VCU College of Engineering

CS 25-332 AI tool for automated scanning and understanding of new scientific or technical posts and alerting about new information relevant to users interests

Project proposal

Prepared for

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Executive Summary

Our senior design team is developing an AI-powered recmommendation system for the educational website arxiv.org that offers personalzied content suggestions that go beyond search and browsing methods. The purpose of the project is to create an AI-recommendation system that understands user's interests based on their interaction with other posts, and brings relevant school articles and reports based on the preferences. The design requirements include building a scalable and user-friendly system capable of processing large data. Key constraints include data privacy, AI accuracy optimization, and meeting development deadlines. Final project will include a prototype of a fully functional AI recommendation system integrated into the arxiv website and a user interface personalzied for user content. The project key deliverables include gathering system requirements, preprocessing data, adn initiating development of AI recommendation system. The project is set to significantly improve user experience with the website as well as enhance and simplify content discovery.

Table of Contents

Section A. Problem Statement

1. Introduction

In a world with over 2.5 million research articles published annually [1] (and growing!), the ability to access, comprehend, and utilize the accumulated information has become increasingly challenging. Alarmingly, it takes an average of 17 years for critical research findings to influence clinical practice and policy decisions [2]. Indicating currently millions of healthcare providers, governance, and every field across all varieties are relying on outdated information. This disconnect not just hampers advancements in healthcare, technology, and policy reform, but also the advancement of common knowledge more generally.

2. The Widespread Challenge

2.1 Healthcare Providers

Imagine a doctor making life-altering decisions based on outdated protocols, simply because they lack access to the latest research. In the U.S. alone, it's estimated that >200,000 deaths occur each year due to preventable medical errors [3].

2.2 Engineers and Innovators

Specifically, engineers across all disciplines, from civil to biomedical, face similar hurdles. They need access to the latest advancements in their fields to update, upgrade, and solve pressing issues like urban infrastructure, public health technology, and waste management just to name small examples. For instance, new materials in structural engineering can significantly improve the safety of buildings in earthquake-prone areas, and the delay in disseminating this knowledge could cost lives and resources.

2.3 Policymakers and Community Leaders

Policymakers depend on accurate scientific evidence to make informed decisions that affect public welfare. However, the complexity of navigating scientific literature can delay crucial legislative actions, resulting in missed opportunities for societal advancement. Delays in policy decisions due to insufficient data can extend for years, causing valuable legislation to be overlooked entirely.

3. The Role of AI-Based Personalized Science

Existing platforms in the engineering space fail to deliver relevant updates effectively. While some resources provide access to research papers, they often do so in a fragmented manner that lacks coherence and contextual relevance. Engineers spend excessive time sifting through irrelevant data, detracting from their ability to innovate and implement solutions.

To bridge this critical gap, we propose an AI-driven personalized science platform designed to tailor content delivery according to individual interests, expertise, and needs. This revolutionary approach aims to:

3.1 Real-Time Updates

Healthcare professionals will receive instant notifications about relevant advancements, transforming how they make treatment decisions and ultimately improving patient outcomes.

3.2 Interdisciplinary Insights

By uncovering connections across diverse fields, our platform will foster collaboration that leads to groundbreaking innovations. For example, merging insights from materials science and public health can yield new strategies to combat infectious diseases.

3.3 Enhanced Accessibility

Complex scientific concepts will be distilled into digestible formats, making it easier for everyone—from curious laypeople to seasoned professionals—to engage with critical findings.

4. Historical Perspective and Existing Solutions

Historically, the transfer of scientific knowledge has been fraught with inefficiencies. While tools like academic search engines and reference management software exist, they often fail to deliver timely, relevant information in a usable format.

4.1 Limitations of Current Solutions

Existing systems, such as Google Scholar and PubMed, provide broad coverage but lack the capacity to package information effectively. They generate overwhelming results without context, forcing users to sift through mountains of data to find what is truly relevant. This fragmented approach results in slow workflows that discourage discovery and innovation.

Competitors in the Space:

1. PubMed - Comprehensive medical literature but not effectively packaged for quick insights.

2. Google Scholar - Overwhelming results with little filtering for practical relevance.

3. ResearchGate - Networking for researchers; lacks streamlined content delivery and relevance.

4. Mendeley - Useful for organization but fails to offer meaningful recommendations.

5. Scopus - Broad database; not designed for personalized, quick content delivery.

5. Human Impact and Community Benefits

The key groups benefiting from this platform include:

1. Healthcare Providers: Who need timely updates to offer the best possible care.
2. Engineers and Innovators: Committed to solving everyday challenges through improved access to scientific advancements.
3. Policymakers and Community Leaders: Striving for informed decisions that benefit society at large and small.

5.1 Economic Growth and Innovation

By streamlining research funding and increasing the efficiency of knowledge application, our platform could lead to substantial economic benefits. Enabling researchers and professionals to focus on meaningful inquiries rather than sifting through irrelevant data could enhance innovation across all sectors.

5.2 Fostering a Science-Literate Society

This platform will cater not just to professionals but also to the general public, promoting science literacy and empowering individuals to make informed decisions about health, technology, and policy.

6. Conclusion

The proposed AI-based personalized science dissemination platform represents a transformative approach to how we share and utilize scientific knowledge. By bridging the gap between discovery and practical application, we can enhance lives, spark innovation, and foster a society that values and understands science. Addressing challenges related to data quality, privacy, and algorithmic transparency will be essential to realizing this vision.

As we move forward, let's prioritize the needs of people and communities, ensuring that science becomes an accessible resource for all. Together, we can create a future where knowledge flows freely, innovation thrives, and society is better equipped to tackle the challenges ahead.

References

1. Benjamin Schneider, J. A. (n.d.). *Science & Engineering Indicators*. NSF. https://ncses.nsf.gov/pubs/nsb202333/publication-output-by-region-country-or-economy-and-by-scientific-field
2. JE;, R. T. B. S. (n.d.). *Medical error reduction and prevention*. National Center for Biotechnology Information. https://pubmed.ncbi.nlm.nih.gov/29763131/
3. Narrowing the 17-year research to Practice Gap | American Journal of Critical Care | American Association of Critical-Care Nurses. (n.d.). https://aacnjournals.org/ajcconline/article/25/3/194/3121/Narrowing-the-17-Year-Research-to-Practice-Gap

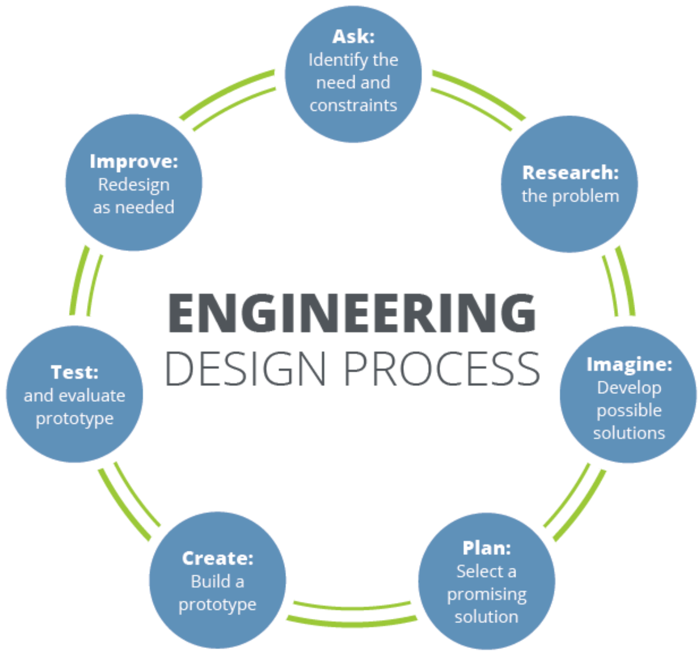


Figure 1. The iterative nature of the engineering design process [2].

Section B. Engineering Design Requirements

This section describes the goals and objectives of the project, as well as all **realistic constraints** to which the design is bound. It is meant to provide a structure that helps to formulate the problem. Design requirements are often derived from client or stakeholder needs. They may consider benchmarking against or improving on currently available solutions, providing novel techniques or design solutions, integration with existing components, systems, or equipment, required codes and standards, general observations of the problem space, etc. Describe how the requirements provided below were researched and decided upon. Common design requirements often include considerations of the design efficacy, cost, safety, reliability, usability, and risk, among others.

Note: The deign requirements should be revisited between major reports to ensure that the design objectives and constraints still accurately reflect the client needs and project goals and to make sure that the team is on track to meet all goals and objectives.

Note: The codes and standards section is not required for the Project Proposal, but is required for all subsequent reports. This section should be comprehensive and thorough, requiring a significant research effort.

B.1 Project Goals (i.e. Client Needs)

The goal of this project is to provide users with an automated tool that scans, interprets, and alerts them about new scientific or technical content relevant to their specific areas of interest. By focusing on the client's needs, this AI tool aims to simplify the process of staying updated with the latest advancements without manual searching or filtering.

Key goals:

- To automate the process of scanning new scientific and technical content.
- To ensure that users receive timely and relevant updates on topics of interest.
- To reduce the time and effort required by users to stay informed.
- To enhance the accuracy and relevance of information delivered to users.
- To create a scalable system adaptable to various industries and areas of interest.

B.2 Design Objectives

The design will automatically scan and categorize newly published scientific literature from at least 5 major open-access journals in the user's specified field within 48 hours of publication, achieving 80% accuracy as verified by subject matter experts, by the end of the first semester.

- The design will deliver personalized content recommendations with a relevance accuracy of at least 70%, as rated by a test group of 18 users, by the end of the project period.
- The design will organize and deliver content in thematic packets for at least 3 major scientific disciplines, reducing the time users spend finding related information by 40% compared to traditional search methods, as measured by user surveys by the end of the second semester.
- The design will achieve a user satisfaction rate of 75% for its content curation features, as measured by feedback from a test group of 18 users, by the end of the project period.
- The design will implement a simple relevance ranking system that improves the precision of content delivery by 40% compared to basic keyword searches, as measured by user feedback from the test group, by the end of the second semester.

- (optional) The design will provide context-rich summaries for 60% of delivered content, improving user comprehension by 20% compared to reading raw scientific papers, as measured by comprehension tests with a sample group of 30 users by the end of the project.
- (optional) The design will implement a basic conflict of interest analysis for 70% of delivered content from the selected journals, as verified by random sampling, by the end of the second semester.

B.3 Design Specifications and Constraints

Design Specification:

- The design must be highly accurate in recommending different posts to users. Accuracy should reach at least 85%
- AI must be compatible with the interactions users have with the archive website. Interactions include the posts they open, if they accessed the articles, what they searched for, the history with other posts, and authors
- The AI should be able to process the archive API LLM, and be able to process the interactions of users
- AI must have a fast response time and bring similar posts one second after user's interaction
- AI must follow data privacy and data protection regulations

Realistic Constraints:

- Design must be worked for 1000 hours without needing maintenance
- Design must operate with archive website and API
- Design must be started from scratch with coding from this group
- Cost of training can't be over $1000
- Scanning should only ascertain relevance from the abstracts, not the full document
- Cost should be partially funded by users. Either by token or a freemium plan.
- Design must run on cloud services and process with high data storage
- Design must be able to work with any devices such as smartphones, laptops, or any other browser device

B.4 Codes and Standards

- Design must run in a reasonable time without an excessive wait time.
- Design main components must be from arxiv, arxiv's API, and the chosen LLC.
- Design must protect all data provided from users.
- Design must follow all the specifications provided by the company/sponsor.
- All aspects in the design and design process must be well documented.
- Code must have comments providing explanations on its purpose.
- All documentation must be stored in the project repository located on github.
- Every task must be completed by the designated date it is required by.
- All members of the design team must have weekly meetings with the sponsor and with the team to share progress on the design.

Section C. Scope of Work

The project scope defines the boundaries of the project encompassing the key objectives, timeline, milestones and deliverables. It clearly defines the responsibility of the team and the process by which the proposed work will be verified and approved. A clear scope helps to facilitate understanding of the project, reduce ambiguities and risk, and manage expectations. In addition to stating the responsibilities of the team, it should also explicitly state those tasks which fall *outside* of the team's responsibilities. *Explicit bounds* on the project timeline, available funds, and promised deliverables should be clearly stated. These boundaries help to avoid *scope creep*, or changes to the scope of the project without any control. This section also defines the project approach, the development methodology used in developing the solution, such as waterfall or agile (shall be chosen in concert with the faculty advisor and/or project sponsor). Good communication with the project sponsor and faculty advisor is the most effective way to stay within scope and make sure all objectives and deliverables are met on time and on budget.

C.1 Deliverables

Deliverables:

- Team contract
- Project proposal
- Fall poster and presentation
- Preliminary design report
- Final design report
- Preliminary functioning AI tool prototype
- Finalized and functioning AI tool
- Capstone EXPO poster and presentation

Potential Obstacles:

- The fall poster and Capstone EXPO poster require the team to meet in person to work on it, so there could be potential scheduling conflicts.
- All the aspects of the project that require purchasing have to fit within the budget of $1,000.

C.2 Milestones

Milestones	Description	Time Estimated	Completion Data
Gathering required resources and archive data	Gathering the required resources to get started on project and getting data from archive website	2 weeks	October 12th
Pre-process and evaluate trained data	Data we are getting is already trained, so we pre-process the trained data and confirm its correct	3 weeks	November 2nd
UI/UX Design (Kyle)	Develop user interface for website	2 weeks	November 16th
Integration to website and testing	Integrate AI onto website and test and debug AI as needed	3 weeks	December 7th

C.3 Resources

The following resources will be required for the successful completion of the AI tool project. These resources will either be covered within the project budget or provided by the project sponsor. The list includes hardware, software, and other services critical to the design, development, and implementation of the AI system.

- **Hardware**: Access to high-performance computing (HPC) systems or cloud-based servers for running machine learning models and processing large datasets efficiently.
- **Software**: Integrated development environments (IDEs) such as PyCharm or VSCode for writing and testing code, as well as machine learning frameworks like TensorFlow or PyTorch.
- **Cloud Computing**: Use of cloud platforms such as AWS or Google Cloud to scale machine learning processes and manage large-scale data analysis tasks.
- **Data**: Databases containing relevant scientific and technical posts for training and testing the AI tool, as well as publicly available datasets for model validation.

- **Libraries & APIs**: Machine learning libraries such as Scikit-learn, Natural Language Processing (NLP) libraries like SpaCy, and APIs for web scraping and gathering new content for the system.
- **Version Control**: A version control system such as GitHub to manage and track changes in code development.

Section D. Concept Generation

A number of methods can be used to help generate design concepts from simple reflection and brainstorming, to working the problem backwards, using reverse thinking techniques, and looking to nature for inspiration (i.e. biomimicry). Existing solutions, or components of existing solutions, can be substituted, combined, adapted, modified, put to other uses, eliminated, or rearranged to meet new design objectives and specifications. A minimum of 3 overall design concepts is required for this section although more are welcome. Provide a brief description of how each design concept addresses the design problem. Discuss the potential pros and cons, including and potential risks of failure, of each of these concepts.

It is likely that each design concept may consist of several components. In this case, one or more of these components may offer a sub-problem that can be further explored, modified, or otherwise improved upon. These sub-problems may lead to the addition of several additional design concepts and may require the inclusion of a design concept chart or matrix to organize all ideas and potential solutions.

Provide any initial design sketches, drawings, 3D renderings, or conceptual models such as dataflow diagrams, process flows, etc. developed during the concept ideation phase. All hand drawings should be drawn to scale using basic engineering drafting tools (i.e. ruler, protractor, and compass). Geometric stencils can also be used to help produce quality hand drawings. Drawings should be presented in a profession manner, preferably done on engineering graph paper and using a high-quality scan. All sketches should be labeled to identify major components and different drawing views or projections if applicable. Basic dimensions should be provided to give a general sense of scale. Label each sketch or drawing with the name of the team member responsible for the sketch, the date it was drawn, and the drawing scale.

Section E. Concept Evaluation and Selection

Using a systematic decision-making process, evaluate each of the design concepts and choose the one that is most likely to succeed in meeting the design objectives and constraints. A Decision Matrix, or Pugh Matrix, helps to analyze alternatives, eliminate biases, and make rational decisions through thought and structure. First, work to develop a set of selection criteria for which to evaluate the previously generated design concepts. Selection criteria often include concepts of performance, cost, safety, reliability, risk, etc. Note that the selection criteria developed here will likely be more general than the project design objectives. As with the design objectives, conversations with the client help define appropriate selection criteria.

In many cases, the client may value the selection criteria differently, preferring that more emphasis be placed on some than others. In this case, weighting factors may be used to place more or less importance on the various criteria in the decision making process. Again, conversations with the client can be used to define criteria weighting factors. Often times, these conversations must be analyzed and interpreted by the team to determine which criteria are more important to the client and by how much. Feel free to discuss the assigned weighting factors with the client to see if they seem accurate.

Next, define an associated metric to represent each criteria. Metrics should be specific and quantifiable, providing numerical values that quantify the often vague concepts of the selection criteria. Metrics can be obtained, generated, or estimated through a number of methods including simple background research, preliminary design calculations, or basic analyses. Note that these metrics do not need to specifically align with the design specifications although there may be some commonality between the two. Provide a brief discussion of the rationale for selecting each of the assigned metrics.

Using the defined metrics, evaluated each design concept against all selection criteria by filling out a Decision Matrix. Design concepts can be compared by using simple rank scoring, raw scoring, or weighted scoring techniques and design concept with which to move forward can be selected. This type of process provides a meaningful, unbiased means for choosing a preliminary design concept prior to moving forward with more comprehensive, detailed analyses as provided in the design methodology section below. The results of this process should be discussed with the project client prior to moving forward with the selected design. Table 1 provides an example of a simple decision matrix.

Table 1. Example of a Decision Matrix.

	Design Concept A	Design Concept B	Design Concept C	Design Concept D
Criteria 1				
Criteria 2				
Criteria 3				
Criteria 4				
Criteria 5				
Total Score				

Note: Weights can be assigned to each criterion if desired.

Section F. Design Methodology

Provide a detailed explanation of the methods that will be used to help evaluate, improve, and evolve the design through the iterative engineering design process. Consider that ultimately, the final design must be verified and validated to ensure that it meets all of the previously developed and listed design objectives and specifications. Verification ensures that the design meets all specification, while validation confirms that the design functions as intended such to meet the client's needs. While it is common for initial design concepts to first be evaluated using simplified design criteria and metrics, the chosen design should be advanced, and later verified, using engineering calculations, computational models, experimental data, and/or testing procedures.

Use this section to describe any underlying physical principles and mathematical equations that govern the design. Provide details of any computer-aided modeling techniques used to evaluate the design including the software used, prescribed boundary conditions, and assumptions. Include a detailed description of any experimental testing methods including required testing equipment, test set-up layout, data acquisition and instrumentation, and testing procedures. If one or more prototypes is to be produced and tested, provide a detailed description of how each will be evaluated.

Note: The contents of this section are expected to vary from project to project. Subsections may be appropriate for providing details of analytical, computational, experimental, and/or testing methods. Some potential subsections that may be included in this section are provided. While critical design equations may be provided here, lengthy mathematical derivations may be included in an appendix. Validation procedures are critical and all projects should address such topic.

F.1 Computational Methods (e.g. FEA or CFD Modeling, example sub-section)

F.2 Experimental Methods (example subsection)

F.3 Architecture/High-level Design (example subsection)

F.5 Validation Procedure

Describe how the design team will validate that the final design meets the client's needs. This section should include a plan to meet with the client towards the end of the project to discuss final design details and demonstrate a prototype, experimental test, and/or simulation results. Provide a relative time frame for this validation to occur (e.g. "mid-March" or "early-April"). Include a brief discussion on how client feedback will be captured, such as a formal survey, interview, or observation notes of the client using the prototype. It may also include plans to solicit feedback from other stakeholders and/or potential users.

Section G. Results and Design Details

Use this section to highlight the major results of the design methodology described above including important analytical, computational, experimental, modeling, assembly, and testing results. This section should be one of the most substantial sections of the report showcasing all of the hard work and effort that went into the completion of the final design and delivery of the project deliverables. Show how the identified problem was solved.

Highlight the prominent features of the final design through analysis results, modeling, drawings, renderings, circuit schematics, instrumentation diagrams, flow and piping diagrams, etc. to show that the design functions as intended and meets all design objectives and constraints. Overview designs such as dataflow diagrams, process flow, swim lane diagrams, as well as presentation-layer designs (e.g. storyboards for front-ends) should be included here. Detailed designs such as database designs, software designs, procedure flowcharts, or pseudocode should be included here. Support computational and experimental results with key plots and figures. All supporting figures should be clearly labeled and annotated to highlight the most important points of the figure (i.e. explicitly point out what the reader should focus on or understand about the image).

Note that while all results should be used to help inform design decisions, not all results may be necessary to include in the main body of the report. Extraneous supporting results (e.g. graphs, data, design renderings, drawings, etc.) that are not necessary for presenting the fundamental findings can be placed in one or more appendices. Detailed documentation of each program module can be provided as appendix.

G.1 Modeling Results (example subsection)

G.2 Experimental Results (example subsection)

G.3 Prototyping and Testing Results (example subsection)

G.4. Final Design Details/Specifications (example subsection)

Note that while the design constraints and specifications may have provided minimum or maximum values, or ranges or values, that the design needed to meet, the final design specifications should be listed here showing that the required design values were met. A list of final design details can also be included demonstrate fulfillment of the design objectives.

Note: Preliminary results should be included in the Preliminary Design Report to show the progress made of the selected design concept to-date. This section should be updated for the Final Design Report to include documentation of all of the work that was completed on the project throughout the entirety of the academic year.

Section H. Societal Impacts of Design

In addition to technical design considerations, contemporary engineers must consider the broader impacts that their design choices have on the world around them. These impacts include the consideration of public health, safety, and welfare as well as the potential societal, political/regulatory, economic, environmental, global, and ethical impacts of the design. As appropriate for the project design, discuss how each of these considerations influenced design choices in separate subsections. How will the design change the way people interact with each other? What are the political implications of the design? Does the technology have the potential to impact or shift markets? Does the design have any positive or negative effects on the environment? Don't forget to consider unintended consequences such as process or manufacturing byproducts. What impacts might the design have on global markets and trade? Are there any ethical questions related to the design?

While it is hard to forecast the various impacts of a technology, it is important to consider these potential impacts throughout the engineering design process. When considered during the early stages of the design phase, consideration of these impacts can help determine design objectives, constraints, and specifications and help drive design choices that may mitigate any potential negative impacts or unintended consequences.

Note: A minimum of 4 of these design considerations, including the consideration of public health, safety, and welfare, are required for the Preliminary Design Report while a section for all considerations must be included in the final design report.

H.1 Public Health, Safety, and Welfare

Provide a list of all design safety features and provide a brief description of each. Discuss the potential effects the design may have on public health, safety, and welfare. References to the codes and standards previous provided and the organizations that produced them may be summarized or referenced here.

H.2 Societal Impacts

H.3 Political/Regulatory Impacts

H.4. Economic Impacts

H.5 Environmental Impacts

H.6 Global Impacts

H.7. Ethical Considerations

Section I. Cost Analysis

Provide a simple cost analysis of the project that includes a list of all expenditures related to the project. If an experimental test set-up or prototype was developed, provide a Bill of Materials that includes part numbers, vendor names, unit costs, quantity, total costs, delivery times, dates received, etc. Do not forget to include all manufacturing costs incurred throughout the completion of the project. If the design is expected to become a commercial product, provide a production cost estimate including fixed capital, raw materials, manufacturing (including tooling and/or casting), and labor costs to produce and package the device. Note that this type of detailed cost analysis may be listed as a project deliverable.

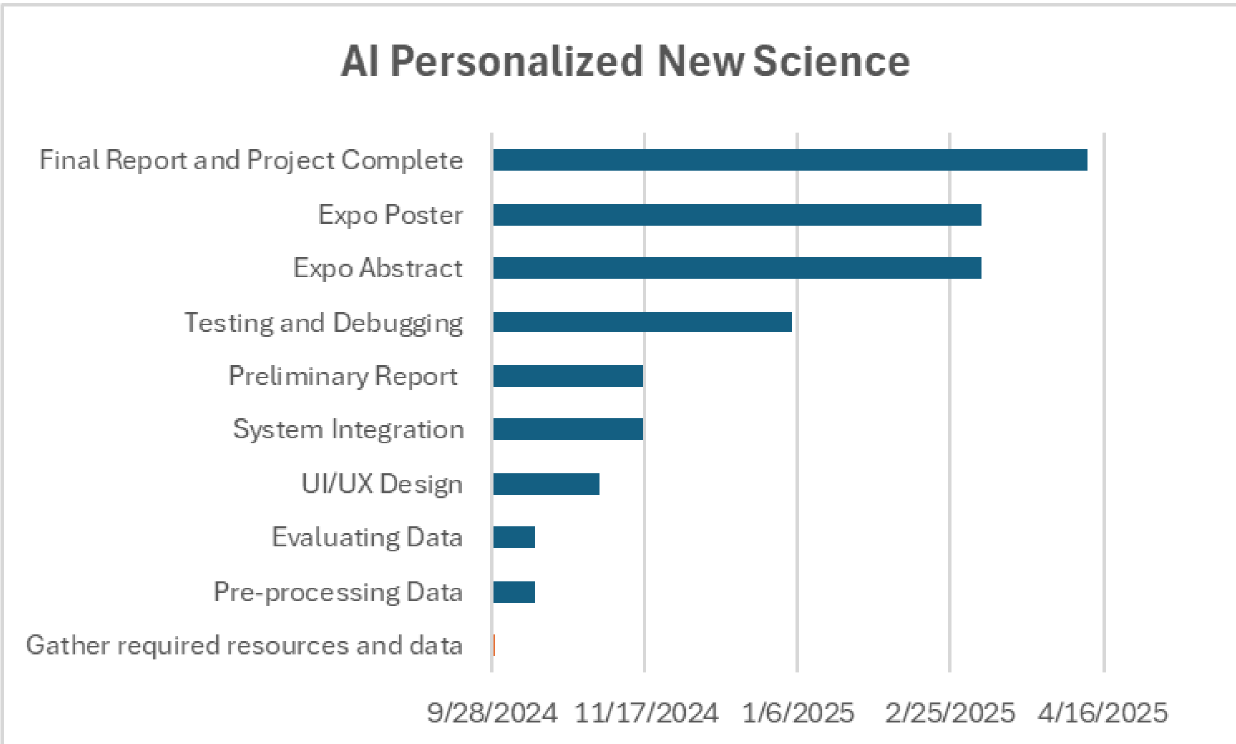
Note: The Preliminary Design Report should include all costs incurred to date. It is expected that this section will be expanded and updated between the preliminary and final design reports.

Section J. Conclusions and Recommendations

Use this section to summarize the story of how the design team arrived at the final design. Focus on the evolution of the design through the use of the engineering design process including lessons learned, obstacles overcome, and triumphs of the final design. Revisit the primary project goals and objectives. Provide a brief summary of the final design details and features paramount to the function of the design in meeting these goals and objectives.

A discussion may be included to discuss how the design could be further advanced or improved in the future. If applicable, summarize any questions or curiosities that the final results/design of this effort bring to mind or leave unanswered. If this project might continue on as a future (continuation) senior design project, detail the major milestones that have been completed to date and include any suggested testing plans, relevant machine drawings, electrical schematics, developed computer code, etc. All relevant information should be included in this section such that future researchers could pick up the project and advance the work in as seamless a manner as possible. Documents such as drawings, schematics, and codes could be referenced here and included in one or more appendix. If digital files are critical for future work, they should be saved on a thumb drive, external hard drive, cloud, etc. and left in the hands of the project advisor and/or client.

Appendix 1: Project Timeline



Appendix 2: Team Contract (i.e. Team Organization)

Step 1: Get to Know One Another. Gather Basic Information.

Task: This initial time together is important to form a strong team dynamic and get to know each other more as people outside of class time. Consider ways to develop positive working relationships with others, while remaining open and personal. Learn each other's strengths and discuss good/bad team experiences. This is also a good opportunity to start to better understand each other's communication and working styles.

Team Member Name	Strengths each member bring to the group	Other Info	Contact Info
Kyle Vinod	Communicates well with everyone, plans out meeting and communicates with advisor, deterministic	1 year internship experience, knowledgeable with Python, C, C++, Java, SQL, JavaScript, and Linux, knowledge of NLP and machine learning	vinodkn@vcu.edu
Katie Martinez	Communication, problem-solving, and adaptability	Experience in Java and C.	martinezk4@vcu.edu
Ryan Ta	Clear communication, willing to learn new things, wide availability	I have experience in C and Java. I will put the work in to learn anything new assigned to me.	tard@vcu.edu
Alexander Larios	Fast comprehension, clear communication, wide and strong curiosity, and creative generativity.	Experienced in C, Java, and Python. Good grip on the overarching fundamentals to the project.	Lariosas@vcu.edu

Other Stakeholders	Notes	Contact Info
Tom Arodz	Faculty advisor and sponsor	tarodz@vcu.edu

Step 2: Team Culture. Clarify the Group's Purpose and Culture Goals.

Task: Discuss how each team member wants to be treated to encourage them to make valuable contributions to the group and how each team member would like to feel recognized for their efforts. Discuss how the team will foster an environment where each team member feels they are accountable for their actions and the way they contribute to the project. These are your Culture Goals (left column). How do the students demonstrate these culture goals? These are your Actions (middle column). Finally, how do students deviate from the team's culture goals? What are ways that other team members can notice when that culture goal is no longer being honored in team dynamics? These are your Warning Signs (right column).

Culture Goals	Actions	Warning Signs
Communicating well within the group	- Texting within Capstone group chat - Communicating any problems help is needed with	- No text back in group chat in few days - Student struggles with a part of the project with deadline coming up
Respectful communication	- Encourage open discussions - Use constructive feedback	- Talking over others - Dismissive tone
Accountability	- Share regular progress updates - Set clear deadlines	- Missed tasks - Avoiding progress discussions

Step 3: Time Commitments, Meeting Structure, and Communication

Task: Discuss the anticipated time commitments for the group project. Consider the following questions (don't answer these questions in the box below):

- What are reasonable time commitments for everyone to invest in this project?
- What other activities and commitments do group members have in their lives?
- How will we communicate with each other?
- When will we meet as a team? Where will we meet? How Often?
- Who will run the meetings? Will there be an assigned team leader or scribe? Does that position rotate or will the same person take on that role for the duration of the project?

Required: How often you will meet with your faculty advisor advisor, where you will meet, and how the meetings will be conducted. Who arranges these meetings?
See examples below.

Meeting Participants	Frequency Dates and Times / Locations	Meeting Goals Responsible Party
Students Only	As needed, we text within the group chat	Update group on day-to-day challenges and accomplishments
Students Only	Every Thursday at 3 pm, we meet on Zoom	Actively work on project, discuss any problems, update group, and discuss new tasks
Students + Faculty advisor	Every Tuesday at 10:30 am in Advisor's Zoom meeting	Update faculty advisor and get answers to our questions
Project Sponsor	Every Tuesday at 10:30 am in Sponsor's Zoom meeting	Update project sponsor and make sure we are on the right track

Step 4: Determine Individual Roles and Responsibilities

Task: As part of the Capstone Team experience, each member will take on a leadership role, ***in addition to*** contributing to the overall weekly action items for the project. Some common leadership roles for Capstone projects are listed below. Other roles may be assigned with approval of your faculty advisor as deemed fit for the project. For the entirety of the project, you should communicate progress to your advisor specifically with regard to your role.

- **Before meeting with your team**, take some time to ask yourself: what is my "natural" role in this group (strengths)? How can I use this experience to help me grow and develop more?
- **As a group**, discuss the various tasks needed for the project and role preferences. Then assign roles in the table on the next page. Try to create a team dynamic that is fair and equitable, while promoting the strengths of each member.

Communication Leaders

Suggested: Assign a team member to be the primary contact for the client/sponsor. This person will schedule meetings, send updates, and ensure deliverables are met.

Suggested: Assign a team member to be the primary contact for faculty advisor. This person will schedule meetings, send updates, and ensure deliverables are met.

Common Leadership Roles for Capstone

1. **Project Manager**: Manages all tasks; develops overall schedule for project; writes agendas and runs meetings; reviews and monitors individual action items; creates an environment where team members are respected, take risks and feel safe expressing their ideas.
   Required: On Edusourced, under the Team tab, make sure that this student is assigned the Project Manager role. This is required so that Capstone program staff can easily identify a single contact person, especially for items like Purchasing and Receiving project supplies.
2. **Logistics Manager**: coordinates all internal and external interactions; lead in establishing contact within and outside of organization, following up on communication of commitments, obtaining information for the team; documents meeting minutes; manages facility and resource usage.
3. **Financial Manager**: researches/benchmarks technical purchases and acquisitions; conducts pricing analysis and budget justifications on proposed purchases; carries out team purchase requests; monitors team budget.
4. **Systems Engineer**: analyzes Client initial design specification and leads establishment of product specifications; monitors, coordinates and manages integration of sub-systems in the prototype; develops and recommends system architecture and manages product interfaces.
5. **Test Engineer**: oversees experimental design, test plan, procedures and data analysis; acquires data acquisition equipment and any necessary software; establishes test protocols and schedules; oversees statistical analysis of results; leads presentation of experimental finding and resulting recommendations.
6. **Manufacturing Engineer**: coordinates all fabrication required to meet final prototype requirements; oversees that all engineering drawings meet the requirements of machine shop or vendor; reviews designs to ensure design for manufacturing; determines realistic timing for fabrication and quality; develops schedule for all manufacturing.

Team Member	**Role(s)**	**Responsibilities**
Kyle Vinod	Project manager and Logistics manager	- Help with assigning different tasks and help with each as needed - Schedule meetings with team members, advisor, and sponsor - Team members are comfortable and able to present their ideas

Ryan Ta	Financial manager and Systems Engineer	- Planning out purchases that need to be made and analyzing how it will fit into our budget. - Working with client requests to ensure that their specifications are incorporated into the final product.
Katie Martinez	Manufacturing Engineer	- Managing deadlines with suppliers/vendors. - Ensuring designs meet manufacturability and quality standards. - Continuous process improvement and troubleshooting. - Strong focus on practical, hands-on production knowledge and process efficiency.
Alexander Larios	Test engineer	- Developing and managing experimental design. - Testing, producing, and overseeing analysis. - Leading presentation of experimental finding and recommendations.

Step 5: Agree to the above team contract

Team Member: Kyle Vinod Signature: Kyle Vinod

Team Member: Ryan Ta Signature: Ryan Ta

Team Member: Katie Martinez Signature: Katie Matrinez

Team Member: Alexander Larios Signature: Alexander

Appendix 3: [Insert Appendix Title]

Note that additional appendices may be added as needed. Appendices are used for supplementary material considered or used in the design process but not necessary for understanding the fundamental design or results. Lengthy mathematical derivations, ancillary results (e.g. data sets, plots), and detailed mechanical drawings are examples of items that might be placed in an appendix. Multiple appendices may be used to delineate topics and can be labeled using letters or numbers. Each appendix should start on a new page. Reference each appendix and the information it contains in the main text of the report where appropriate.

Note: Delete this page if no additional appendices are included.

References

Provide a numbered list of all references in order of appearance using APA citation format. The reference page should begin on a new page as shown here.

[1] VCU Writing Center. (2021, September 8). *APA Citation: A guide to formatting in APA style.* Retrieved September 2, 2024. https://writing.vcu.edu/student-resources/apa-citations/

[2] Teach Engineering. *Engineering Design Process*. TeachEngineering.org. Retreived September 2, 2024. https://www.teachengineering.org/populartopics/designprocess