Reflection [1]Report

Space optimization of study places

Submitted by:
Côme GRANDPIERRE, Sander KASSELS, Jurrian Marten KOSTERS, Thomas LORENTZ, Lohim Luc Allain QUIQUE, Ilian WILLEMS.

Group Number: 19.

NTNU
Norwegian University of Science and Technology

[1] Reflection is “the practice of periodically stepping back to ponder the meaning to self and to others in one's immediate environment about what has recently transpired” Raelin, J. A. (2001). "Public Reflection as the Basis of Learning." Management Learning **32**(1): 11–30. A reflective practitioner is a person capable of learning, acting and adapting to environments, someone who is constantly seeking to widen their experience and knowledge by adapting their manner of work in the profession. Someone who always learns through what they do, and who continually combines action with reflection on what has been done.

Table of Contents

1. Introduction

Our project is based on a simple observation: the lack of study places in the Realfagbygget and NTNU in general. Starting from this statement, we wanted to find a viable solution that could be proposed to NTNU to tackle this problem. This project was highly relevant to us because we wanted to do a product-based project, and this subject impacted every member of the group given that we all study at university. Even if we come from different horizons, we all have been confronted with this problem at NTNU and in our own universities. This was a great base to succeed since we knew that everyone would be involved. Likewise, we believed that having accessible stakeholders and end users was key to creating motivation and a sense of thrive around our project.

Our original aim for the project was to deliver a complete design of innovative study places that created additional spots in existing study rooms. Our project consisted in the creation of the design based on the state of art and investigations. The project also included an evaluation of the utility of our product to propose it to NTNU and other universities. In the preparation (pre-project) phase of the project we identified and mapped the stakeholders of the project and defined the success factors that we needed to achieve our goal. Unfortunately, the risk management plan wasn't studied enough to erase uncertainty of the project. The pre-project report also included a division of the group into roles and responsibilities to prevent overlapping roles and task attributions. To structure our project, we elaborated a detailed plan to finish the project on time which was maybe the hardest success criteria to reach. In fact, the schedule and timeframe of the project were very tight. Condensing and organizing every work package in the tight schedule proved difficult.

Passing this starting point on which we based our pre-report we began the investigation phase. Through a survey and the interactions with end-users (students) we realized that our initial problem was not on point. The need did not originate from a lack of space but rather non-optimized working spaces. The survey underlined that individual working spaces were not too complicated to find. However, when it comes to group work, the bigger the group, the harder it is to find a place to work. From the survey, user interactions and state of the art research, we elaborated a list of requirements that had to be in our product.

Once the investigation was completed, we moved to the prototyping phase. This stage was crucial as it embodied all of the knowledge we had gained in the previous phase. The design drafts and prototypes had to respond to all our requirements (such as user convenience, soundproofing, flexibility, practicality…). One problem that we had was the large panel of possible solutions, and the fact that we didn't decide in which specific area we wanted to implement our solution. We therefore had to define where our solution would be implemented. After multiple visits and thorough debating, our choice went for the "*Realfagbygget etage u1 undervisningsrom*". This led us to four final designs that we evaluated using a weighted criteria method based on the requirements defined earlier. The design with the highest score was further developed and modelized digitally in *Fusion 360* and *Ultimaker Cura* and printed with the 3D printers from MAKE NTNU, after taking a beginners course. We also did some rendering of the product in *Blender* to see how it will look in the environment.

Our final product is an innovative modular combination of chairs and tables which can be used in many configurations to work either alone or in groups of various sizes. Our product will be implemented in a whole room or in a specific space so people can assemble the products as they want depending on how many they are. We paid attention to the comfort, colors, lights, materials, and practicality to propose the best design possible.

2. Evaluation of Project management effort

In this section, we will assess the group's efforts throughout the project. In other words, this part will reflect on the group's organization, work distribution, risk management and communication.

Evaluation of the group's organization and work distribution

Concerning the organization of the project group, we didn't completely respect the roles and responsibilities mentioned in the pre-report. Indeed, we changed the purpose of the project so based on that, we needed to adapt to succeed. The distribution of the tasks was flexible. At some points of the project when we felt the need to split the work, we did it depending on the preference of the different group members, which went well.
Additionally, we tried to stick to at least one meeting per week. Towards the end, the frequency of the meetings increased to make sure we finished the project on time. It was important to do meetings in real life and not only from home because with 6 people it would be impossible to share ideas, discuss and do the project well. There was a big part of creativity and design in the project, to enable us to have general brainstorm sessions we needed this time together.

As will be elaborated in the success factor's part, sometimes it happened that a group member worked on a task outside of its expertise zone or competence zone. This was not a bad thing because it allowed us to learn about software, tasks or competences that we were not used to put in practice.

When it came to deciding making, nobody took the responsibility on his own. For example to choose the final design of the product we needed everybody to agree with it and be sure that our expectations and requirements concerning the product were matching. It's linked with the fact that we needed everyone to aim in the same direction and be sure that we were heading to the same purpose.

Then, concerning the planning expected during the preparation phase of the project, we used it to keep the pace as a base, but we didn't follow it completely. It was optimistic to match the reality which included attending other courses, making us unable to get involved 100% on this project. In the end we prefer quality over quantity.

Evaluation of the risk management plan established in the pre-report.

The risk management plan elaborated in our pre-project was very superficial and lacked insight. The risks identified and the way to monitor them were very generic and not project specific. This lack of thorough risk identification can be traced back to the way we defined the risk management plan. Risk identification should be based on multiple methods, sources and means. We only based our identification phase on brainstorming and our minimal experience from previous scholar projects. Given the short pre-project phase we lacked the end-user's perspective. The user involvement was carried out after the pre-project and allowed us to have a better understanding of the project context, objectives, and constraints. Likewise, the lesson on project risk management and the slides regarding the sources of risks allowed us to take a step back and re-plan our risk management plan. We realized that the combination of our survey and the 4 categories of risks identified in the slides allowed us to have a better plan, especially those regarding requirements, features the product should include, the technical risks, the availability of tools and instruments, the people (end-users) and many more. In other words, the pre-project risk management plan was too generic, but we managed to re-define it afterwards to have greater risk management throughout the project.

Despite an inaccurate plan, we dealt and monitored risks quite well. Even though we faced low end-users' involvement, we adapted our scope of work and reframed our objectives according to the requirements gained through end-user involvement. Likewise, we were very proactive in compensating for our lack of knowledge and skills. To do so we rapidly engaged in 3D printing

courses and started familiarizing ourselves with *Fusion 360* (CAD software). We dealt quite well with the competence, availability, and motivation within our little organization (group project). This meant that we were very proactive in terms of developing solutions and minimizing product risks.

The main risk we failed to address well was time constraint and end-user management. The correct mitigation strategy would have been to involve end users earlier and more frequently through reference and focus groups. We really struggled to induce a sense of ownership for the end users. This caused critically low end-user involvement and therefore feedback. Likewise, time constraints were too optimistic and the scope of work may have been too broad at first. As mentioned earlier we could have dealt with scope of work risks better if we had had greater end-users' involvement and interviewed experienced project managers in the pre-project phase.

Evaluation of the effectiveness of communication plan

We used English to communicate in the group and with the different stakeholders as planned. Within the group we communicate in a WhatsApp group chat. It was effective because we could keep everyone informed on the progress that is made and about the deadline. To share documents and be able to work on it simultaniously, we used Google Drive and Microsoft Teams. We decided that each urgent matter required an extra meeting planned by the chairman. The people who will attend the extra meetings will give an update to the rest of the group and if applicable the relevant stakeholders. This was the case for example at the end when we had to increase the number of meetings to finish the project on time.
During our project there was clearly a lack of communication with stakeholders. Our plan was that during each meeting the secretary will write an email composed of the updates for the stakeholders once approved by the group it'll be sent as a weekly update on the project. But unfortunately, we didn't do it, we think that it came from the lack of interest from NTNU students and staff.

Finally, surveys were a good idea to have data and led to a change of purpose. When doing quantitative research, we used Google Forms. This data collection tool was used to make sure every group member has access to the data. When doing interviews, we also used Google Docs.

To evaluate our product, we interviewed several students from NTNU, they are the end-users, and we cannot assume that our product is great without their approbation. When we had the 3D-printed prototypes and rendered pictures and videos we were able to present them to random students to ask them what they thought of our design, if they might use it and finally if they think we must change something to improve it.

Evaluation of the respect of deadline and results regarding to the original success criteria

As we said a few times in this report, the main purpose changed a little bit. But even with considering that change, the result of the project was good and even beyond our original expectations. So even if we made a deviation from the original purpose, we could consider our project as a success. Indeed, we had a strict deadline which was the hardest success factor to handle. But we still managed to do a product that matches with our requirements and those from our end-users. We did a 3D-model that we could print and render in pictures and video to be sure that it will fit. And finally, we had confirmation that it was useful from the end-user which is a huge support and success criteria.
To what extent do you agree with the following statement: "*We evaluate our project management effort as successful*"

Scale	**Strongly Disagree**	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly Agree**
Your response				**x**	

3. Evaluation of the impact (Project success)

In this section, our group self-evaluates the impact and the significance of our final product.

Target audience of the product

The prime target of our product are students and staff of NTNU. The end-users are undoubtedly NTNU students studying at Gløshaugen. However, the product is aimed for NTNU facility managers and the NTNU board as they are the ones choosing whether to implement new infrastructures within the university facilities. The targeted audience can be extended to other buildings in NTNU, other campuses (Gjøvik and Ålesund) and even other universities. The asset of our solution is that it is self-sufficient and very universal. Its field of use could go beyond scholar facilities and be used for open spaces in companies. However, the targeted group for this project were NTNU students studying in Gløshaugen as they are easy to reach out to. Available end-users was one of our criteria when choosing our project. This made it possible to get feedback and engage in conversations about things that we could adapt to meet their needs.

Evaluation of the product

From the beginning of our project, we acknowledged the importance of involving stakeholders in an early phase. This was also one of the reasons why we picked this type of product, since the issue concerns ourselves, as well as our fellow students, which is a group that is easy to reach for us. In the initial phase that concerned problem definition and idea generation, we decided to conduct a survey among as many people from the target audience as possible. The adopted approach was a way to collect quantitative data to find the needs and issues that the average student experiences while looking for a spot to study. The nature of this survey was mainly exploratory, with questions like in what kind of environment people prefer to study, how severe they consider the issues we addressed, and how difficult they would consider it to find a studyplace with varying group sizes (see figure 1).

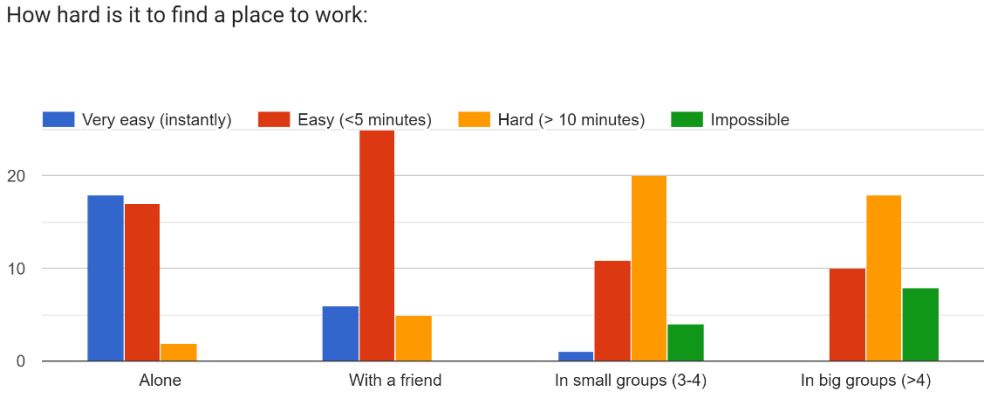


Figure 1: The difficulty to find a study spot with varying group sizes.

Aside from the multiple-choice questions, there was still room for suggestions in several open questions, which made that the results of this survey formed the basis for our product. Design requirements were obtained based on these results, to match the needs of the target audience as closely as possible. The next phase, the design process, mainly contained brainstorming and idea generation within the project group, after which we picked one of the designs based on the requirements. This design was worked out in more detail, with several moments where the Head of Design showed the progress and asked for feedback to the rest of the project group members. After the design was finalized, it was decided to also 3D print a prototype. This made the product tangible and enabled us to try out different configurations, but most importantly to have something to show to the target audience aside from the CAD and blender models.

For the evaluation of the final product, we choose to adapt a more qualitative approach. The reason for this was that we not only desired to verify whether the target audience liked the product, but also wanted to find out what improvements they would suggest and what their main concerns about the

design were. To enable us to make iterations towards the "perfect" final product, this type of information is crucial, and was believed to be gathered best by having an interview in the form of a conversation, to be able to ask more in-depth questions and let the participants elaborate on topics they perceive relevant.

We went around the targeted area to validate our final design by interviewing students (the end-users) by first explaining the project and the idea behind our product. Subsequently, we showed them the renders of the digital models of the design, as well as the 3D printed scaled prototypes. After hearing out their initial reaction and thoughts, we started asking about potential improvements. This part of the interview included questions like "Would you be willing to move these types of chairs around to optimize table/chair usage? If not, what is the limiting factor?" and "What would you consider as potential improvements for this chair and table?"

The results were very optimistic. The targeted audience again acknowledged the relevance of the issue we try to tackle, by stating that it is indeed an annoying problem they encounter frequently. The concept of modularity was something that most of the participants were enthusiastic about, mentioning that they would be willing to use and move these chairs to adapt to the required group size.

As was aimed for by posing more in-depth questions, we also received various points of feedback that we could implement in the future developments of the product. Several participants mentioned for example that the chairs look quite heavy and were concerned about their ability to move them around. Suggestions included adding wheels or using a lighter product material. Another thing that was mentioned was the availability of plugs on the sides and a concern on how they would work when you move a chair around. Participants were wondering where to put their jacket while studying too. We thought about the space underneath the chair to be used as a storage space for student's backpacks, but not considered jackets yet. A hanger on the side was suggested, although this might hinder the ability to put chairs side to side. This suggestion was a great example of the importance of stakeholder involvement, since it revealed topics, we hadn't thought of ourselves yet.

Although these suggestions generated a lot of potential future improvements, the first reaction of the participants reveals the positive attitude of the target audience towards the product. Therefore, we consider the project to be successful based on the initial objective of trying to solve the lack of study places in the Realfagbygget building.

Group self-evaluation

To what extent do you agree with the following statement: "*We evaluate the quality of our final results as outstanding*":

Scale	**Strongly Disagree**	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly Agree**
Your response				**x**	

Given the time available to carry out such a vast project, we believe that our end-product is satisfactory. One must consider that the project lasted 50 days. In such a short timeframe developing a full project from defining the scope, pre-project report to the final deliverable is a challenging task. Likewise, one must consider that our scholar work structure is comparable to a weak matrix organizational structure. Having a detached team, fully dedicated to the project would have been much easier and work could have been done much faster. We believe that our final product is satisfactory. However, when combining all these external factors, answering "*Agree"* to the previous statement is coherent.

4. Factors that have contributed to failure / success

Here is a list of the different success factors inherent to our project and why we choose to pay attention to these particularly if they were a cause of success or failure. Success factors are necessary to complete the success criteria, but they are different concepts. As defined in the course by Bassam Hussein: A 'success factor' is a term used as a description of the ground rules that should be adhered to during project planning and execution.

Clarity of project purpose: If the purpose of the project is not well clarified and understandable by each member of the group it is impossible to succeed. At first, we all were from the idea that there was not enough space to study at Gløshaugen. After seeing the results of the survey, we had to reflect on this idea. So, it was a case of not just following our own ideas but considering results from a larger group. After exploring these, we had to change our main purpose of the project from 'space-creation' to 'space-optimization' which had a big impact on designing our product. It was thus very important to not just stay at our 'tunnel vision' idea but instead be open to others' experiences.

Clarity of roles and responsibilities: We tried to clarify the roles at the beginning of the project as it can be seen in the pre-report. But during the project it happened that one member worked outside of his competence zone. Then, we tried to match the different parts of the work with the speciality of each member, for example the design was assigned to a design student, but the work was consequent, and the resources needed were more than one person so other group members were working on the design phase. Also, we are all equal in the group and since the beginning we wanted to be sure that no decision was taken alone, so before deciding we always wanted to be sure that everybody agreed. We think that we managed well this success factor that led us to succeed.

Effective communication: To succeed we needed good communication within the group. We are 6 members; it is enough to fail if we don't communicate. Indeed, we didn't have a lot of time in the week to be all together and work, a massive part of the work had to be achived individually. We needed to be synchronized and to do that we needed to talk. We used a lot of WhatsApp to communicate about work and organize our meetings. We think that we did not completely manage to communicate well because on WhatsApp it happened a lot that not every member responded to a message, so we didn't have the comment of everyone. But it was useful to organize our meetings. Then, we also need to communicate effectively to the other stakeholders. Because we need to constantly check if we are taking the good direction, one of the success criteria is that our product can be utile and used by the client, end-users and that the other stakeholders approve our final product if it meets their expectations. On this side we are not satisfied because the investment of some stakeholders was not as much as expected and we didn't manage to invest them more than they wanted to.

Flexibility: Flexibility was a quality that we needed to develop to overcome the uncertainty of our project. Our project was not a peaceful road, we needed to react when we were facing problems or unexpected happenings. For example, we had many changes to make concerning the purpose of the project, which affected a lot of things in the planned organization. However, we manage to deal with those changes, and we succeeded thanks to our flexibility.

Structured risk management process/ Use of lessons learned from previous projects: We didn't make a good risk management plan at the beginning because we didn't really know how to make it and deal with risk. But fortunately, we manage to use our experience, skills, knowledge, and competence (project manager/ contractor, and project group) to overcome uncertainty. In fact, every lesson from the previous project was useful to save energy and time so we don't repeat any mistake. That's here that being 6 is a strength because we can all use our experience to benefit the whole group.

Support: We can be as involved as we can, work well and hard but if we don't have support, it is almost impossible to succeed. That's where the way that we manage the stakeholders is a key, so they support us in opposition to sabotage our project. Unfortunately, we didn't get enough support from the different stakeholders. For example, the end-users were not really interested in helping us to design a product that suits them. That came from the problem of our first purpose that was not relevant, that is why we changed it.

Adequate project planning: This success factor is closely linked to the time constraint. Indeed, we need very good early planning to finish our project on time and successfully. The time constraint is set by some of the stakeholders, it may not be a success criterion for our group to do it on time but if we want to satisfy everybody we need to. We managed to follow our planning and that was a big success factor considering the deadline set by Mr Bassam Hussein.

We all agree that all these factors are important. But during our project we noticed that the clarity of the project is crucial. Without a clear purpose that is useful and problem solving, you do not know what goal you are working towards. If the purpose of the project changes (as with our project), there is probably a lot more that changes (e.g. stakeholders, roles and responsibilities…).

If we compare the factors, we have mentioned above with the factors listed in (Hussein, 2018) pp-92, we see some similarities. Clarity of project purpose, clarity of roles and responsibilities, flexibility, structured risk-management process, and adequate project planning are all literally in (Hussein, 2018) as well. Where effective communication can also be found indirectly as adequate and timely information flow between project and stakeholders. Support on the other side is more general and can be found in different other success factors. Examples are: 'Motivation of project team/project manager' and 'End user/client/stakeholder involvement'.

5. Most important lessons from your project

You should first identify the learning objectives of your final product before deciding on the type of product. In our case, the objective of the project concerned developing, producing, and validating a product (an authentic product). The aim of this was to give us the opportunity to experience the entire life cycle of a project from initiation to delivery. Other course learning objectives include the general competences. “Recognize the importance of involving stakeholders to identify project goals, risk factors and mitigation methods” is one of these general competences that provides guidance in the initial phase of the project. With this in mind, we started brainstorming about ideas for the product we desired to develop. One of the important requirements was stakeholder involvement, and therefore we chose to pick a familiar target audience: students.

Our advice is to have a similar approach in first identifying the learning objectives, and then generating ideas that fulfil these objectives. The targeted stakeholders being approachable helps a lot to exchange ideas and verify the needs and wishes of potential customers. In our case we could question ourselves what a familiar problem or issue is, to find a product that forms a solution. Seating shortage on campus was one of these main issues, with also lots of opportunities to interview stakeholders and do field research.

We learned that it was important to be critical about our work. It is crucial to think about the work we are doing and question it to find if we made mistakes or not. Thanks to that project we realized that time management was a key factor to succeed. We learned how to do a realistic GANTT even if it was not correct at the first draft because we still needed to acquire the competence to estimate the workload of tasks. But during the project we took some time to take a step back and reconsider objectives and planning. So, our advice for students who are starting a new product-based project is that it can be wise to be a little pessimistic about the planning in the pre-project phase so they don’t run out of time at the end and it can prevent frustration and stress, the planning must align with the objectives. Then, it might be obvious, but we learned about teamwork and group management. In fact, even if we were used to teamwork, every project is different. This time we were all coming from different horizons, and we barely knew each other at the time of group forming. But as advice, students must know that every group has its own challenges, and each member can offer something to reach success as a group. Finally, a product-based project can develop our design thinking attitude which we are sometimes not used to as engineers.

Our experience suggests that in a project which has a certain deadline at the end and not intermediate ones, it is easy to fall into reactive behaviour. Laziness can happen but cannot be tolerated. That is why it is great to have a decent plan and to follow it to keep the pace. It is important to anticipate problems instead of being forced to handle them when they come. Also based on what we experienced we can advise to not think only about the course and the grade but more as an immersive project where we can apply the concepts that we saw in the courses. That mentality allowed us to be focused on the documents needed to achieve our goals, for example the literature review/ state of art even if it was not for a grade but only for the success of the project. Also, we think that our project is the perfect example where we couldn’t keep a “tunnel vision” and don’t pay attention to feedback. We had to reflect on the surveys to change the main problem to overcome. That shows that to succeed it is not wise to follow only our own ideas but also to be open and listen to the final users and other stakeholders. Finally, we didn’t have a deep risk management plan. But for students that are about to do a product-based project it is wise to go deeper into risk analysis to anticipate issues and be able to handle them much easier.

6. Reflection on learning and unlearning

Looking back on the whole process of our project, here are some of the things we had to learn and unlearn in order to succeed.

What we had to learn:

- **Critical thinking** - At every step we take in the process, it is important to think critically about whether nothing has gone wrong. A mistake discovered only later can have bigger consequences than being there right away. Thus, critical thinking can ensure that we detect errors earlier during the project. Questions after each step such as: 'What have we achieved now? Did we add some value? How can we move forward?' can help to achieve this.
- **Estimating and mapping workload (Time management)** - Realistically our GANTT was too optimistic and the time frame too narrow. We did not manage to correctly estimate the workload of the work-packages in the pre-project phase. We quickly ran behind schedule and every task was more time consuming than expected. We therefore had to take a step back before the hand-in of our two reports to slow things down and reconsider our objectives and the projected work for the upcoming weeks. Our second time estimates were far more accurate and feasible than the first ones. This prevented a lot of frustration and stress within the team members.
- **3D-printing (workshops)** - Some of us did not know anything about 3D-printing. Therefore, we had to follow a 3D-printing workshop with "MAKE NTNU" to gain the right knowledge. We learnt about the different machines and their applications. This step was critical to unlock our access to 3D printers and prototype our design(s).
- **New CAD softwares** - During the prototyping phase, our group had to select one CAD software. We chose *Fusion 360* because of its ability to combine multiple users on one project. Most of us were used to *Créo*, *Blender* and *Solidworks*. CAD designers therefore had to promptly learn and adapt to this software's features. This technical adaptation was decisive to rapidly create our CAD designs.
- **(Applying) Project management tools** - Identifying and mapping stakeholders, success factors and criterias, WBS and work-packages as well as RACI became a lot more concrete when applying them in the pre-project report. Likewise, the more abstract notions linked to project management success became a lot clearer as we applied them during our own project.
- **Furniture design specifications and norms** - During the state-of-the-art research, we were able to get a lot of insight into norms and "rules" of furniture design. We found some interesting and valuable information about the color codes and their effect on studying and creativity. These interesting facts and "rules" discovered in the state-of-the-art study were then applied to the prototyping phase.
- **Teamwork and group management** - Even Though this might sound as an obvious and deceitful attitude, every group work comes with its own challenges. Embracing and adapting to every group member's personality, abilities and implication is very different from one group to another. Every new group project enriches our abilities, techniques, and group management faculties. This even evolved during the project as roles and responsibilities changed with the different steps of the project.
- **Design thinking attitude** - Applying the skills some of us had learned during our design thinking course. Using empathy to immerse ourselves in the core of the problem we aimed to tackle. Being proactive to seek end-user insight and going to their workspaces to see what was missing and what had to be changed/improved. This came very handy during the investigation phase.

What we had to unlearn:

- **Reactive behaviour** - The fact that the project had no review meetings and intermediate deadlines forced every group member to be proactive. Reactive behaviour and laziness could not be tolerated. Constantly anticipating problems and changes was necessary in order to steer the project in the best direction possible.
- **Grade driven mentality** - Working for the grade was not the right way to approach this project. The project had to be addressed from an immersive project management perspective. This allowed us to tackle issues and map our work with greater objectivity. The immersion process was key to fully engage in the project and fully engage in it.
- **Fictitious scholar work** - Leaving aside the fact that this task was a scholar project, it was key to engage in it. At the start we kept going back to the fact that the project was fictitious and that we were pretending to address a problem that we had fabricated. Leaving this futile mentality behind was key to engaging in the project and gaining the whole meaning of the project.
- **Obstinate vision and mindset** - At first, we all shared the idea that there was not enough space to study at Gløshaugen. After seeing the results of the survey, we had to reflect on this idea. So, it was a case of not just following our own ideas but considering results from a larger group. After exploring these, we had to change our main purpose of the project from 'space-creation' to 'space-optimization' which had a big impact on designing our product. It was thus very important to not just stay at our 'tunnel vision' idea but instead be open to others' experiences.

7. Acknowledgments

We would like to acknowledge and give our warmest thanks to Mr Bassam Hussein who made this work possible. We learnt a lot through his book, lectures and feedback, which we put into application in this project. We would also like to thank the student assistants for their availability, comments and suggestions.

We would also like to give special thanks to all the participants that helped us through surveys or interviews. This helped us a lot to succeed and continually questioned ourselves to know if we were going on the right way.

Finally, we would like to thank MAKE NTNU for their workshops. Some of us did not know anything about 3D-printing. Therefore, we were able to learn about the different machines and their applications. This step was critical to unlock our access to 3D printers that were free of charge and prototype our design(s).

References

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.

Appendix

Appendix. 1: Pre-report

See attached file at the end of the appendix

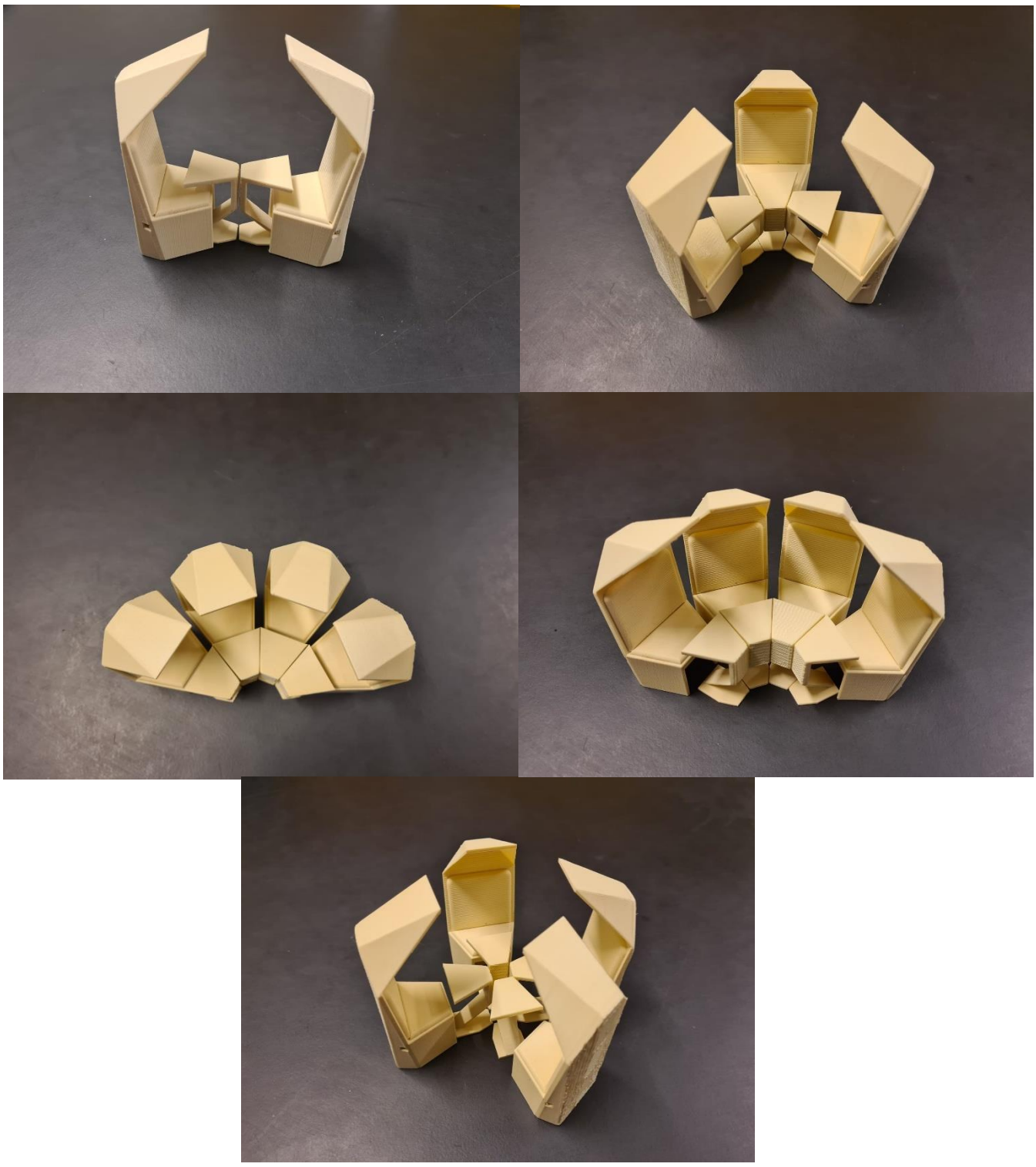
Appendix. 2: Link to our video presentation:

https://clipchamp.com/watch/WrKlJoGwIRC
or
https://youtu.be/QRNSDsFuJtA

Appendix. 3: Link to our product:

https://youtu.be/K-jXtQedP1g
or
https://clipchamp.com/watch/5mqeRhK4Ogq

Here are some photos of the product to complement the video:



Pre – project report

TPK5100 – Applied project management

Group 19

GRANDPIERRE Côme | KOSTERS Jurrian | KASSELS Sander QUIQUE Lohim | LORENTZ Thomas | WILLEMS Ilian

Table of contents

I – Type of product

The problem our group aims to address is the lack of study space during exams period at NTNU. Our project is to propose a viable solution which can be interesting and used within the NTNU or other universities. We want to create a design of a new product which is optimizing the space to study.

Figure 1 - Space optimization example

Our project will not focus on the final product and especially to actually build it. We need to focus on the investigations. Through these investigations with the different stakeholders (see part III)) we are going to study the usefulness of our product and if it is interesting for the potential clients and end-users. We will do research of what is already existing, then we will design our product and do a small scale prototype. During our designing phase we can focus on sound reducing materials. This way we can make a distinction between space for group work, individual work, video conferences etc. Our objective is that our product fits everyone's needs. We hope that our work will be used to build the real product and use it in NTNU for example.

II – Expected benefits of the product (the outcome)

We need to pay attention to the difference between the purpose, the output and the outcome which can be defined as the potential tangible and intangible gains of the project on the organization, end-users, and other stakeholders.

Two distinct scope can be identified: The outcome for the project group (us) and for the end users.

For the project group the main outcome will be the experience that we gained by doing this project. For some of us we choose this course without any experience in project management and all the different tools and aspects that we can use and explore to succeed. By doing an actual project we can use all the knowledge from the lecture and the book from Mr Bassam Hussein in a real case. It is interesting because we already know that we will not do it perfectly at the first try, and making mistakes is the best way of learning, we will gain experience and we will use it for our future project. So the outcome of the project will match the outcome of the whole applied project management course.

For the users we hope that our work will be used to build the real product and finally that the final product will be used by students and staff of NTNU and that they will appreciate it. Also we think that it will help students to find study places when a lot of them want to study at the same time so especially during exam period.

For the other stakeholders we hope that they will find our project attractive and maybe finance it for some stakeholders. One great outcome of our project will be the satisfaction of all the stakeholders and that it will match their expectations. Also we think that our design will be well optimized so the cost of the product and the amount of materials to build it will be as low as possible.

III – Stakeholders

Identifying stakeholders in the pre-project is essential in order to show that the full scope of the project is understood. The chosen project will take place within NTNU Gløshaugen. The reason we chose this project is to have reachable stakeholders with whom we will be able to collaborate. We believe that having tangible stakeholders allows the project to be more concrete and legitimate.

The following stakeholders have been identified:

- **NTNU students** - The whole aim of the project is to increase the number of studying booths, tables and rooms for students studying at NTNU Gløshaugen. They will be our end users.
- **NTNU university board**, the **head of the library**, **SIT cafeteria** and the **head of NTNU Gløshaugen's facilities –** The project will be carried out in their facilities. Their approval and input on the project will need to be met and listened to.
- **NTNU department of finance –** If the project was to materialize, the finance aspect of the project would need to be run by the finance department of the university.
- **Library staff –** Working in the library on a daily basis allows them to have in depth knowledge of students expectations and complaints. Their consultation will be a very valuable benefit to the project.
- **Department of design –** Involving the department of design and architecture could be interesting. Their knowledge of existing solutions and their creativity will benefit the project. Some of their students could partake in the project.
- **Project group 19 of TPK5100 –** Even though this might seem trivial, our project group will be key in this project. We will assume the role of the project team.
- **Teacher assistants of TPK5100 and Mr Bassam –** Even though this project will be carried out as a real project, the work carried out will be assessed and must meet certain imposed criteria. Likewise, deadlines and reports content are specified by this group of stakeholders.
- **Health and service department of NTNU –** Their approval will be mandatory if the project was to materialize. Likewise an **occupational therapist's** expertise will be necessary.
- **Make NTNU –** This NTNU society will take part during the prototyping phase of our project. Their 3D printers and expertise will be utilized during this phase of the project.
- **Other universities/institutions** having undergone similar changes or willing to do so. The transfer of knowledge and project experience will affect them.

- **Room booking NTNU and MazeMap –** The website will need to adapt to the change in configuration and will need to standardize their website.
- **Association of disabled students –** Their thoughts and advice might be valuable for the project. Adapting our project to meet the mandatory requirements to host disabled people is important.

Once the stakeholder inventory is done, an influence/interest matrix can be made. The mapping of stakeholders is a strategic tool to define what strategy to adopt the appropriate management and communication method for each of them.

Table 1- Influence/Interest matrix of the project

		Interest	
		Small	**Large**
Influence	**Critical**	Health and service department of NTNU NTNU department of finance NTNU university board	Head of NTNU Gløshaugen facilities Head of SIT facilities
	Marginal	Association of disabled students Room booking NTNU and MazeMap Other universities/institution Make NTNU Department of design	Library staff NTNU students Disabled students Teacher assistants of TPK5100 and Mr Bassam

As described above, 4 distinct categories can be identified. Key stakeholders (G1), must be involved in every step of the decision-making process. Close collaboration with this group is key to success. It is key to give them a sense of ownership of what is going on and in the steer of the project. In order to do so, at least one meeting will be held every week with the project group. The head of NTNU and SIT facilities will be updated through weekly emails and will be involved at the beginning of the project. Realistically it will be through interviews and maybe a meeting if their agenda allows it.

Stakeholders with critical influence and low interest (G2) must at all-time be satisfied. This category is critical to the success and failure of the project. Keeping them informed at all times throughout regular meetings and close collaboration is key. The requirements of each entity will be drafted at the start of the project in order to define the project guidelines. The frequency of board meetings will depend on the availability of the discussed entities. Engaging them will be important but their interest for the project is hard to predict. Nonetheless we will meet their requirements in order to get their approval.

Stakeholders with high expectations and low influence (G3), must be informed. This category is often neglected by project managers given their low influence on the project. We will engage the library staff early in our project to get their thoughts on the project and hear their advice. The same will be done for students, we plan on doing a survey within the first week of the project to get an insight of their needs and expectations. Bi-monthly reports will be made with the up to date information of the project. An e-mail address and a coordinator will be appointed to answer

questions and concerns. If the time allows it, a mid-project meeting might be organized with them to get them involved and gain their support.

Marginal stakeholders (G4), need to be monitored. In other words, staying in touch with them is important in case their status evolves during the project. As mentioned, an e-mail address and a coordinator will be established to keep a line of dialogue for this group.

IV - Project risk assessment plan

Here we are going to Indicate the main risks and how we are going to address these risks:

Suboptimal learning environment - The danger is that students sit too close together, which can disrupt concentration. It is up to us to take this into account.

Skills resource risk - Another risk that could raise the price of staff retraining or transfers is staff incompetence across different project divisions. We will have to follow a workshop for 3D printing to get the right skills and to get access to the 3D printing room.

External hazards risk - A new epidemic could mean that students will not be allowed to attend university and will have to study from home. In this case our product is not needed, because there will be no or very little attendance in the library. This is a risk we can not really do anything about.

Health and safety risk - Of course we have to check if our product requires the safety norms. If people have to take stairs those have to be stable for example.

Market risk - Market risk is likely to manifest itself when a project doesn't achieve the expected results. The advantage could be used by rivals to bankrupt the company and drive it out of business. We will have to see if our product is really needed and make sure that we manage all the risks and get the deadlines.

Budget risk - A good estimation of the budget is needed.

V - Skills

Here are the main skills that we need to acquire in order to produce our product and how we will acquire these skills:

Furniture design – Even though one of the group members is a product design student, the rest of the group will need to acquire knowledge on the subject. A literature review will be done to be acquainted with existing solutions for our product. The group will also impregnate the knowledge shared by the product design student.

3D printing – 3D modeling will be used for the prototyping phase. CAD designs and sizing will be done by the mechanical engineering students of the group. The 3D printing phase and topographical optimization will be done in collaboration with Make NTNU. Literature on 3D printing and the Make NTNU workshops should allow us to overcome this knowledge gap.

Team management – Even though we will work as a group, we believe that the project must have a coordinator to make sure work pages and deadlines are delivered on time and that the whole team is informed. Through TPK5100 and online modules of literature, the project coordinator can overcome this knowledge gap.

VI - Project breakdown structure

Using the work breakdown structure is key to identify the full scope of our project. The first step was to break down each major deliverable into sub deliverables. The second step breaks down every sub deliverable into work packages. Identifying every work package is key to spot crucial tasks and prevent problems. Likewise, the WBS will also allow us to assign responsibility and create a RACI matrix.

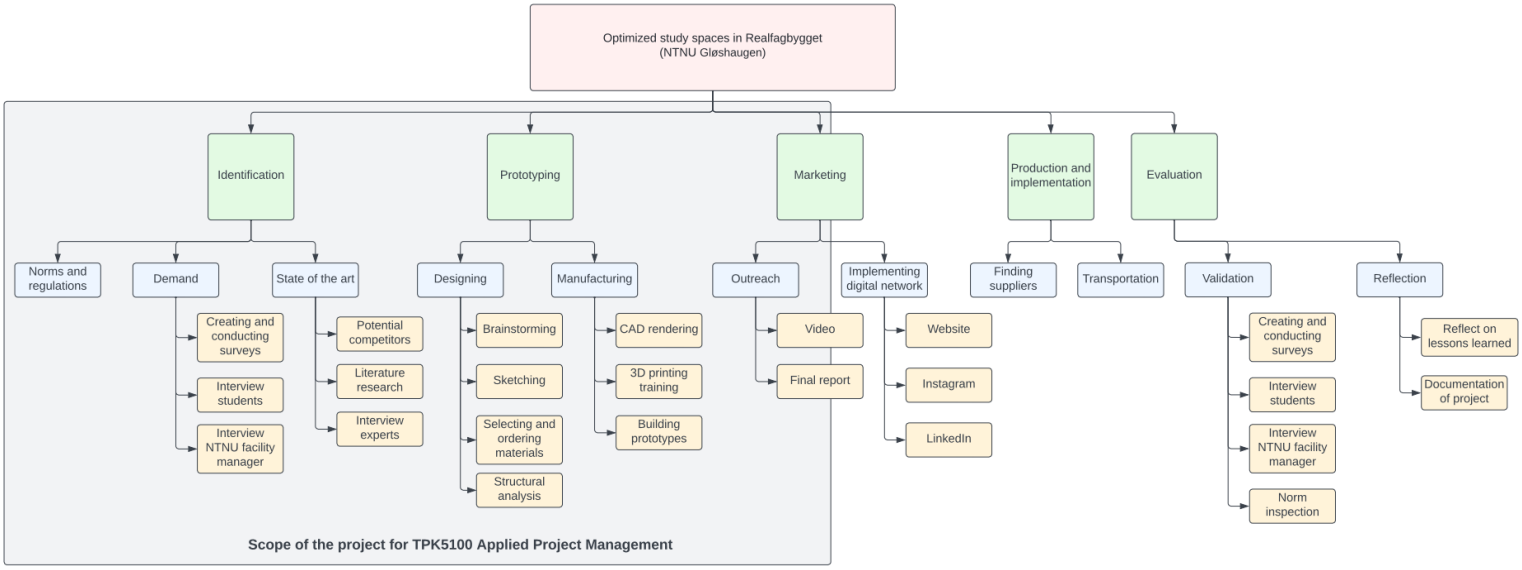


Table 2 - Work breakdown structure for the seat optimization project in Realfagbygget

Our project is the preparation phase of a potential large scale project. Therefore, our WBS will address both what we will undergo during the prototyping phase as well as the potential work package for its implementation.

VII - Project schedule

In order to get a good overview of our project, we attribute a time estimation to each of our work packages. With these results we then created GANTT to have a better understanding of the time constraints.

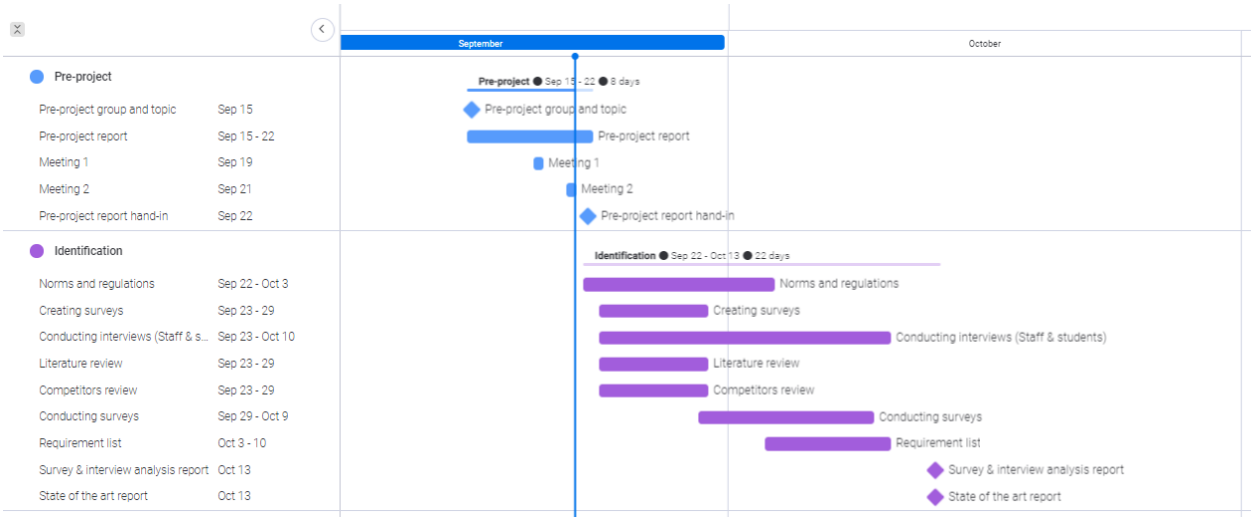


Figure 2 - Extract of the GANTT from september to october 2022 pre-project and identification phase.

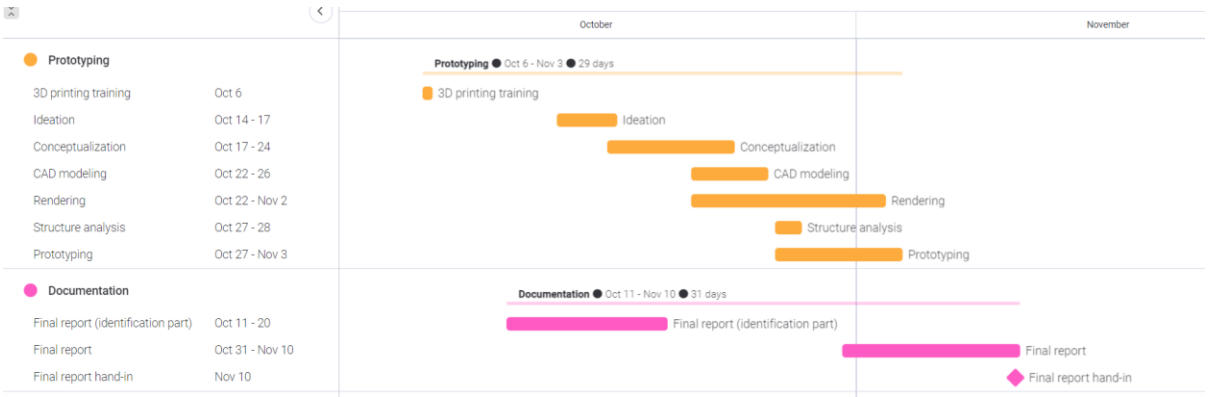


Figure 3 - Extract of the GANTT from october to november 2022 prototyping and documentation phase

VIII - Success factors

Here is a list of the different success factors inherent to our project and why we choose to pay attention to these particularly. Success factors are necessary to complete the success criteria but they are different concepts. As defined in the course by Bassam Hussein: A 'success factor' is a term used as a description of the ground rules that should be adhered to during project planning and execution.

Clarity of project purpose: If the purpose of the project is not well clarified and understandable by each member of the group it is impossible to succeed. Indeed if we are all going in the same direction with the same objective it is a huge success factor, maybe one of the most important.

Clarity of roles and responsibilities: In the continuity of the precedent factor, being well organized within the group is a success key. It will certainly be the most difficult part of the project. Dividing the work is important, and also to do it correctly, we have a huge time constraint for the project so this success factor will save us a lot of time so we don't do some parts of the work twice. Also, we are all equal in the group but to have a sort of hierarchy and certain rules so one member does not take all the decisions may be good.

Effective communication: To succeed we need good communication within the group. We are 6 members, it is enough to fail if we don't communicate. Indeed, we don't have a lot of time in the week to be all together and work, a massive part of the work will be archived separately. We need to be synchronized and to do that we need to talk. We will organize at least one meeting per week and maybe more, and we have other tools to communicate like google drive and whatsapp.

Then, we also need to communicate effectively to the other stakeholders. Because we need to constantly check if we are taking the good direction, one of the success criteria is that our product can be utile and used by the client, end-users and that the other stakeholders approve our final product if it meets their expectations. We need to apply the strategies that we discussed in III) to manage all types of stakeholders considering their influence and interest.

Flexibility: Flexibility is a quality that we need to develop to overcome the uncertainty of our project. A project is not always a peaceful road, we need to react when we are facing problems or unexpected happenings. This concerns for exemple our way to manage the group, the planning and our capacity to behave when something unexpected happens to modify our plans.

Structured risk management process/ Use of lessons learned from previous projects: We also need to use our experience, skills, knowledge and competence (project manager/ contractor, and project group) to overcome uncertainty. In fact, every lesson from the previous project can be useful to save energy and time so we don't repeat any mistake. That's here that being 6 is a strength because we can all use our experience to benefit the whole group.

Support from top management: We can be as involved as we can, work well and hard but if we don't have support it is almost impossible to succeed. That's where the way that we manage the stakeholders is a key, so they support us in opposition to sabotage our project.

Adequate project planning: This success factor is closely linked to the time constraint. Indeed, we need very good early planning to finish our project on time and successfully. The time constraint is set by some of the stakeholders, it may not be a success criteria for our group to do it on time but if we want to satisfy everybody we need to.

Client consultation: This is linked to some of the previous factors, but if we want to succeed we need to know the expectation of the client, which can be different from the expectation of the end-users if they are not the same stakeholder. And to do that we need to communicate well and to consult them during the entire project and not only at the end and the beginning even if it's the most interesting phase for the client.

People management: To meet all the previous requirements to succeed we need to manage every person to be sure that everything is going the right way. This is strongly linked to good communication and a clarity of the roles and responsibilities. Then we can learn from some of the management techniques or our previous projects or internships experiences to manage the group and the stakeholders.

Project follow-up and feedback: Finally, to know if we succeeded we need to have feedback, it can be from the stakeholders, from us or even from some external and neutral person. The project will not be finished at the time we hand-in the final report, it will continue to live beyond that, and

sometimes a project can be a success a long time after it is done. Also, a key factor is to learn from this project so we can succeed at the next one.

IX - Roles and responsibilities in the project

- **Chairman** *[Côme G]*
  Responsible for keeping up with the schedule and coordinating meetings. In charge of making sure everyone is up to date and understands their tasks/ role in the project.
- **Secretary** *[Ilian W]*
  Responsible for safeguarding deadlines of deliverables, takes notes during meetings, responsible for quality control.
- **Head of Design** *[Jurrian K]*
  In charge of coordinating the design phase from ideation to prototyping.
- **Head of Communication** *[Lohim Q]*
  Responsible for communication with stakeholders, mainly in the identification and evaluation phase. Responsible for meeting user requirements.
- **Head of Engineering** *[Thomas L]*
  Responsible for the resistance of the structure and the choice of the characteristics required for the materials used.
- **Head of Research** *[Sander K]*
  Coordinate and lead the identification phase. In charge of supervising the drafting of requirements for the prototyping phase.

X - Communication plans

During the project a clear communication is vital. Therefore we made this communication plan for how we should communicate with each other. This is for both online and offline communication. For the communication within and to other stakeholders of the project we use the english language and for all the documents we use academic english.

To communicate within the project group we use a Whatsapp group. The Whatsapp group is used to keep the others in the group informed on the progress that is made and on the deadlines that are in place. It can also be used for checking whether everyone will be at a meeting. Moreover, when one or more group members are absent we can update them on important information and decisions everyone should know about. Whatsapp is also used for canceling meetings with a good reason, for example having a lecture or other study related activities.

For the sharing of documents we have a shared GoogleDrive. Here everyone has access to all the documents of the project. The drive can also be used to work together on documents. On the drive we will share all project related documents so everyone has access to them at all times.

We also keep, all along the project duration, a clear and transparent communication with our stakeholders. Every Wednesday we have a scheduled meeting with the whole project group. This meeting will be summarized in a report written by the secretary that will be added on the shared Gantt chart. Copy of this report will imperatively be put on the shared GoogleDrive.

Each urgent matter will require an extra meeting planned by the chairman. The people who will attend the extra meetings will give an update to the rest of the group and if applicable the relevant stakeholders.

During each meeting the secretary will write an email composed of the updates for the stakeholders. Once approved by the group it'll be sent as a weekly update on the project. They'll also be able to follow the advancement through media communication and events.

When doing quantitative research we will use GoogleForms. This data collection tool will make sure every group member has access to the data. It also is very accessible for the participants that participate in the research. When doing interviews we will use Google docs.