NTNU

Reflection Report for Product-Based Assignments

The *Power* Box

DIY Student Learning in a Marketable Form

Project Group 15

Submitted by:

Mone Seifu Gragne

Gabriel Nichols

Elias Strunz

Federico Zadra

Korbinian Thomas Georg Götz

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1. Introduction

Producing sustainable energy is essential for future global development. While there are different sources of sustainable energy, in Norway a significant portion is from hydropower productions. In this production process the turbine is the main part, and there are different types of turbines depending on the head difference used, the efficiency, cost, etc.

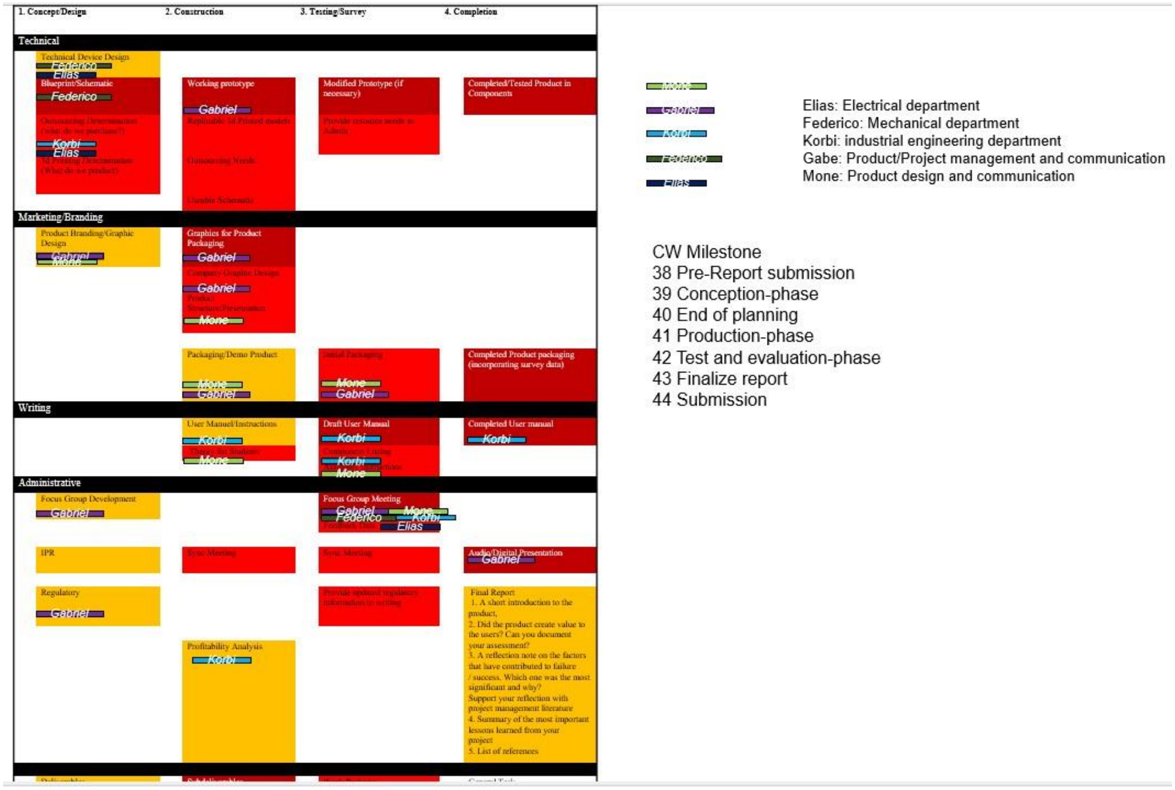
The aim of our project is to introduce this energy source to the coming generation in the way that makes them enjoy as a game and learn more about the turbine system, how it functions and what the outcome is. In this context, we have produced an educational kit that targets students in the 14-15 age-group which could be marketed to schools as a convenient and effective scientific learning tool. The produced package consists of turbine part, the electric part, user manual and pamphlet. The turbine part consists of Pelton turbine bucket which is used to rotate the runner by using the force coming from the water pressure, the runner which move the shaft due to the force applied from the bucket and the hydraulic energy is changed into mechanical energy and the shaft which connect the generator to the turbine. The electric part consists of a generator, electric gauge measure and wire. The generator is where the mechanical energy is changed into electrical energy and the wire connects the generator and the gauge. The gauge is used to show the production capacity depending on the water pressure. The user manual is included to show how the above-mentioned components are assembled. The pamphlet describes the background of sustainable energy, hydropower production and the description about Pelton turbine. All the above mentioned are included to give broader knowledge to the kids which will help them to enjoy and know about the hydropower production system in an uncomplicated way. The rational behind the product is to help the user develop some important ideas for their future learning and prime an interest in sustainable energy sources. This object is extremely timely with the EU designation of 2022 as the year of European Youth (Council of the European Union 2021) and with the collective prioritization of sustainability as a core focus area for youth education (Council of the European Union 2022).

2. Evaluation of Project Management Effort

From an internal evaluation perspective, the *Power Box* project is a project management success. It abided by the triple constrains of the "golden triangle" (as cited in Husein 2018) and achieved its initial goals for production/duration. While some deliverables were either modified or deemed unnecessary during regular meetings in the execution/control phase of the project, all critical elements were completed and were consistent with the initial shared vision of the project members. Contributing to this successful management are the areas of organization structure, risk management, communication, and the alignment of project results with initial vision. These separate areas are evaluated below:

Organization, Task Distribution, Responsibilities

In the pre-report, the original tasks and project domains are defined in the *Project Structure with Deliverables, Sub-deliverables, and Work Packages* table [the modified version of this table is reproduced below]. Early meetings informed this breakdown of tasks, and the project group had already formed a well realized shared vision of the final project and had discussed extensively each other's individual competencies. Following the submission of the pre-report, we actively used this breakdown to define individual roles and responsibilities along with a general timeline for completion. Furthermore, we discussed what additional skills/certifications would be necessary for project completion and ensured those certifications would occur in-time (with redundancy to spare).



Defining this early on ensured good individual understanding of responsibilities and reduced project ambiguity. This also reduced the need for unnecessary communication because distinct responsibilities were well understood. Where this could be improved is that, although regular meetings did occur, during the execution and control phase of the project, little actual control occurred. This resulted in little in-progress monitoring which hindered the quality of the final project—such as in the areas as ergonomics of design, packaging standards, and media quality.

Risk Management Plan

In the original plan, we defined two types of risk broadly. These were the market risk, and the real-world risk. Within the market risks, we had broadly defined a (fictional) environment wherein we were a project team designing a new product which could be produced for a company such as Ravensburger AG which would conceivably show interest in designing and distributing a product targeted at educational upper secondary institutions for use in introducing sustainable energy competencies to youth. This type of market analysis is difficult to run and would be conducted through a profitability analysis and then over the course of a limited release (this we are unable to do at his time).

The real-world risks we defined were technical in nature (an inability to actually produce what we had envisioned) and personnel related (culture and/or communication breakdown). For the technical side, redundancy in skills (and clearly demarked responsibilities) prevented any major breakdown as did pre-established "plan B" scenarios. The best example of this is in the attempt to leverage stakeholders to gain access to a "focus group" of users that could have provided feedback (one of the group members had contacts at the local highschool). When this fell through, we were able to leverage another source of users and gain feedback from on the completed project. While these were discussed during operation, the "plan B" actions were not defined clearly in the pre-report and should have had a greater presence in the initial planning phase.

Communication Plan

Even before initial submission of the pre-report the group had already established routines for communication and distribution of files and materials. General communication occurred on WhatsApp and specific sharing of files and materials occurred over Microsoft Teams. These tools were effective and required no adjustment during the execution of the project. While communication had been a risk identified in the risk management plan, early discussion and survey of available tools prevented any negative effects. These tools proved robust enough to deal with time sensitive issues such as late notifications of additional requirements teaching staff.

Project Result

From initial concept, to final product the project achieved its stated goals during production (although for this project specifically true project success could only be determined after an initial market release). We designed and packaged an educational toy that could be produced and marketed to educational institutions to support STEM (Science, Technology, Engineering, and Mathematics) curricula and introduce the target age-group (14-15) to sustainable energy sources. The project did deviate from the original goals in being able to incorporate and modify the design based off user feedback. This was caused by delays in the arrival of key outsourced parts, and by a failure for a key stakeholder to follow up in supporting the establishment of a potential support group. As a result, the design, while functional, did not go through multiple iterations to improve its design. Additionally, while we were able to package the product in a prototype form, the lack of access (or knowledge of where to get to access) to industrial packaging equipment forced us to adopt labor intensive (and less professional) methods of packaging. This detracted from the final product as it is marketed as a whole item, in which the visual aspects are critically important for marketing.

Group Project Determination

Scale	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Your response				X	

3. Evaluation of the Impact (Project Success)

The product targeted multiple stakeholders, with an intended end users of youth 14+ in a school academic setting. While they would be the actual users, the product would be marketed to schools and academic institutions as a convenient kit for use in science courses which could effectively introduce to sustainable energy. This is captured in our attempt at packaging, and with the inclusion of an instructions pamphlet and user assembly instructions. This product fits into the current trend for producing academic and/or science type toys to encourage student child interest in STEM topics. To this end, we achieved project success (in the near-term evaluation). Nevertheless, as this project is a simulated development of an actual marketable product, full evaluation of the project success is not currently possibly as it would need to be assessed over a given period of time for profitability and acceptance in accordance to the scope of the project and its general logistical requirements and profitability. This assessment must occur through research and simulation—areas that were (in the simulated context) unable to perform.

While our original plan of conducting a user focus group did not occur, nevertheless we did conduct a presentation for a student within our target group. They provided positive feedback to the concept and believed that the proposed assembly would be very reasonable and expressed interest in the idea of producing power from a water stream. They asked several follow up questions about if there was/could be a light or other indicator that could turn the produced current into useful work (this is an element we had not included). Additionally, they asked if the turbine could function with simple airpower—via compressed air or by simply the physical blowing of air by students. While we had not included these elements in the product kit, these types of creative questions are precisely those that our product seeks to inspire in students.

As cited in the introduction this product is also well targeted for the current market as the current priorities cited by the EU for education and youth development include sustainability and early competency development in sustainable energy sources. Likely, a rapid production of this product could allow a business to take advantage of the current market climate to promote such product.

An area where we should have improved and could have gained valuable insight would have been by conducting a survey of another key stakeholder—teachers and instructors of the target audience. These stakeholders, while not holding significant influence, would have a high level of interest which could result in eventually an increase in influence should the product be of interest/provide a useful teaching tool for the classroom. Future development of our project must include engagement with that stakeholder group.

Group Project Determination

Scale	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Your response				X	

4. Factors that have contributed to Failure/Success

In the following, success factors which had crucial impact on the overall success are presented and shortly explained, categorized into project management success, process success and project success.

Project management success:

- *adequate project planning:* The project phase was quite short. Seven weeks were available from choosing the assignment topic to the deadline of the report. To have a structured execution phase, major deadlines and deliverables were set before the execution of the project started. To make the project well structured, one of the students was chosen as an overall project manager, while still having flat hierarchies
- *clear division of tasks:* To achieve all the deadlines and to make the project feasible, clear tasks were distributed and every team member had a main task. This simplified the execution phase, as our schedules differed a lot. But by having clear tasks, everybody could do the allocated task when it fitted into the personal schedule. Nevertheless, if there were problems, everybody tried to help fast
- *clarity of product purpose:* as the time of the project was short, major changes during the execution phase could have led to success failure. Therefore, the purpose of the project was defined as clear as possible. The main functions of the product were intensely discussed before the start of the execution phase and were not changed anymore. However, minor changes within the assigned deliverables occurred, but they did not change the overall purpose

Process success:

Process success is about how certain stakeholders experience the project implementation. Within this project, the main stakeholders were the project team members. Therefore, the following points refer to the project team

- *adequate choice of product:* To achieve a high level of satisfaction within the project team, it was necessary to produce a product to which everybody can contribute something with his or her set of skills. The water turbine met this requirement perfectly, as mechanical, industrial, electrical, and hydro power engineering knowledge is available in our group as well as project management and design expertise. Hence, everybody had a positive attitude towards the product

- *involvement, support, and positive communication:* The project team has a dense schedule besides this project because of other modules and work alongside the studies. Therefore, it was obvious that the project will not be the focus of everybody to any given time. Nevertheless, everybody tried to stay involved, to communicate positively and to act fast if there were any problems. With this set of mind, a positive atmosphere was created throughout the whole project and everybody had a positive feeling while doing something for the project or supporting the others.

- *positive project start-up:* To start with a positive feeling and a good attitude, the project start-up was tried to be as good as possible. By choosing a product on common-sense, talking about how to act as a group and how to create a functioning team, the project started the right way with a positive atmosphere.

Project success:

- *involvement of end-users to achieve a high level of satisfaction:* as the product's purpose is educational, the involvement of the end users (children) is important, to see whether children really think it is interesting to use and how to adapt it to make it even better. The end-user involvement in this case was based on the review/reaction of one child which was positive. In the future, more children and educational professionals like teachers should be consulted. However, as the goal of the project was to build a functioning prototype, this success factor still can be seen as achieved, even though the end-user involvement was based on one review.

All in all, the *adequate project planning* and *product choice,* as well as *involvement, support and positive communication* were the most important success factors within the project. These factors finally led to a well-planned project within a positive atmosphere.
And align with the factors listed in (Hussein 2018, p. 92). Specific examples include "commitment", "clarities of roles and responsibilities", "skills, knowledge and competence", and "motivation of project team."

5. Most Important Lessons from Your Project

The aim of the project (for the group members) was to gain practical insights into all the stages of a project and what pitfalls and difficulties arise when managing it. Now that the project is over, the collective experience gained can be used to formulate key learnings, that can be also used as advice for similar projects.

1. We learned that assigning a project manager within the team helps to achieve a well-organized project. Even if there are flat hierarchies, it is useful to have one person in charge of adhering to deadlines, checking the distributed tasks regularly and to communicate with the professor or teaching assistants if there are any questions or help is needed
2. Our advice is to try to create a positive atmosphere. As already stated within the success factor *involvement, support, and positive communication,* a positive atmosphere is crucial within the project team to create a functioning team, a good attitude towards the project and to make overall success possible
3. You should try to make a product choice with which everybody is satisfied and not just, for example, 50%. If several people are not happy with the choice of the product, the involvement of those persons is not secured. To prevent this, enough time should be spent on product choice. At the beginning, it was helpful for us not to think about concrete products, but to do a session of brainstorming without any boundaries. This helped us finally to find the ideal product for our group
4. We learned that schedules differ a lot, if people from different fields of studies are working together. Therefore, deliverables and deadlines should be introduced. But other than that, every team member should be free to decide how to finish his or her deliverable and when to do it
5. Our experience suggests that one week should be retained as a buffer, to make sure that the project can be finished even if problems or difficulties arise. Moreover, the documentation (video and report) should not be underestimated, and enough time must be planned for this.
6. You should check the university's facilities to realize whether a product is feasible or not. NTNU has good facilities to realize a physical product. In our case, the free use of the facilities of MAKE NTNU was ideal to 3D-print some parts of our product and to finally assemble it.

6. Reflections on Learning and Unlearning

To achieve a successful project, the project team needed to learn and unlearn several hard- and soft-skills. In the following, knowledge, behavior, insights, or ideas that had to be learned or unlearned are shortly presented. Furthermore, if specific examples are available, it is explained in which situation these (un-)learnings were critical to the project's success

1. Necessary Learning:
   - *Basic knowledge about water turbines:* as the main goal of the project was to build a functioning, easy to use water turbine, everybody had to gain knowledge about the principle of water turbines
   - *3D-printing skills:* almost all mechanical parts of the water turbine were created with a 3D-printer. Although one of the team members already had experience with 3D-printing, he had to expand his knowledge about constructing water turbines and how to use the 3D-printers at NTNU
   - *Having trust and confidence:* as mentioned earlier, the schedules of the team members and the way of working have differed. Thus, everybody had to learn to accept diverse ways of getting things done and to believe in the other team members
   - *Total consensus on important decisions:* At the very beginning of the project, it took us quite a long time to decide on which product to produce, as everyone had promising ideas, but there was not one idea having the agreement of all of us. Although we discussed having a majority vote to decide what to do, we finally decided to take another turn and tried to find a product which fits everyone. Finally, this led to the water turbine, which everyone was excited about. If we had gone for the majority vote, there is a high probability that the involvement of the team members would not have been as good as it was with the water turbine and therefore, the success of the project could have been endangered. Hence, during this critical phase of the project, we learned that it is important to have a total consensus on major decisions
   - *Communicating professionally in a foreign language:* 80% of the team has mother tongues other than English. Therefore, communicating professionally in a foreign language was also an important learning for most of the group. We learned to take enough time to explain complicated things, not to take everything word by word, and to ask too often rather than too seldom
2. Necessary Unlearning:

- *Verifying everything theoretically:* At one point of the project, the engineering team needed to select a suitable motor. Since there are a lot of different motors, having many variables, such as torque and rotational speed, it is not easy to choose a suitable one. Therefore, the team tried to do some calculations and to verify theoretically which motor to buy. Unluckily, at this stage of the project there were too many unknown variables, so it was not possible to do a proper calculation. In the end, the engineering team decided to completely discard the calculation and just to choose the motor which they think suits the best based on their experience and feeling. In fact, the motor fitted well and was optimal for the project. Hence, the engineering team unlearned the urge to verify everything theoretically during the project and learned that sometimes it is faster, easier, and more effective to try things out
- *Detailed planning:* During the beginning of the project, we tried to plan the project very precisely, even though major tasks were distributed. After some time, we noticed that this restricts rather than helps. Therefore, we changed our mind during the project and unlearned this behavior. We simply agreed on important deadlines and everyone was free to choose how to deliver the assigned deliverable.
- *Having regular meetings:* Connected to the previously mentioned point, the team tried to organize weekly meetings to talk about the current state of the project. After a while, we noticed that the meetings were not effective, and that other work could have been done during the time spent. In consequence, we unlearned or changed this behavior and switched to meetings that were held when everybody thought that a meeting was necessary

7. Acknowledgements

We would like to thank the assistance of Emmaus Nichols, our “user” who provided valuable feedback on the product and asked several pertinent questions about its development and highlighted several possibilities for future development.

8. References

Council of the European Union (2022). *Council adopts recommendation to stimulate learning for the green transition and sustainable development.* Press Release. Retrieved November 2, 2022, from https://www.consilium.europa.eu/en/press/press-releases/2022/06/16/council-adopts-recommendation-to-stimulate-learning-for-the-green-transition/?utm_source=dsms-auto&utm_medium=email&utm_campaign=Council+adopts+recommendation+to+stimulate+learning+for+the+green+transition+and+sustainable+development

Council of the European Union (2021). *Commission kick-starts work to make 2022 the European Year of Youth*. Press Release. Retrieved November 3, 2022, from https://ec.europa.eu/commission/presscorner/detail/en/IP_21_5226

Hussein, B. (2018). *The Road to Success: Narratives and Insights from Real-Life Projects*. Fagbokforlaget.

Raelin, J. A. (2001). "Public Reflection as the Basis of Learning." *Management Learning* 32(1): 11–30.

9. Appendix

Link to Product	[physical project with no digital aspect]
Link to Video Presentation	https://ntnu.blackboard.com/ultra/courses/_37263_1/cl/outline

10. Product Image

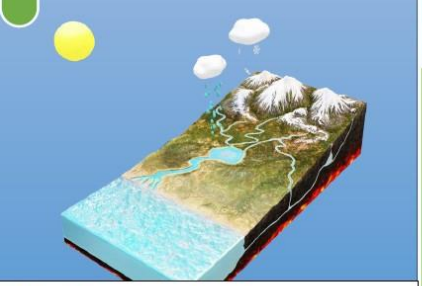
11. Product Educational Pamphlets

<u>Sustainable Energy</u> is one that can meet the growing demand of today's people without compromising the demand of the people that would require it in the future. Renewable energy sources have a lower Environmental impact. All renewable energy sources like solar, wind, hydropower, wave, and tidal power, are forms sustainable energy

Hydropower is away of producing electricity using water. There are 2 types of hydropower generation.

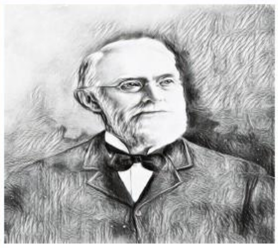
1, runoff river (ROR), is a little of no use of storage to generate the electricity. storing it for the n

2, storage hydropower, the water is stored in barrier called dam and the electricity is generated when needed.



All hydropower plants have components to generate the electric power. From all the important parts it need turbine. Turbine is the main part that change the potential energy into kinetic energy.

There are different types of turbines, 1 is PELTON TURBINE.



Lester Allan Pelton

Pelton turbines are classical hydraulic machines to convert stream flow energy into electricity for medium to high heads. Although invented already in the 1870s by the American Lester Allan Pelton, his runner design is still largely used today in the hydroelectric power industry. Compared to Francis turbines, Pelton wheels offer particularly favorable partial load efficiency degrees and are preferred for low flow rates. They are unrivalled for very high heads above some 700 m, so that their application is mainly in the high mountain regions all over the world. Pelton runners exist in all size classes, from very small Pico hydro applications, e.g., to use tap water from water delivery systems to the largest units with capacities of more than 400 MW like in the Swiss Bieudron hydropower scheme with a current world record head of 1883 m.

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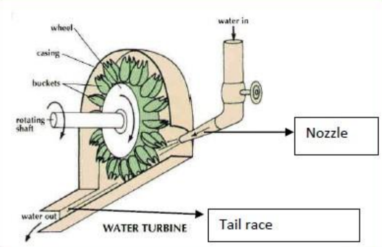


Each component of Pelton turbine has different function and are made from different material.

PENSTOCK: A penstock is a sluice or gate or intake structure that controls water flow, or an enclosed pipe that delivers water to the turbines systems.

NOZZLE: It is connected to the end of the penstock its main function is to increase the speed of the water and run the buckets of the turbine.

BUCKET: *Each Pelton turbine runner has a fixed number of buckets attached. The buckets begin to rotate along the runner with the water hit.*

RUNNER: Runner is a heavy circular disc on which the buckets are attached.

TAIL RACE:is the channel that carries the water away

CASING: ***casing of Pelton turbine doesn't perform any hydraulic action; it is only used to prevent the splashing of water while working and helps the water to discharge to tail race.***

The working of Pelton turbine is as follows

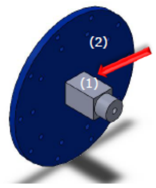
- THE WATER IS TRANSFERRED FROM THE HIGH HEAD SOURCE THROUGH A LONG CONDUIT CALLED PENSTOCK.
- Nozzle arrangement at the end of penstock helps the water to accelerate and it flows out as a high-speed jet with high velocity and discharge at atmospheric pressure.
- The jet will hit the splitter of the buckets which will distribute the jet into two halves of bucket and the wheel starts revolving.
- *The kinetic energy of the jet is reduced when it hits the bucket and due to spherical shape of buckets the directed jet will change its direction and takes U-turn and falls into tail race.*
- The water collected in tail race should not submerge the Pelton wheel in any case.
- To generate more power, two Pelton wheels can be arranged to a single shaft, or two water jets can be directed at a time to a single Pelton wheel.

Advantage of pelton turbine

- The Pelton Turbine is simple in design and the construction is not complex.
- *The water which is not clean cannot cause very rapid wear in high heads.*
- *The overhaul and inspection are much easier than another turbine.*
- *It can work on relatively less Q(discharge) of flow rate.*
- *In the <u>Hydraulic Turbine</u>,* it is the most efficient turbine.
- The parts assemble of the Pelton turbine is very easy. No complexity here.
- The water striking and leaving the runner at atmospheric pressure only.

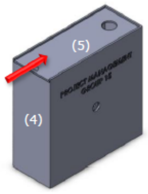
12. Product Instructions Pamphlet

User Manual



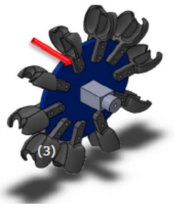
Step 1:

Put the shaft (1) and the paddle wheel (2) together as shown in the figure.



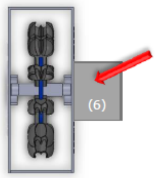
Step 4:

Now attach the top panel (5) to the box (4) via the plug-in connection.



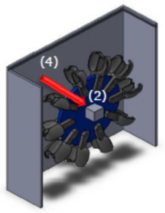
Step 2:

Attach the paddles (3) to the paddle wheel (2). BEARINGS



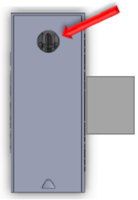
Step 5:

Attach the motor (6) to the housing (4).



Step 3:

Place the paddle wheel (2) in the drill hole of the box (4).



Step 6:

Let water flow through the provided opening.

TPK5100 PROJECT PROPOSAL

Project Assignment Group 15

Mone Seifu Gragne

Gabriel Nichols

Elias Strunz

Federico Zadra

Korbinian Thomas Georg Götz

Contents

Project Type and Description

For the project assignment we decided to develop, design and build a Hydropower Educational Toy. In other words, a small water turbine that can be powered by the water outlet of the sink/bathtub with a simple interface, giving us the amount of generated electrical power. This toy should have pre-build sections that can be assembled by the end user in order to increase the attention and fun-factor. Furthermore, an instruction manual should be created, so that the user can be guided step by step during the "construction" phase of the toy and accompanied with some theory and general knowledge about Hydropower Plants and renewable energy.

Expected Benefits (Outcome)

The benefits of our project are the introduction to a sustainable energy source (hydropower) in an early stage in order to raise awareness to younger generations on how electricity is produced in a renewable way and hopefully awake the interest and thus subliminally priming for further interest in sustainable energy sources.

By doing so we align with STEM priorities in education system and let the users learn (acquire knowledge) by doing and simultaneously having fun. Sometimes a much more effective way to inspire kids and try to raise questions/doubts then normal lessons.

Anticipated Stakeholders and Involvement Plan

During the implementation of the project, several stakeholders need to be considered. In the following, these are briefly named. Moreover, it is described how the stakeholders are involved in the project.

- Users

The userbase consists mainly of children aged 10-14 years. At this age, parents must be also considered, as they only let their children use the product if they think it is good and useful. Since being educational is the focus of the products application area and a broad usage within educational institutions is a goal, concerns and needs of educational institutions acting as customers must be considered to develop a satisfying product. All the aforementioned users will be involved during the design and testing to create a successful product. Before entering the market, a prototype should be extensively evaluated by users and based on these evaluations finally adapted.

- Hypothetical Clients

The hypothetical clients are B2B customers. First, a possible client is Ravensburger, which is a German game and toy company. Ravensburger already has a big range of educational games and therefore the knowledge to distribute and develop educational products. As the company is very experienced, Ravensburger should be consulted early during the design phase to make the best possible product. Via Ravensburger, finally the private sector for interested customers can be targeted.

Second, educational institutions like schools or universities are possible clients. Schools represent large and long-term B2B partners for innovative educational products. As schools have a big responsibility for their pupils, they must be consulted early to ensure that their concerns are met.

- Educational authorities

Since the product is aimed to be used in schools, educational authorities which are responsible for curricula must be contacted. The communication with those authorities ensures that the product is suitable for educational usage. Further, the contact with educational authorities might also create the chance of distributing the product to public educational exhibitions. Consequently, communication with educational authorities is important during the design of the product.

- Regulatory authorities

If a physical product is produced and sold, several regulations must be met. Therefore, regulatory authorities depict a stakeholder. For example, the product needs the CE certification, which shows that all the relevant EU requirements have been met. The authorities must not be involved heavily during the project, yet the project team must understand the regulations and must ensure that the product meets all requirements. Moreover, the product must be registered with the authorities on-time.

- Investors

Investors are needed to finance the project. Hence, investors are important stakeholders. Clear as well as comprehensive communication with the projects investors is crucial. Furthermore, the progress and evolvement of the project should be transparent for them. Therefore, the investors should be frequently addressed for constantly updating them.

- Suppliers

Several parts are needed for the final product. Hence, relevant suppliers must be selected. Clear communication with those suppliers about quantities, deadlines etc. is important once the product is developed and ready to be distributed.

Risk Assessment Plan

Product based

With regard to the risk, there are several aspects that should be taken into account. The basic prerequisite for being able to finance the project is that our financial backer "Ravensburger" maintains the order during the project and provides us with the necessary financial resources. As long as liquidity is ensured, the project can be carried out, all relevant components can be procured, and production can take place in a factory.

In addition to the financing, the production and preceding construction of the product represents a further risk. Since we are targeting academic institutions with our product, we need to make sure that our selling price is within a reasonable range so that these institutions can buy our product at all. Thus it needs a construction of our product, so that the individual components, can be procured and/or manufactured favorably, so that on the manufacturing costs still another appropriate profit margin can be added and the selling price nevertheless not too highly become.

The aforementioned purchase of various components in order to be able to manufacture the product represents a further risk. If there are difficulties in the supply chain of our suppliers, for example due to a shortage of raw materials (chip industry) or geopolitical events (Ukraine war), this can have a serious impact on our procurement. In short, if we are unable to procure components, the sale of our product cannot be realized.

Another risk factor is our customers. If the academic institutions decide against our product, we will not be able to sell anything and will have to expect serious losses. In this case, it is conceivable that we could take on another market. For example, our hydropower educational toys could then be sold to the private market via toy stores and online stores. Of course, this would then only be possible with appropriate marketing communication.

This also represents the next risk factor. We have to communicate with our customers and ensure, for example through contracts, that the quantity of toys we produce is then also purchased at an agreed price. Through constant exchange with our customers, we can also adapt or adjust the toy to make it even more suitable for use in academic institutions.

Last but not least, we would like to point out technical complications after the production of the product. If there is an error in the production or construction of the products, they may not function properly and have to be returned. As a logical consequence, the costs for our company would then explode, whereby our liquidity would dissolve strongly to completely and the reprocessing, or new construction of the toys would hardly be financeable without further means of our customer.

Project based

- Cost risk

Cost is one of the major risks during the front end and implementation process of projects, it is expected it will affect the progress. This includes the non-monetized risks such as time, scope, and quality monitoring. The major cause of cost overruns is:

Underestimation of cost: cost estimation is done during the planning period of the project. under estimation of cost may cause cost overrun during the execution period which will cause economic crises for the project. Overestimation of cost is also another constraint which will cause the loss of stakeholders for supporting the project.

Lack of communication: this project is done in a group of five students from different background and culture, and each of the group member will have different responsibility which may hinder the communication ability and flow of information within the group. Lack of effective communication about the costs spent in every direction may lead to cost overrun.

Poor management: any project faces different potential risks. Poor project management may create a poor risk management plan, this leads to unexpected risks that affect the project and bring cost overrun.

To prevent the risk due to the cost overrun and to address the above risks:

Estimating the cost: before starting the execution of the project it is decided to have the benefit cost analysis. Having a cost analysis will help to predict the cost needed for the execution of the project. This will decrease the risk due to cost.

Developing effective communication: communication also can be used to manage the risk of cost overrun. Excellent communication cannot be created within a night but through time it can be developed. Everyone in the group will have different expenses, which is explained in monetary and non-monetary terms, and having effective communication about the cost spent in all directions may help to prevent the cost overrun.

Keep to the plan: following the plan is the other important thing to reduce cost overrun. Keeping the cost estimation, sticking to the estimated cost, and having the expense for each project will reduce the cost overrun.

- Technical risk

Technical risk arises from unpredictable or predictable reasons and uncontrolled technical system. Some of the technical risks arise from operational error and others from defects. This will cause equipment failure which will lead to breakdown and may prevent us from achieving the goal of the project. To prevent such risk in the project; deep investigation should have to take place, checking the progress at every stage of the project, checking the efficiency of equipment's and materials available.

- Operational risk

The aim of the project is to deliver a product that can operate and give an outcome. However, during delivering projects there may be operational risks. This risk comes from different directions such as risk from people related to performance, losing motivation, human error, and human intervention, improper management, quality issues, uncontrollable events, and other technical problems. Product design flaws and internal failure can cause failure of the project process.

How to address the risk:
Human error: this is the most common error that occurs during operation. Eliminating such type of error is difficult but it can be minimized. It can be minimized by collecting all information related to the project, reading, and practicing, getting sufficient knowledge, motivating each other in every stage of the work.

Technical error: because of unknown technical defect, there is high operation risk. Good plan for the execution and following the plan may minimize it.
Uncontrollable event: external environment such as weather change and disease cannot be controlled but affect the performance of individual and put the output at risk. This is hard to prevent but good follow-up may reduce the risk.

Anticipated Skill-Gap and Development Plan

There are several types of skills known such as soft skills which are related to leadership, prioritization, and interpersonal skills, and the other is hard skills related to technical skill include learned skills. At the end of the project, it is expected to develop these skills within the group. These are as follows:

- Planning
- Leadership
- Problem solving.
- Time management.
- Communication.
- Knowledge of user experience and design.
- Knowledge about software such as (CAD,3D printing,)
- Market research

These skills can be acquired by:
- Empathizing with each other when brainstorming innovative ideas for products.
- Clearly define the problem, so each one can focus on the solution.
- Discussing time management experience of each other and following the best which suit each one and having the schedule and follow it.
- Asking, and giving feedback to each other and identifying in which area improvement is needed.
- Working with each other and having effective communication in every direction.
- Taking opportunities to play on leadership in the group.
- Working with each other in every stage of development and participating in the process with full potential and developing the relationship with the design and assembly team, asking about the product, the material, and the process, asking, and working with each other.
- Searching on the internet and reading various literature related to the project.

Project Structure with Deliverables, Sub-deliverables, and Work Packages

1. Concept/Design	2. Construction	3. Testing/Survey	4. Completion
Technical			
Technical Device Design			
Blueprint/Schematic	Working prototype	Modified Prototype (if necessary)	Completed/Tested Product in Components
Outsourcing Determination (what do we purchase?) 3d Printing Determination (What do we product)	Replicable 3d Printed models Outsourcing Needs Useable Schematic	Provide resource needs to Admin	
Marketing/Branding			
Product Branding/Graphic Design	Graphics for Product Packaging		
	Company Graphic Design Product Structure/Presentation		
	Packaging/Demo Product	Initial Packaging	Completed Product packaging (incorporating survey data)
Writing			
	User Manuel/Instructions	Draft User Manual	Completed User manual
		Component Listing Assembly Instructions	
Administrative			
Focus Group Development		Focus Group Meeting	
		Feedback Data	
IPR	Sync Meeting	Sync Meeting	Audio/Digital Presentation
Regulatory		Provide updated regulatory information to writing	
	Profitability Analysis		Recommendation for Production
Work Package	Deliverable	Sub-Deliverable	General Task

Project Schedule

CW	Milestone
38	Pre-Report submission
39	Conception-phase
40	End of planning
41	Production-phase
42	Test and evaluation-phase
43	Finalize report
44	Submission

Success Factors

The success of the project depends on various factors. Some of the most important ones are listed below

- realistic time planning
- comprehensive understanding of the purpose of the product
- gaining knowledge and skills needed for the project (3D-printing, electrical knowledge, project management skills)
- target-oriented problem solving
- end-user involvement
- client consultation
- individualised communication and transparency to stakeholders
- good in-team communication
- cost consideration during the design of the product
- considering the whole life cycle of the product

Roles and Responsibilities

Elias: Electrical department
Federico: Mechanical department
Korbi: industrial engineering department
Gabe: Product/Project management and communication
Mone: Product design and communication

Communication Plan

Communication within the project team takes place via communication software such as teams. In addition, weekly meetings are held on site.
Furthermore, our stakeholders are involved via telephone calls and personal meetings. If necessary, the corresponding teaching assistant is contacted.