

# Student Comparison - #11 vs #20

December 9, 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. 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.

3. 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.

4. 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 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

The following two essays were prepared by students according to the above instructions.

## [STUDENT #11's 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 CO<sub>2</sub> 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 CO<sub>2</sub>. 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 Seoul. 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 STUDENT #11's ESSAY]

[STUDENT #20's ESSAY]

I was in the Monster group for this course, SHIP Research Planning and Skill A. Monster truck refer to oversized vehicles that have excessive weight and height. Our group focused on how these vehicles damage the infrastructure. I learned that over-weight vehicles can affect both bridges and roads. For instance, cracks at the structure of the bottom part of the bridge can be caused when an overweight vehicle repeatedly drives over. After studying the accidents caused by the Monster trucks and the current countermeasures for them, we decided that our goal was to generate solutions that would help maintain safe and secure infrastructure while having these types of vehicles.

I started thinking about my solutions by researching current solutions that are available. When researching I did not specify a region or a country as I wanted to collect different kinds of solutions. Also, because different regions will have varying environments with different traffic standards, I assumed that I could encounter solutions that I would not usually see or come up with. One of the existing solutions that I found interesting was the idea of using a monitoring device only for oversized trucks. The reason I focused on this solution is that it seemed to work in almost any road environment. Studying existing solutions is effective as it allows the solution to be more feasible. The fact that it is already being used in real life indicates that this solution is more doable than those that are not.

After choosing an existing solution I combined the solution with my ideas. This was how I invented my solution, Transport ID. It was necessary to generate new ideas so that it is an improved version of the solution. The improved idea would have new features that would solve the problems of the current solution. For instance, I added a data encryption feature to the Transport ID. I thought that this feature is necessary to prevent other parties such as the drivers from falsely inputting the data and cheat their way into unpermitted roads.

The Monster Truck group was divided into three subgroups each in charge of one solution so that we would have three solutions in total. I was in the Transport ID group as I was very involved in generating the solution. Hence, one of my roles in the Monster Truck group was to develop Transport ID as one of the solutions for our goal to maintain a safe and secure infrastructure. As the inventor of the Transport ID, I came up with its design. When creating the design diagram for the Transport ID I made sure that it was easy to understand. I avoided adding too many details to avoid confusion but enough information to show what the ID could do. In addition, I generated features that would solve the problem of current solutions, and finally, I considered and proposed the feasibility of this invention.

I also contributed to the group by asking questions to other group members. By asking questions and commenting on some of the details, I feel that they were able to reflect on their solution that they generated. I was able to go through the same process. When I was asked questions, I would add more details to the presentation so that it was more easily understood. In addition, I would also speak to the other groups about our group. I would often briefly talk about the solutions that we generated and the improvements we realized that we need to make the solutions more effective and feasible. This allowed me to summarize the things we have done that day so that we can acknowledge the progress of our project.

One of the important things I learned while participating in this workshop is the importance of asking questions to my group members and to other groups in the workshop. When I was asked a question by other people I noticed some aspects that need to be improved which I would have not noticed if they did not ask about it. When they pointed out these aspects, I was able to make improvements on it so that my solution became more efficient and feasible. Not only the questions but I learned that comments from other people during a workshop are helpful. The comments were often new ideas that could be added to the solutions I generated. More comments meant that more features were added to the inventions and they would solve more issues related to the pre-existing solutions.

Another procedure I realized was important was frequently having short meetings while working on the presentation. Often times, I would have a meeting with the group members in the very beginning to divide the work. After working on the presentation, we would have our second and final meeting to make sure that all parts of the project are complete. Nonetheless, I noticed that having frequent meetings, more than twice is more helpful. During this project, I received more comments that significantly made my solution more effective and feasible due to the more frequent meetings we had.

[END of STUDENT #20's ESSAY]

Compare and evaluate the above two essays according to the rubric specified below.

#### [SCORING RUBRIC]

##### Comprehensive Evaluation of Workshop Course

##### 1. Technical Knowledge and Application (1/3)

- Understanding of Concepts: Evaluates how well the student grasps the technological and theoretical concepts relevant to the project.
- Practical Application: Assesses the effectiveness of applying technical knowledge in practical situations, specifically in project design and development.
- Innovation and Problem Solving: Measures the creativity and innovation in addressing project challenges and proposing effective solutions.

##### 2. Teamwork and Collaborative Skills (1/3)

- Individual Role and Contribution: Looks at how clearly the student defines and fulfills their role within the team, and their contribution to the project.
- Team Interaction and Communication: Evaluates the student's ability to communicate and collaborate effectively within the team.
- Peer Engagement: Considers the student's participation in peer learning, support to team members, and contribution to the team's dynamics.

##### 3. Reflective Learning and Personal Growth (1/3)

- Self-Reflection and Insights: Assesses the depth of the student's self-reflection on personal learning and development throughout the project.
- Design Thinking and Process: Measures how well the student demonstrates the application of design thinking methods and management of the project process.
- Skill and Attitude Development: Evaluates the growth in the student's professional and soft skills, like critical thinking, adaptability, and communication.

[END of SCORING RUBRIC]

Compare and evaluate two essays based on the three main criteria in the above rubric: Project Description, Role and Contribution, and Reflection and Insight. Summarize the comparison of the three main criteria and then determine which essay is better overall.

The final score should be as follows. If one is superior to the other even slightly, award +1 point to the superior essay, and -1 point to the other. If one is clearly superior to the other, award +2 points to the clearly superior essay, and -2 point to the other. If both are the same, give each a score of 0.

To compare and evaluate the two essays by students #11 and #20, I will use the specified scoring rubric, focusing on three main criteria: Project Description, Role and Contribution, and Reflection and Insight.

#### 1. Project Description

- Student #11 (Net Zero X: All Electric Airplane)
  - Understanding of Concepts: #11 demonstrates a good understanding of the concepts involved in designing an all-electric airplane. They discuss the impact of electric airplanes on CO2 reduction, the use of different battery types, and the feasibility of solar power in aviation.
  - Practical Application: #11 applies this knowledge practically by conducting simulations and analyzing data related to electric airplanes.

- Innovation and Problem Solving: There is an evident effort in exploring innovative solutions like regenerative braking and solar power generation for airplanes.
- Student #20 (Monster Track: Damages on Infrastructures by Oversized Vehicles)
  - Understanding of Concepts: #20 shows an understanding of how oversized vehicles impact infrastructure. They discuss the damage to bridges and roads and the use of monitoring devices.
  - Practical Application: #20's application of their knowledge is seen in their development of the Transport ID concept, which includes data encryption to prevent misuse.
  - Innovation and Problem Solving: #20's invention of Transport ID demonstrates creativity in addressing the problem of infrastructure damage.

Comparison: Both students display a good understanding and practical application of their respective project concepts. However, #11's project involves more complex technical aspects and innovative solutions, while #20's focuses more on an improvement of existing solutions.

Score: #11 +1, #20 -1

## 2. Role and Contribution

- Student #11
  - Individual Role and Contribution: #11 clearly describes their focus on the charging aspect of the electric airplane, particularly on regenerative braking and solar power generation.
  - Team Interaction and Communication: The essay indicates collaboration with the team but doesn't elaborate much on specific interactions.
  - Peer Engagement: The essay lacks detailed examples of engaging with peers beyond the division of tasks.
- Student #20
  - Individual Role and Contribution: #20 explains their role in the development of Transport ID, including designing and proposing its features.
  - Team Interaction and Communication: #20 mentions contributing to the team through questioning and helping refine ideas.
  - Peer Engagement: The essay describes how #20 engaged with other group members and other groups, fostering a collaborative environment.

Comparison: #20 provides a more detailed account of their contribution and interaction within the team, demonstrating a stronger emphasis on collaborative skills.

Score: #11 -1, #20 +1

## 3. Reflection and Insight

- Student #11
  - Self-Reflection and Insights: #11 reflects on the importance of aligning individual work with team goals and the need for frequent information sharing.
  - Design Thinking and Process: The essay shows an understanding of design thinking methods but lacks detailed insights into how these were applied.
  - Skill and Attitude Development: Reflection on learning from mistakes and the importance of goal alignment is evident.

- Student #20
  - Self-Reflection and Insights: #20 reflects on the importance of asking questions and receiving feedback for improving solutions.
  - Design Thinking and Process: The essay discusses the process of combining existing solutions with new ideas, demonstrating an application of design thinking.
  - Skill and Attitude Development: #20 shows growth in understanding the value of feedback, teamwork, and frequent communication.

Comparison: Both students show good reflective learning, but #20 provides a more comprehensive insight into their personal growth and application of design thinking.

Score: #11 -1, #20 +1

### **Overall Comparison and Final Score**

- Student #11: Total Score = -1
- Student #20: Total Score = +1

**Conclusion:** While both essays are strong, Student #20's essay is slightly better overall, with a more detailed and reflective account of their role, contribution, and learning process.