Good Rating 3	Satisfactory Rating 2	Unsatisfactory Rating 0	Rating given by the instructor for the section
Literature Survey	Exhaustive and identify benchmark products, technology, current use, and future trends in use and technology	Good description of current products in the market. Identify major products and their features.	Current products and technology are briefly discussed. No benchmark products are identified.	Fail to provide sufficient information of current products and technology. No future trend or use are described.	
Eng. Design Specification (EDS)	Requirements are extensively covered. Complete list of multiple design constraints is provided. Eng. Standards (ASME etc.) are specified	Project design requirements are given with multiple design constraints.	Limited design requirements and multiple constraints are given.	Project design requirements are not covered adequately. No multiple constraints are considered.	
Project Management Plan (PMP)	Objectives and scope have been established. Every element of PMP has been discussed. Work Breakdown Structure (WBS), Risk, Budget, Gantt chart and all required elements are presented and discussed in depth.	Objectives and scope have been identified or presented. Most of the important PMP elements are discussed well in the report.	The PMP misses several elements of PMP but provides sufficient details to cover important aspects.	The PMP misses a lot of important elements and does not provide a clear demonstration of how the project will be managed. Responsibility of individual members, risk, budget control, Gantt chart are not adequately described.	

Report Title:

Section	Excellent Rating 4	Good Rating 3	Satisfactory Rating 2	Unsatisfactory Rating 0	Rating given by the instructor for the section
Alternative Concepts and Evaluation	Multiple concepts have been considered. The concepts evaluation criteria are thorough, relevant, and include importance weightage, and rating. Morphological matrix shows all possible combinations of concepts. Final selection of design concept is based on the analysis.	Multiple concepts have been considered. The concepts evaluation criteria are appropriate. The evaluation method includes importance, weightage and rating. The morphological matrix includes most possible combinations.	Several alternative concepts have been considered. The evaluation criteria are satisfactory. Some elements such as importance, weightage, and rating may are missing.	One or two concepts have been considered but there is no proper evaluation and selection of the best design.	
Parametric Design Calculations and Optimization	In depth parametric calculations have been performed. Modern software has been used in the analysis. The analysis is thorough and confirms the validity of design.	Parametric analysis has been undertaken. Modern software is used in the analysis with sufficient depth.	Parametric analysis has been completed but one or two secondary important parameters are not presented. Modern software has been used to minimal level.	Parametric analysis failed to produce accurate values of parameters and the use of modern software tool is absent.	
Detail Design	Professional level shop drawings for each and every component have been prepared according to ISO or ASME Y14.5 standard. Drawings include both 2D and solid models. Bill of Material (BOM) has been presented.	Drawings have been prepared according to ISO or ASME standards. Drawings are professionally looking with the omission of some minor details. Bills of Material (BOM) omits secondary components.	Drawings have been prepared according to ISO or ASME standards. Drawings are missing some dimension looking with the omission of some minor details. BOM is limited to a several major components.	Drawings do not look professional. Dimensioning and lettering doe not follow any engineering standard. No Bill of Materials (BOM) is presented.	

Report Title:

Section	Excellent Rating 4	Good Rating 3	Satisfactory Rating 2	Unsatisfactory Rating 0	Rating given by the instructor for the section
Prototyping	Complete description of manufacturing process and steps are given. Relevant materials and fabrication process have been undertaken according to **relevant industry standards.** Visual images of most steps of the fabrication process are provided.	Good description of manufacturing process and steps are given. Relevant materials and fabrication process are identified according to industry standards.	The manufacturing process provides brief description of the work and identify the relevant standards to be followed. The documentation of the process is adequate even though not exhaustive.	The prototyping or the manufacturing process not documented adequately. Fabrication description is limited to one or two components.	
Testing and Evaluation	Extensive testing has been completed according to a plan and all parameters have been evaluated and compared with the design values.	Tests have ben conducted and parameters have been evaluated. Test plan is adequate.	Tests have been completed but clear test plan is not visible. Parameters have been evaluated.	Testing and Evaluation has not been conducted.	
Budget Control & Management	Budget control and management is well documented showing the schedule and the budget control for every week. Graphical description is based on the Earned Value Analysis is well constructed and shows the sound control over the schedule and the budget.	Budget control and management is well documented showing the schedule and the budget control for every week. Graphical description is based on the Earned Value Analysis and it is adequately constructed.	Budget control and management is documented showing schedule and budget control for every week. No graphical summary of the budget and the schedule control are provided.	Budget control and management is a vague analysis and does not provide a clear picture of weekly control.	

Report Title:

Section	Excellent Rating 4	Good Rating 3	Satisfactory Rating 2	Unsatisfactory Rating 0	Rating given by the instructor for the section
Results, Discussion, Recommendation, & Conclusion	Summarize the objective, constraints, team work, difficulties, innovative solutions to challenging problems, and emphasize the importance of project management at every phase of the project. Provide concrete conclusion and make recommendations for further improvement of the design and design activities.	Summarize the objective, constraints, team work, difficulties, innovative solutions to challenging problems. Provide conclusion and make recommendations for further improvement of the design and design activities.	Summarize the design experience adequately and discuss the design solutions and make recommendation for future work.	Results, Discussion, and recommendations do not provide any insight to the design experience. Discussion of constraints, team work, development of innovative solutions is absent.	
Appendices	Include all secondary calculations, drawings, weekly budget and schedule monitoring sheets, technical literature, and product manual.	Include all secondary calculations, drawings, weekly budget and schedule monitoring sheets and some technical literature.	Include all secondary calculations, drawings, weekly budget and schedule monitoring sheets.	Appendices are not provided.	

Average numerical rating: **Rating of the report:**

………………………………………………….. ……………………………………..

Instructor Date

Appendix ‘C’

CRITICAL DESIGN REIVIEW (CDR) - PRESENTATION
TEAM/IND. MEMEBR ORAL PRESENTATION EVALUATION SHEET

Evaluator's Name: ____

Project Title: ____

List the total score that you feel best represents the quality of the presentation and design efforts, using the following guideline.

	Poor	Average	Good	Very Good	Excellent
Delivery / (10)	2......4	5 __6. .7	7.5.........8.5...	8.5......9.5	9.5 10

- pronunciation
- eye contact/body language/distracting mannerisms
- professionalism
- Organization

	Poor	Average	Good	Very Good	Excellent
Overall Effectiveness/ (10)	2......4.........	5 __6. .7	7.5.........8.5...	8.5......9.5	9.5 10

- visual aids/question response
- Supporting Materials

	Poor	Average	Good	Very Good	Excellent
Design Process/ (30)	6...12......................	12...15.........	15...25............__	..25.. 27...............	27....30.

- Need statement
- Literature search
- Project Management
- Realistic constraints -EDS
- Concept generation & evaluation
- Calculations & optimization
- Modern software tools used
- Engineering drawings

TEAM SCORE ______________

TEAM MEMBERS INDIVIDUAL BEHAVIORS (50 Points)
In the table below, post number of assigned points between 0 and 10 (with 10 being the best) in each category.

Team Member	Assigned Content Organization	Use of Language	Supporting Materials of the Assigned Section	Delivery-Volume/ Clarity/ Enunciation/ Speed	Ability of Conveying the Central Theme of the Content

IND.SCORE ______________

TOTAL SCORE =Team Score + Ind. Score =
Comments:

Evaluator's Signature **Date:**

Appendix 'D'

FINAL SHOW AND PROTOTYPE EVALUATION
TEAM EVALUATION SHEET

Project Title:

List the total score that you feel best represents the quality of the presentation and design efforts, using the following guideline.

Poor Fair Average Good Very Good Excellent

Delivery 2…………3………5………6……….7.……… 8………….9……………10

- Quality of poster ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
- Communication ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
- Professionalism ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Overall Effectiveness 2…………3………5………6…………7.……__8…… 9__ 10

- Visual aids ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
- Question response ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Prototype 2…………………………5………………………7…. ……..8…………9..............10

- Form test → Does the product have an acceptable appearance?
  ☐ ☐ ☐ ☐ ☐ ☐
- Fit test → Do the parts fit together and also fit the user, with an acceptable precision?
  ☐ ☐ ☐ ☐ ☐ ☐
- Function test → Does the product fulfill the main functions as planned?
  ☐ ☐ ☐ ☐ ☐ ☐
- Optimization → Systematic approach or random tinkering?
  ☐ ☐ ☐ ☐ ☐ ☐
- Consideration of cost/manufacturing/safety/maintainability/retirement/etc.
  ☐ ☐ ☐ ☐ ☐ ☐

COMMENTS/NOTES

Evaluator's Name: __……………………………… Affiliation: __……………………………………

Signature Date:

______________________ _________________________

Appendix 'E'

Final Oral- Presentations

TEAM/IND. MEMEBR ORAL PRESENTATION EVALUATION SHEET

This evaluation sheet has two components – Team Evaluation, and Individual member evaluation. Please complete both sections.

Name of the Evaluator: __ ________________

Project Title: ____________________________

1. Team Evaluation

List the total score that you feel best represents the quality of the presentation and design efforts, using the following guideline.

	Poor	Average	Good	Very Good	Excellent
Delivery / (10)	2……4	5 …..6. .7	7.5……8.5	8.5…….9.5	9.5 ……10

- Pronunciation
- Eye contact/body language/distracting mannerisms
- Professionalism
- Organization

	Poor	Average	Good	Very Good	Excellent
Overall Effectiveness/ (10)	2……4	5 …..6. .7	7.5……….8.5	8.5…….9.5	9.5 ……10

- Visual aids/question response
- Supporting Materials

	Poor	Average	Good	Very Good	Excellent
Design Process/ (30)	6…….12	…12…15………	15……25	25…. 27	27……30.

- Need Statement
- Literature Search
- Project Management
- Realistic Constraints -EDS
- Concept Generation & Evaluation
- Calculations & Optimization
- Use of Modern Software Tools
- Quality of Engineering drawings

TEAM SCORE ______________

Continued…

2. Individual Member Evaluation

Team Member	Content Organization (Please check what is applicable)	Language	Delivery	Supporting Material	Central Message
	Very Good	Memorable & Compelling	Compelling & Polished	Superior & Highly Qual.	Compelling
	Good	Thoughtful & Effective	Interesting & Cmftble.	Good & Convincing	Clear & Discernible
	Acceptable	Mundane & Commonplace	Tentative & Unclear	Appropriate & Satisfct.	Understandable
	Weak	Not appropriate	Dull & Uninteresting	Not Relevant	Unclear & Cloudy
	Very Good	Memorable & Compelling	Compelling & Polished	Superior & Highly Qual.	Compelling
	Good	Thoughtful & Effective	Interesting & Cmftble.	Good & Convincing	Clear & Discernible
	Acceptable	Mundane & Commonplace	Tentative & Unclear	Appropriate & Satisfac.	Understandable
	Weak	Not appropriate	Dull & Uninteresting	Not Relevant	Unclear & Cloudy
	Very Good	Memorable & Compelling	Compelling & Polished	Superior & Highly Qual.	Compelling
	Good	Thoughtful & Effective	Interesting & Cmftble.	Good & Convincing	Clear & Discernible
	Acceptable	Mundane & Commonplace	Tentative & Unclear	Appropriate & Satisfac.	Understandable
	Weak	Not appropriate	Dull & Uninteresting	Not Relevant	Unclear & Cloudy
	Very Good	Memorable & Compelling	Compelling & Polished	Superior & Highly Qual.	Compelling
	Good	Thoughtful & Effective	Interesting & Cmftble.	Good & Convincing	Clear & Discernible
	Acceptable	Mundane & Commonplace	Tentative & Unclear	Appropriate & Satisfac.	Understandable
	Weak	Not appropriate	Dull & Uninteresting	Not Relevant	Unclear & Cloudy
	Very Good	Memorable & Compelling	Compelling & Polished	Superior & Highly Qual.	Compelling
	Good	Thoughtful & Effective	Interesting & Cmftble.	Good & Convincing	Clear & Discernible
	Acceptable	Mundane & Commonplace	Tentative & Unclear	Appropriate & Satisfac.	Understandable
	Weak	Not appropriate	Dull & Uninteresting	Not Relevant	Unclear & Cloudy

Comment:

Signature of the Evaluator: Date: