

Rubric for Student Essay

November 16, 2023

The workshop course is provided by technology-oriented engineering department. The goal is to understand technologies but also to foster motivation and active involvement of groupwork. The assignment given to the students was as follows:

1. Kinematic Synthesis of Mechanisms <Train Gap Filler>

The gap between the train and the platform at train stations is a significant safety hazard, often leading to accidents. This risk is especially high for children, the elderly, and individuals with physical disabilities with wheelchairs. The challenge is to devise a mechanism that effectively mitigates this danger.

2. Kinematic Synthesis of Mechanisms <Say “NO” to Door Knobs>

This project develops a new mechanism for touchless doors, inspired by the widespread unease with touching door handles in public spaces like schools, hospitals, and restrooms during the Covid-19 pandemic. This design aims to eliminate the need for physical contact with door knobs.

3. Net Zero X <Carbon Dioxide Removal>

Given that emissions of CO₂ are produced by all sectors of society, identifying effective ways to capture CO₂ and store it safely is crucial. Create methods to extract CO₂ from the air and separate it into its constituent elements, carbon and oxygen, and explore how these elements can be repurposed effectively.

4. Net Zero X <All Electric Airplane>

The objective of this project is to develop a strategy for reducing CO₂ emissions from airplanes. It involves researching the current challenges faced by the airline industry regarding CO₂ emissions and conceptualizing an all-electric airplane as a viable solution to significantly lower these emissions.

5. Radioactive <Science Communication on High-Level Radioactive Waste>

High-level radioactive waste (HLW) is created by the reprocessing of spent nuclear fuel. Storage cannot provide the permanent isolation of the wastes from human's environment. This workshop aims to reveal the current conditions and possible disposal methods of HLW, and understand ways of dealing with real social issues.

6. Monster Track <Damages on Infrastructures by Oversized Vehicles>

The oversized loading induced an excessive external load which exceeds load-carrying capacity of bridges, resulted in collapse incidents. Clarify the common challenges in protection of infrastructures during their life cycle from oversized vehicles and come up with initiatives and solutions to this issue.

Around six students formed groups and challenged one of the above six problems in seven 3-hour workshops: ideation, interim report, prototyping, final report, and a reflection essay at the end. Each student is requested to create an individual reflection essay including the following descriptions.

- Project description (300-400 words)

Title, goal and conclusion of the project

Process of the project: how you applied design thinking methods

- Contribution (300-400 words)

Your role in the project

Your contribution to the project

- Reflection (200-300 words)

Write freely but we are interested in what you learned from the series of workshops not only professional knowledge and skills but also how to contribute to and facilitate the workshops

Here is a student essay to be evaluated.

[STUDENT ESSAY]

Out of all topics related to Net Zero, our team decided to focus on transportation aspects. In specific, we picked an electric airplane. Our project was named, "All-electric airplane - CO₂ reduction". First, we redefined what is net-zero and what is an electric airplane. Our goal is to construct an airplane that runs with electricity and emits net-zero CO₂. We calculated how much emissions will be reduced by replacing a current jet-fuel plane with an electric airplane and considered what we need to do to reach net zero by utilizing it. Next, from the many problems and potentials of an electric airplane we detected, we chose some of the major ones and introduced them. For example, we found the airline industry's contribution to the emission issues. It provides 2.5% of global emissions, and that is 1.04 billion tons per year. However, if we succeed in constructing FEA (full electric airplane), 87% of CO₂ will be reduced. We can state that this electric airplane has great potential to contribute to reducing emissions. Based on this information, we divided our challenges into 3 parts, which are science, charging, and cost. With the science aspects, we tested multiple batteries to idealize the best suitable battery type. Currently, Lithium-ion battery shares a large part of electronic devices, such as a smartphone. However, all-solid-state battery might be more suitable for electric airplane because it provides high specific energy, more safety, and less weight. Next, with the charging aspect, we simulated building a new electric power plant. Also, we examined the multiple methods to recharge electricity during flight. Lastly, we researched costs we need to commercialize electric airplanes. Since part of fuel price and maintenance cost will be cut, we can assume that we have at least 50% low-priced ticket. In conclusion, as we simulated with an airplane with 180 passengers for an 800km flight, an all-solid-state battery is the most appropriate battery. It leads to reduce about 87% of CO₂. This can also lower ticket prices by about 50-80%. Although the technology is not ready to commercialize planes yet, we believe more investigation will make it possible.

In this project, I mainly focused on the charging perspective, especially recharging during flights. Even if we use the most efficient battery, FEA still raises the cost and takes more time to charge compared to the current jet-fuel airplane. First, I focused on the regenerative brake. It is a technology that an airplane uses electricity for acceleration and propulsion, and charge electricity when it decelerates and level down. There is an airplane from JAXA, which succeeded with using regenerative soaring during a flight. I introduced a graph that shows the motor shaft output, which is basically how much energy it uses, and the remaining battery of the airplane. From the graph, we can observe that there is a moment that motor shaft output gets negative values. At the same time, the amount of remaining battery keeps constant or even increases. From this data, we can conclude that this airplane succeeded with regenerative soaring and recharging electricity. The minimum power we require for an airplane with 180 passengers' airplanes is calculated as about 6 MW. This is the potential energy we can convert to electricity. Although the specific values of efficiency to convert energy into electricity are not determined yet, I consider this technology will help to reduce the initial electricity we need. Next, I decided to work on solar power generation. This is the same technology we conduct on the ground, but for this situation, it is on the wing. I calculated the energy airplanes we can get from solar power with the equation $E = TSI * A * E * \text{flight time}$, where TSI is the total solar irradiance, A is the surface area wing, and E is the solar photovoltaic efficiency. As I calculated the percent of energy from solar power against total flight energy is about 0.07 to 0.7%. Although this does not contribute much to reduce the initial energy we need, I consider investigation on this field is still ongoing, so these values will be improved in the future.

From the lectures of this course, I learned a variety of methods evaluating the challenges we face. In the class time, we mainly use them to share the contents of research we did outside class. Also, we use it to divide work and research about the specific area each of us focused on. Overall, one of the most important things I learned through this course is to determine specific common goals initially, so that we can try to reach them with different perspectives. We considered having different perspective and

works on individual tasks are important and useful methods. However, sometimes we lost the most important goals and concentrated into individual works too deeply. Therefore, we sometimes did calculations with different conditions. For example, I calculated the possible energy we can get with solar power generation during flight from papers I found. I tested with multiple situations, such as flight from Tokyo to San Francisco, Tokyo to Beijing, and Tokyo to Soul. I was not aware that our goal is to create an airplane with 180 passengers with an 800km flight. Our group members discussed and decided within the class time, but I was too into my work and unaware about it. From this experience, I learned that it is important to share the information more often and check what is the final goal so that we do not lose.

[END of ESSAY]

Please do the followings:

1. First, define a rubric that will serve as the evaluation criteria.
2. Explain the existing theory behind determining the above rubric.
3. Use the rubric to evaluate the student's reflection essay above on a scale of 30 points.
4. Explain the reason why you gave the above points.

To evaluate the student's reflection essay effectively, we'll first establish a rubric, then apply it to the essay.

1. Evaluation Rubric

A. Project Description (10 points)

- Clarity and Completeness (4 points): Clear articulation of project title, goal, and conclusion. Inclusion of key project elements.
- Application of Design Thinking (3 points): Demonstrates understanding and application of design thinking methods in the project.
- Coherence and Structure (3 points): Logical structure and flow of information.

B. Contribution (10 points)

- Role Clarity (3 points): Clear explanation of the student's specific role in the project.
- Contribution Detail (4 points): Detailed account of the student's contributions to the project.
- Integration with Team (3 points): Description of how their work integrated with and supported the team effort.

C. Reflection (10 points)

- Insight and Learning (4 points): Depth of insight into what was learned from the workshops, including both professional skills and group dynamics.
- Self-awareness (3 points): Evidence of self-awareness and understanding of one's strengths and areas for improvement.
- Application of Learning (3 points): How the student plans to apply the learning from this experience in future endeavors.

2. Theory Behind the Rubric

The rubric is based on educational assessment theories that emphasize clear, measurable criteria. It addresses three key areas relevant to the workshop and the essay's requirements:

- Project Description: Focuses on the student's ability to succinctly and coherently present the project, reflecting Bloom's Taxonomy in understanding and knowledge.
- Contribution: Assesses the student's self-awareness and ability to articulate their specific role and contributions, aligning with social constructivist theories of learning in group contexts.
- Reflection: Evaluates critical thinking and reflection, key components of experiential learning theory, allowing the student to connect their experiences with broader learning objectives.

3. Evaluation of the Student Essay

A. Project Description (7/10)

- Clarity and Completeness: 3/4
- Application of Design Thinking: 2/3
- Coherence and Structure: 2/3

B. Contribution (8/10)

- Role Clarity: 3/3
- Contribution Detail: 3/4
- Integration with Team: 2/3

C. Reflection (6/10)

- Insight and Learning: 2/4
- Self-awareness: 2/3
- Application of Learning: 2/3

Total: 21/30

4. Explanation of Points Awarded

- Project Description: The essay provides a detailed project overview but sometimes lacks clear structure. The application of design thinking methods could be more explicit.
- Contribution: The student's role in the charging aspect is clear, and there's a good level of detail on their specific tasks. However, the integration of their work into the overall team effort could be more pronounced.
- Reflection: Insights are present but somewhat surface-level. The student demonstrates self-awareness, particularly in recognizing their oversight regarding the project's specific goals. The application of learning to future situations is mentioned but not deeply explored.

Overall, the essay is strong in detailing the project and the student's role, but it could benefit from deeper reflection and a more structured presentation of information.