

How Would a Chatbot Fare in Capstone?



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Overview

Capstone instructors, whose students are always working on new problems that do not come from textbooks, have not needed to worry about copies of tests and homework answer keys available online, but could an AI tool be used to “cheat” in a capstone design course? Is it cheating? How well would the chatbot do in class?

This work summarizes an exercise using a chatbot to complete the early stages of a design project.

Want to talk more?
Come to Panel 4D:
AI & ChatGPT in
Capstone

Setting the Stage

Easy access to internet resources, such as file shares, pirated solution manuals, and homework help services such as Chegg have led to an endless cycle of trying to stay one step ahead of the latest scheme.

Meanwhile, in Capstone Design...



About ChatGPT

- Generative Pre-trained Transformer (GPT) based on a large language model
- Public release in Nov 2022 – information is not current
- Scored ~60% on FE exam!
- Generally good at summarizing and translating

Prompt
I teach an engineering capstone design class. What are some examples of responsible uses of AI in my class?

ChatGPT response

In an engineering capstone design class, responsible use of AI can greatly enhance the learning experience and the quality of projects. Here are some examples:

- Project Ideation and Development:**
 - Idea Generation:** AI tools can help students brainstorm and refine project ideas by analyzing existing solutions and suggesting innovative approaches.
 - Design Optimization:** Use AI to optimize designs for efficiency, cost, or performance. For example, AI-driven simulations can test different design parameters and suggest the best configurations.
- Research and Data Analysis:**
 - Literature Review:** AI-powered research assistants can help students quickly find and summarize relevant academic papers, patents, and technical documents.

Research Questions

- Could a student actually use ChatGPT 3.5 to “cheat” in Capstone Design?
- Can ChatGPT provide targeted and legitimate aid for students in Capstone Design?

Methodology

- The project description submitted by an RIT MSD client was the starting point.
- Prompts were based on the assignments given to students to step through the design process.
- This exercise focuses on the Problem Definition phase.
- All questions were asked in a single chat, so that later prompts could build on earlier prompts and responses.
- If the response to a prompt was low quality, it was refined and resubmitted.

Sample Results

Playing to ChatGPT's Strengths

Problem statement submitted by client

A customer has requested the following: "Design a chair with a PVC base, able to be totally submerged and water proof with counter balancing for anti tipping a seat with waterproof mesh material that can conform to an individual body an opposed to a hard plastic 90 degree seat; capability to adjust the recline of the back of the seat to up to 120 degrees; adjustable foot and leg support to allow for 90 degree bend in the knees or to support the leg/feet off the ground; have 2 different adjustment points one for the back rest and one for the foot/leg support; a butterfly or H shaped harness that zips in the front like a vest and supports the trunk and a seatbelt around the waist. All materials need to be completely waterproof. Weight limit up to 250 lbs" What clarifying questions might I ask them to better define the problem?

To better define the problem and ensure a clear understanding of the customer's requirements for the chair design, you might want to ask the following clarifying questions:

- Waterproof Specifications:**
 - What specific level of water submersion are you expecting? Is it occasional splashes, constant exposure, or immersion for extended periods?
 - Are there any specific environmental conditions the chair needs to withstand, such as exposure to saltwater or chemicals?
- Counter-Balancing and Anti-Tipping:**
 - Could you provide more details on the desired counter-balancing mechanism to prevent tipping? Are there any specific safety standards or regulations to consider?
- Mesh Material for Seat:**
 - Are there any preferences for color, texture?

What relevant industry standards should I consider in both the design and testing of this wheelchair?

Designing and testing the wheelchair for use in a therapy pool involves adherence to various industry standards to ensure safety, reliability, and performance. Here are some relevant industry standards to consider:

Design Standards:

- ISO 7176 Series - Wheelchair Design:**
 - ISO 7176 consists of several parts that cover different aspects of wheelchair design and performance. Parts 1, 5, and 19, in particular, provide guidelines on dimensions, safety requirements, and test methods.
- ISO 10885 Series - Wheelchair Seating:**
 - This series of standards provides guidelines for the design and testing of wheelchair seating systems, ensuring proper support and comfort.
- ISO 15840 Series - Wheelchair Seating Systems Testing:**
 - ISO 15840 standards focus on the testing of wheelchair seating systems, including methods for evaluating pressure distribution, stability, and durability.
- ANSI/RESNAIS WPM - Wheelchair Performance, Testing...**

A complete and (mostly) accurate problem statement

Write a 1-paragraph problem statement for this project. It should include current state, desired state, key goals and deliverables, and key constraints.

The current state of aquatic therapy for children with physical disabilities lacks a specialized wheelchair designed for safe and supportive mobility in zero-entry therapy pools. Currently, children with diverse physical needs face challenges in accessing therapeutic water activities, leading to their ability to benefit fully from aquatic therapy. The desired state is to introduce an innovative aquatic wheelchair specifically tailored to address these challenges, providing a buoyant and stable platform for safe movement in water. Key goals include developing adjustable seating for individualized needs, incorporating a harness system for trunk stability, and ensuring waterproof and durable materials. Deliverables comprise a functional prototype that meets regulatory standards, comprehensive design documentation, and a manufacturable solution. Key constraints involve adhering to budgetary limits, regulatory requirements for medical devices, and ensuring the wheelchair is user-friendly and accessible to a broad spectrum of physical abilities. This project aims to bridge the current gap in aquatic therapy accessibility, enhancing the therapeutic experience for children with physical disabilities in zero-entry therapy pools.

Person-first language (Nice job, OpenAI!)

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Use With Caution

The wheelchair will be used in a zero-entry therapy pool, with a focus on children under the age of 18. The harness provides trunk support for children with physical disabilities. Given this, write a preliminary set of customer requirements and a set of measurable and testable engineering requirements.

CRs are valid but lack insight. Without additional input, they will be incomplete.

Identifies a potential test method

Temping to accept metrics, but what's the justification?

Important-looking... but unsubstantiated

Implied priority

Leads to ERs that are

Mediocre results overall, even with prompt refinement

Team Member 4 doesn't get a task until Weeks 9-10

Rough order of tasks is good

Any these tasks into a 28 week schedule for a 4-person team, assigning jobs to one or more team members. Refer to the team members by number, e.g. "Team Member 1"

Week 9-10: Harness and Seatbelt Design and Prototyping

- Team Member 2: Design the harness and seatbelt components.
- Team Member 3: Create 3D models and fabricate physical prototypes for key components.

Team Member 4 doesn't get a task until Weeks 9-10

Prompt refinement is required

- Replace priority words such as “must” and “should” with numerical importance ranks 1, 3, and 9 in the customer requirements
- At most, half of the customer requirements can be ranked 9
- Engineering requirements include units of measure, marginally acceptable values, ideal values, and direction of improvement.
- Modify design tasks and schedule to only deliver a basic prototype
- Modify design tasks and schedule to follow a systems engineering process

A Point to Ponder

If a student recognizes that a prompt is insufficient and engineers the prompt to provide the required information, does that demonstrate that they understand the material?

Additional Notes

- Tasks that required summarizing and repackaging information were well-aligned with ChatGPT's capabilities.
- Continuity is maintained from response to response, which may help students see the connectedness of design artifacts.
- The act of refining prompts makes you think carefully about the question you really want to ask.
- Can save time on low-value-add, tedious tasks.
- ChatGPT ≠ Solution Manual

Key Takeaways

- A student *could* use ChatGPT to “cheat” by covering for lack of preparation, but grades may suffer.
- At the time of writing the paper, significant prompt engineering was required in some cases to generate even mediocre work.
- ChatGPT could be a valuable tool in helping students overcome fear of a blank page.
- ChatGPT can help students conversationally sort through a large volume of information.
- We need to prepare our students for a future where these tools are both readily available and technically capable.



Mindlessly using AI Tools in Capstone

Applying critical thinking skills to a new tool in order to work more effectively

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