Integration of Artificial Intelligence (AI) Technologies into the Capstone Design Model at Southern Arkansas University

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Objective

To integrate Artificial Intelligence technologies (AI) constructively into capstone design education to enhance student learning while strictly adhering to ABET ethical and accreditation standards.

Introduction
SAU Capstone Model

Fall semester

- SAU capstone design is a two-semester course sequence.
- Design activities are carried out in three design phases - preliminary, embodiment, and detail design phases as shown in Figure 1.
- There are two design reviews in fall semester – preliminary design review and critical design review.
- Design work is complete on paper at the end of fall semester.

Spring semester

- Prototyping, testing, evolution, and refinements are completed in spring semester as shown in Figure 2.
- Students also complete assignments related to ethics and engineering industry standards.
- Students defend their design solutions in oral presentations before an evaluation panel and public, and close out activities after design showcase.

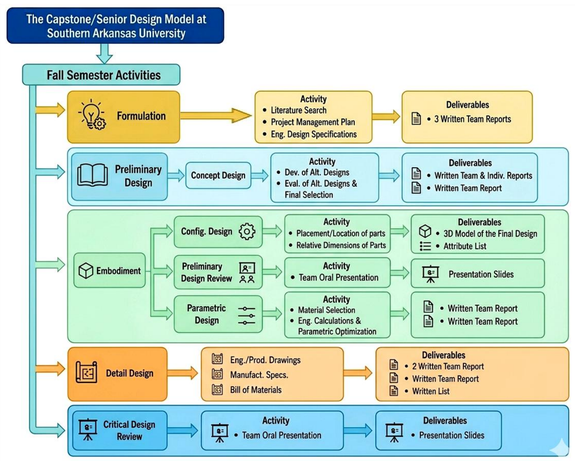

Figure 1. SAU Capstone Model – Fall Semester

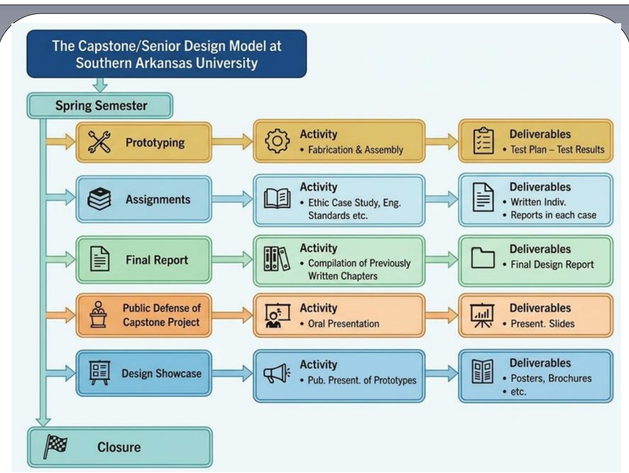

Figure 2. SAU Capstone Model – Spring Semester

Methodology

Five design teams used the ChatGPT 5.3 model in their design work **under the supervision of the instructor**. The process is outlined as follows:

Literature Survey

- Each team generated research topics using AI and researched those topics.
- Each team improved the written content of its literatures survey using AI.

Project Management

- AI critiqued each team's project management plan, and the teams used AI feedback to improve the content.

Problem Formulation & Eng. Design Specification

- Each team used AI to generate multiple design constraints related to safety, ethics, manufacturability, operating conditions, and performance criteria. The instructor reviewed AI produced information for technical accuracy, relevance, and adoptability. Students then prepared the written content under the supervision of the instructor.

Concept Development & Evaluation

- Students were not allowed to use AI in concept development to guard against using AI to replace their creativity, critical thinking, and imaginations. However, each team was allowed to use AI to get a critical review of its final design concept and improve it based on AI observations.

Embodiment Design

- Each team was allowed to use AI to generate an alternative configuration design based on its original concept and compare the location of important components. AI suggestions that improved any component location was adopted.

Parametric Calculations and Optimization

- Teams were allowed to use AI to identify the types of analysis needed for the design problem.
- Teams reviewed AI suggestions, filtered out some suggestions or added additional analysis, simulations, and optimizations according to the advice of the instructor.
- Teams were not allowed to use AI produced analysis in parametric calculations and optimization to ensure analytical validity.

Manufacturing/Prototyping and Testing

- Use of AI was optional during testing activities and limited to evaluating test plans and possible improvements.

Implementation and Data Collection

- Four teams - ASGC Rover Team, Ground Shakers, Mini Dredger Arm, Mini Dredger Pontoon - documented how they used AI (ChatGPT 5-3 architecture) in tabular form. The instructor's reviewed those records and summarized them in Table 1.

Table 1: Use of AI by Design Teams-Instructor's Review

Design Team Name	Literature Survey	Project Manag.	Engineering Design Spec.	Concept Development	Parametric Analysis and Optimization	Detail Design	Manufacturing and Prototyping
ASGC Rover	Yes – to re structure literature review	Yes – to identify missing elements in PMP.	Yes – inquiries related to frame design requirements, material, weight limit etc;	Yes- to obtain possible frames for the Rover. Most AI suggestions were rejected due to complexity and weight. Basic triangular frame selected and modified.	Yes-Partial use. Requested suggestions to optimize a triangular frame.	Yes – Fed the Rover configuration to AI to obtain a better lay - out.	Yes-Partial use. Sought suggestions in 3D printing.
Mini Dredger Arm	Yes-to generate research topics	Yes-to Structure the team document	Yes-to develop constraints. Team rejected overly generalized constraints	Yes – to evaluate team's multiple concepts. Suggested geometry for arm rejected being unrealistic.	Yes-Optimized workflow for fabrication was Sought. Adopted phase approach to manufacturing . Rejected optimization suggestions that were not specific.	Yes-Requested suggestions to improve CAD design. All AI suggestions were rejected as they did not improve the overall CAD model	No – AI suggestions were sought. All manufacturing and prototyping were done using team's expertise.

Design Team Name	Literature Survey	Project Manag.	Engineering Design Spec.	Concept Development	Parametric Analysis and Optimization	Detail Design	Manufacturing and Prototyping
Mini Dredger	Yes – to source key informatio n and web sources	Yes – to correct grammar and structure the team's document .	Yes – inquiries related to materials. Industry standards and performance requirements. Suggestions for materials and industry standards were selected.	Yes- to obtain a critique of the team's concept design and identify improvements. Suggestions for excessive number of barrels for pontoon and heavy material were rejected.	Yes, to obtain an optimized solution of the team's design. AI suggestions were rejected as its analysis based on Aluminum, which he team did not select.	Yes – AI did not produce any improvements	No – Team used its experience.
Ground Shakers	Yes-to generate research topics. Rejected topics related to overly complex suspensio n systems	Yes-to Obtain task planning, time schedule etc; Rejected un realistic schedule	Yes-to define engineering requirements on mobility, pay load etc; Rejected all suggestions that could not be verified.	Yes – to evaluate the concept developed by the team. Adopted the idea of simple motor mount. Rejected ideas that require high degree of fabrication.	Yes-to optimize the drop chute. Team checked the suggestions using Solid Works. Parts that require tight tolerances were rejected.	Yes-Requested suggestions for detailed CAD geometry. Rejected features that did not fit with the team's design.	Yes- sought suggestions for manufacturing the drop chute. Rejected the suggestions that required precise machining.

Sample Prompts and AI Suggestions

- Figure 3 is wiring diagram produced by AI in response to a prompt by "Ground Shakers" team, which was accepted.
- Figure 4 shows the the initial concept prompt of a mini dredger arm and the AI produced dredger arm design.
- The Mini-Dredger arm team rejected the AI suggested design citing "*AI generated an awkward unrealistic design for the dredger arm. Hydraulic cylinders cannot be bent and function properly*".

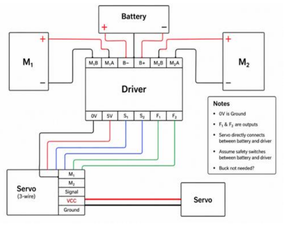

Figure 3: Example of an Accepted AI Solution

Figure 4: Example of a Rejected AI Solution

Conclusions

Review of the use of AI in each design phase y design teams led to the following conclusions.

- Student reliance on AI is highest during initial information-heavy stages and becomes more critical as projects move toward physical reality.
- However, as teams entered embodiment and detail design, AI's limitations became apparent.
- AI showed some inherent lack of understanding regarding physics and manufacturing.
- AI integration in Capstone design enhances learning without compromising educational or ethical standards with strict supervision by the instructor.

References

1.Criteria for Accreditation of Engineering Programs, 2023-2024. Publication by the Board for Accreditation of Engineering and Technology programs (ABET).
2. DeBartolo, Elzabeth A, "How Would a Chatbot Fare in Capstone"., Capstone Design Conference, June 3-5, 2024, Knoxville, Tennessee.
3. Hewavitharana, L., & Ahmed, M. K. (2025, March), Capstone Design Experience at Southern Arkansas University (SAU)-The Model, Implementation, and Relevance in ABET Accreditation Process. Paper presented at 2025 ASEE Southeast Conference, Mississippi State University, Mississippi. 10.18260/1-2-54149.

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