PROGRESS REPORT

Team 2 - Chroma

Evi Nikoloudaki, Giorgio Serafini, Luka Jelić, Joachim Bron

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1. Team & background

Giorgio Serafini:

Nationality: *Italian*

Age: *23*

Studies: *BSc International Business Administration '21| MSc Finance & Investments '22*

University: *Rotterdam School of Management*

Moved from Italy to Rotterdam in 2018 to study International Business Administration at the Rotterdam School of Management. During my first year of my bachelor, I started working as a marketing and events manager for the software company Quyntess BV in Rotterdam, but at the same time, I started developing more interest in finance. After a minor in Mergers & Acquisitions, I decided that I wanted to focus more energy and time to learn about the sector. Therefore, after graduating, I decided to continue my studies with a Master of Science in Finance and Investments which I started in September 2021. At the same time, I was working as a research assistant for the department of finance at the Rotterdam School of Management with the task of testing a new integrated valuation model and presenting the results to the members of the Erasmus Platform for Sustainable Value Creation. Then I decided to apply for the Cern Ideasquare summer school since I have been always curious about deep tech innovations and working with people from different backgrounds and different academic education from mine to be exposed to different points of views and ways of working to broaden my managerial skills and knowledge at the same time.

Luka Jelić:

Nationality: *Croatian*

Age: *20*

Studies: *BSc Applied physics '23*

University: *TU Delft*

Both my parents are from former Yugoslavia, but I was born and raised in Rotterdam. I have always been very interested in physics and technology and that is why I chose to study Applied Physics at TU Delft. After my first year, I have decided to participate in the honours track of my faculty. It is here where I first heard of the CERN summer school. I have participated in this summer school as part of my honours track. I was very curious to see what kind of technologies were developed at CERN and how these technologies may be used for different applications. I thought it would also be very useful to learn more about the business side and how to bring new technologies to the market.

Joachim Bron:

Nationality: *Dutch/Belgian*

Age: *20*

Studies: *BSc Aerospace Engineering '23*

University: *TU Delft*

After finishing highschool at the United World College Costa Rica (UWCCR) boarding school in Costa Rica in 2020, I moved to Delft to pursue a BSc Aerospace Engineering as I've always been interested in STEM. Having played football all my life, as soon as I started university I also joined FC Tutor, a university futsal team, and I've been playing there for the past two years. At the start of my second year, I also joined the Delft Aerospace Rocket Engineering society to learn more about rocketry. Finally, at the end of my first year, I joined the honours programme to further challenge myself academically by taking extra courses and conducting research in supersonic aerodynamics. Having lived in many countries in my youth, I knew about the power of intercultural teamwork, which drew my attention even more to the interdisciplinary teamwork of the CERN Summer School. This coupled with an affinity for technologies and an interest to develop my soft-skills and entrepreneurial mindset led me to participate in the CERN Summer School.

Evi Nikoloudaki:

Nationality: *Greek*

Age: *23*

Studies: *MSc Physics and Astronomy*

University: *University of Amsterdam*

Born and raised in Greece, I studied Physics at the Aristotle University of Thessaloniki. In 2021 I moved to Amsterdam to continue my studies with a Master in Physics and Astronomy. I have specialized in experimental particle physics and thus visiting CERN was one of my dreams as a physicist. Studying in Amsterdam has introduced me to entrepreneurship and innovation, after following some relevant courses and I have since become interested. Therefore this summer course was the ideal opportunity that combines both elements.

See Appendix 1 for Team Members' characteristics and personality traits.

2. Innovation process & milestones

This section explains the steps of the innovation process and milestones that led the team to develop an idea, concept and finally a prototype starting from the assigned ATTRACT technology.

2.1 Define phase

The lectures in Delft and the work by the team during this period lead to a few milestones. We came up with a name, logo and team video, shaping the team's spirit. The technology was unpacked and a technology video was made. The context of the technology was explored by coming up with more than 100 possible domains of application. Finally, a few ideas for the scientific paper were discussed and generated.

2.1.1 Tools from lectures

The lectures provided the team with tools that were used throughout the whole summer school. When the team was formed we had to share our superpower and our dragon. With this tool to describe each other's strong and weak points, we were able to create better group rules. After the first bit of team building, we had to prepare ourselves to learn about and understand the technology that we would end up with. We got a lecture about patents in which we got to see the way these patents described certain technologies. Later when we were assigned our technology we had to come up with a "we know how to", to describe our technology. Similar to the description in patents, our "we know how to" had to be specific enough to differentiate what made our technology so special, but not so specific that it starts to limit the things you could do with the technology. Besides, it should also be understandable to a small child. With these tools, we were able to achieve a good understanding of what our technology could do, and we were able to explain it to others. To make a business out of technology, however, you also need to be able to solve a problem. To evaluate if there is a need for a product we learned that we had to ask ourselves and others: how big is the pain that this product would solve/relieve and how much would people be willing to pay for the pain relief? During these lectures, we also got our first chance to talk to people working at CERN IDEAsquare and learn more about them and what they do.

2.1.2 Technology Unpacking: HipMed by Pentaomix

The technology that was assigned to the team was the **HipMed** technology by **Pentaomix**. The HipMed technology is based on a novel optical modality, utilizing hyperspectral imaging and machine learning used for cancer cells. Using proprietary algorithms, the system can map multiple biomarkers on a single slide and accurately identify each cancer cell. Detailed cell classification is done not only based on morphology but additionally based on the unique colour expression profile of each cell. Machine learning algorithms applied to this deep characterization of the tumour will enable better diagnosis, and prognosis as well as predicting the medicine needed.

The technology allows its users to acquire the spectrum at each pixel in the range between 400nm and 800nm during the scanning of the slide. Therefore the spectral information, which cannot be observed with the eye, is available to the user. The technology is then integrated with an AI algorithm that allows the complex data extracted to be practically used. Pentaomix uses an AI algorithm specific for the recognition of cancer cells.

During this preliminary Technology Unbundling phase, the team did some research about our technology and how it worked. We wrote down everything we thought might be interesting to know as well as our insights on the tech. Some of our thoughts were: “use the technology for crop and seed quality investigation”, or “use in combination with other technologies to create a more complete system". We then proceeded to write down our technology’s “We know how to” statements. These statements were used to explain what we can do with our technology in the most simple terms possible as if it were explained to our 10-year-old nephew. We also brainstormed about why our technology has potential and wrote down any remarks and insights we had as shown below.

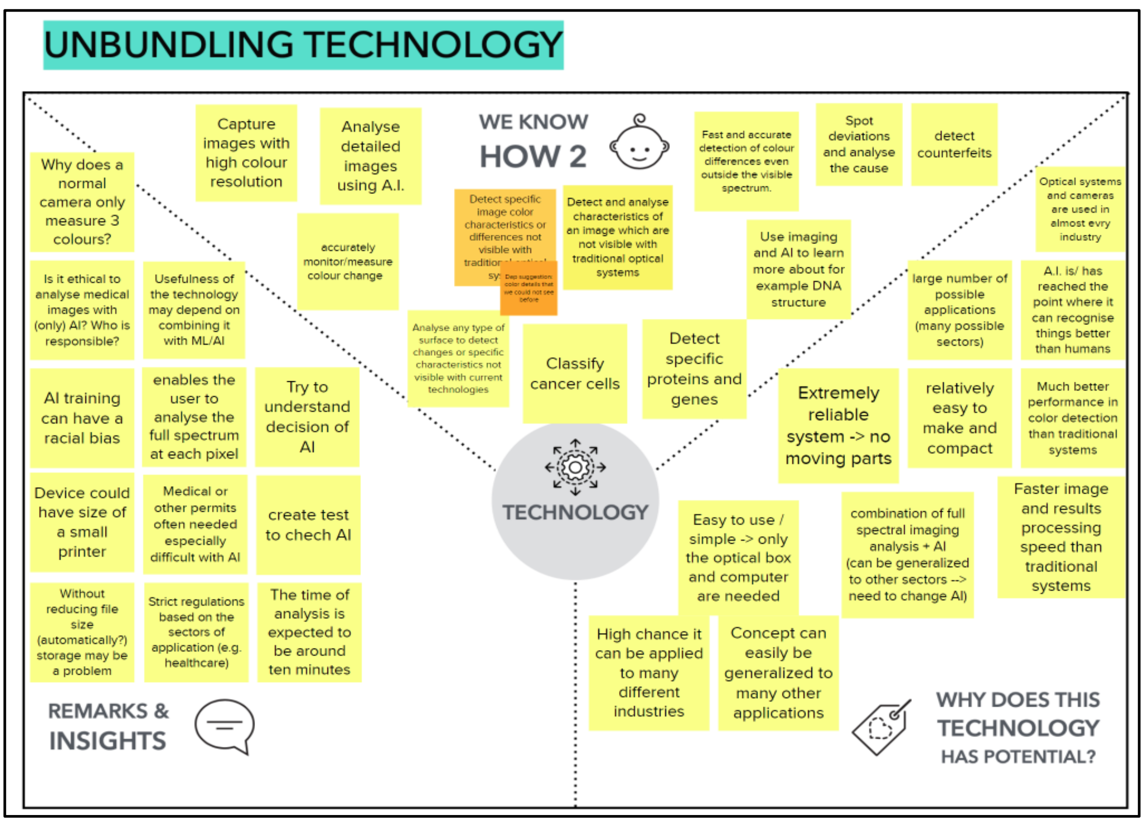


Figure 1: Unbundling Technology Mural Board

Then, we had a virtual meeting with Yuval Garini, the ATTRACT program technology contact person and co-founder of Pentaomix & HipMed technology. He gave us a small presentation about his technology and we had a small Q&A in which we asked him questions about possible applications and further tried to understand the technology. This discussion was particularly useful in putting aside some myths we had about the technology and clearing some doubts about its workings and capabilities, but also to get more involved in the project by connecting with the co-founder.

2.1.3 Context of technology: domains and sectors

On top of the technology unbundling, the team made a list of 100 different domains/sectors and subdomains that would be interesting for applications of our technology. This was the divergent stage of finding domains. We tried to come up with as many domains and sectors as broadly as possible

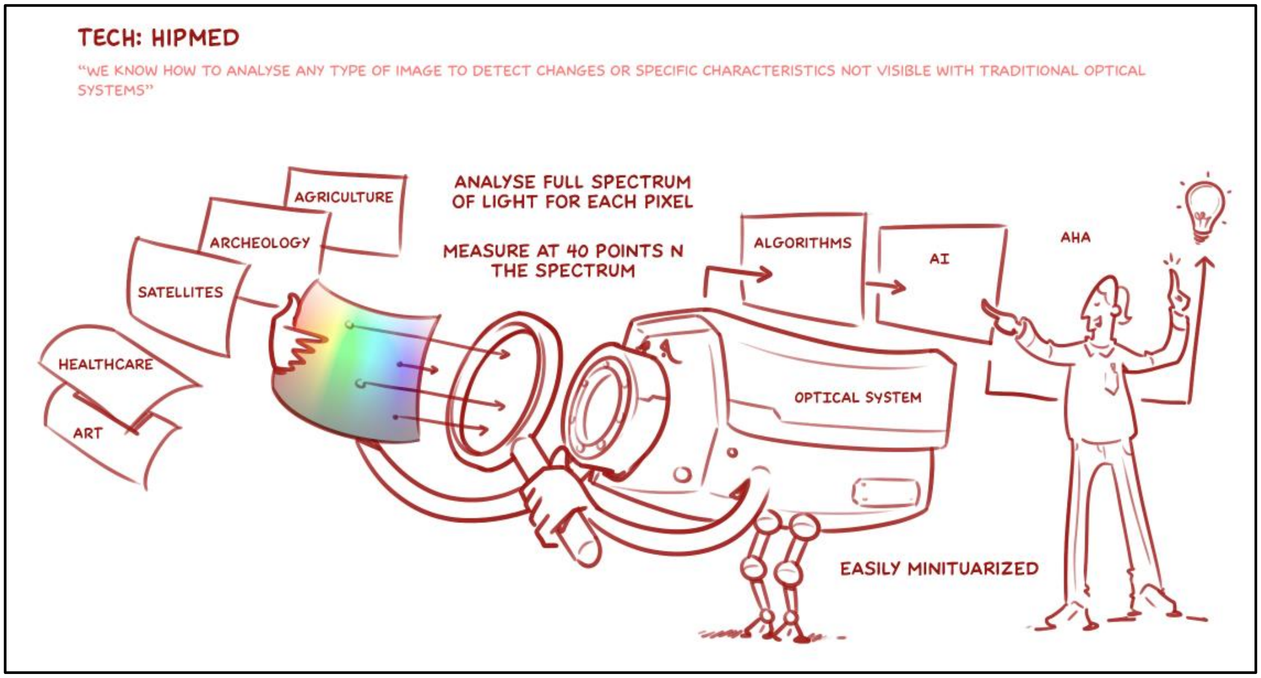
y. To highlight the broadness of the sectors, notice how "Agriculture", "Space" and "Fashion" are all included and almost unrelated. The 100 domains that we found are shown in Figure 2. A legend of the colours and their meaning is given at the top of the figure.

2.2 Design phase: Design Sprint 1 (Week in Delft)

The week in Delft resulted in multiple innovation process milestones in preparation for the Geneva Design Sprint. The team gained a real understanding of the technology by a continuation of the technology unbundling. A convergence was made from the divergent stage of the domain finding process, yielding 10 interesting domains that would be kept during the next stages of the ideation process. Finally, the team came up with ideas for the scientific paper.

2.2.1 Unbundling Technology

During the technology unbundling, we were presented with the infographic (Figure 3) of our technology after having chosen our final "We know how to", which was: "We know how to detect specific image colour characteristics or differences not visible with traditional optical systems".



Then, we used all the knowledge gained about our technology up to this point to create a "technology tree", in which we divided our technology into the technological sub-components needed for it to properly function. Some of these elements were for example "microscope", "HipMed", and "AI & algorithms". To each sub-component, we then assigned first estimates of the strategic impact, such as "Pacing" or "Emerging", as well as the level of technology maturity, such as "Embryonic" or "Mature". We then proceeded to classify each of our technology's components based on their competitive position, i.e. whether in each technology sub-component we were leaning more to the "clear-leader"/"strong" side or to the "tenable"/"weak side". We discussed some of the implications and noticed that to have some feasibility, the technologies need to have a strong competitive position and emerging strategic impact (which our

HipMed tech had), or have technologies which are base/key in strategic impact but where our competitive position is favourable/tenable (which the other technology's subcomponents were).

Finally, we also had the chance to discuss our technology with various experts. Based on feedback we decided to improve our "We know how to" to the following final form: "*We know how to detect image characteristics not visible with traditional optical systems*". We also asked about their personal opinions on which fields/domains seemed most promising for our technology application to have an impact in. An expert gave us a lot of information about the food industry and possible applications we were not yet aware of. This interaction with experts outside the team was very useful in getting fresh perspectives we had not yet thought of.

2.2.2 Opportunity fields convergence

After the divergence phase of looking for domains, the team proceeded with the convergence phase to narrow down and refine the ideas. From the more than 100 domains previously found, through discussion the team collectively chose 30 domains to continue with. Then, from these 30 domains, each member of the team chose 3 different domains which seemed most promising, resulting in convergence to 12 domains.

This convergence phase was then followed by another divergence phase. Each of the 12 domains selected was expanded by the team by brainstorming and adding images, using free association, finding several problems that each domain faces, and contacting people related to the domains. All of the above leads us to find solutions to the respective domains' problems using our technology. Interestingly, free association of words was a tool that turned out to be very helpful in the ideation process when we sometimes felt blocked. The ideas we came up with are shown below and the solutions we found ranged from determining overfishing in the oceans to locating microplastics in food.

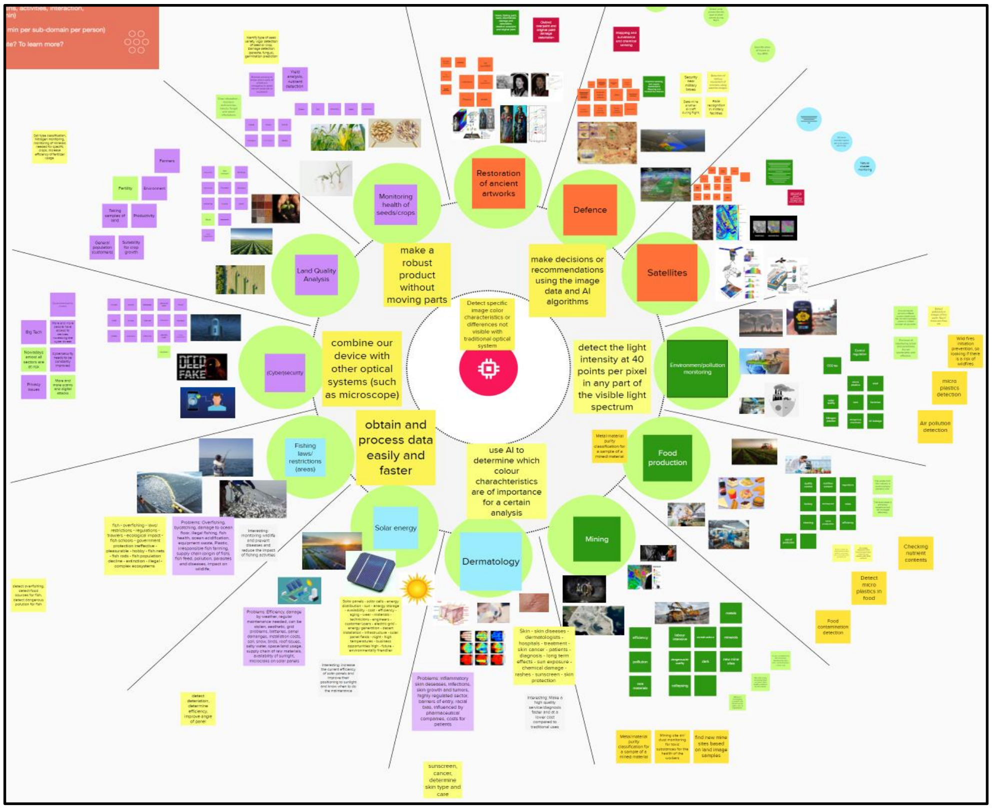
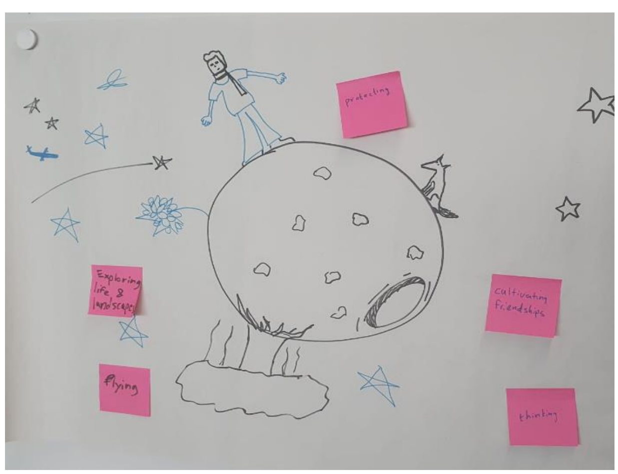


Figure 4: Opportunity Field Covergence Wheel

After a lecture by Marc Tassoul on creative thinking, we used another instance of the converging-diverging method to find new applications that could emerge. This was done by taking inspiration from the book 'The little prince', something completely unrelated to our technology. We drew a sketch that came to our mind from the book and from that we used free association and lateral thinking by coming up with a few dynamic words that described the drawing.



During the break, something peculiar happened. By observing the surroundings outside the building and thinking about the story, we ended up with applications that we hadn't thought of before. Some of them were the use of the technology as a night camera, which was derived from the shadow of the trees, as well as using the tech for temperature measurements and correct sunscreen application, due to the heat of that day. The interesting takeaways here were that changing one's environment and unconscious thinking were helpful tools we didn't know about until we experienced them for coming up with new applications. A discussion with Marc then led to some interesting new applications: tectonic plates moving and analyzing the redness of the skin to see if it is browning or burning.

On the final day of the first design sprint, we started by interacting with members of the other teams. By forming groups of 3-4 people, we presented our technology and the others helped us with brainstorming and tried to give new ideas and feedback. Getting different points of view and getting feedback from people with different backgrounds who hadn't studied the technology that deeply, lead us to eliminate some of the applications which were not feasible or already existed, as well as come up with completely new ideas.

The day continued in Rotterdam where we organized three brainstorming sessions and initiated another divergence phase. During each session, one team member would take the lead and be responsible for the planning and the method. The first session started with random word association. After many rounds, one of the domains we ended up with was the domain of water. From that, we found sub-sectors such as corals, sewage and drinking water, and new applications such as monitoring coral growth or sewage bacteria profiling.

The second session was mainly focused on the 'we know how to'. We thought of problems that we face where a very good colour resolution is needed or cases where very small color differences need to be determined. This leads us to come up with different problems in which light is either very dark or very bright such as in deserts, where stuff is far away like in telescopes, or where there are slow changes like ice cap melting.

In the last session, we applied the 'provocative way of thinking' method. We wrote down sectors and ideas that probably didn't have anything to do with the technology (e.g. galaxies and psychology) and that helped us to find some interesting new applications. Many of these were, unfortunately, and as expected, not that feasible in the end but some were compelling: checking for leaks in packaging or signature forgery detection.

To conclude, we noticed that looking at a problem using different methods helps in coming up with new ideas, especially when it looks like all ideas have already been found.

2.2.3 Scientific paper ideas

Ideas for the paper's research question were brainstormed. This was complemented by how we intend to do the research and what steps we would take to conduct it. At first, we thought of investigating how the background of each individual affects the innovation process and assumed that it could be addressed using surveys. This is because we thought the background of a person significantly influences the way of thinking and might thus also influence the thought process when involved in innovation. However, this initial idea was modified during our week at CERN after discussions we had, which will be elaborated on in a later section. The set-up remained the same and consisted of a literature review, determining the methodology, collecting the data through surveys, analyzing the data and gathering conclusions based on this analysis.

2.3 Week in Geneva

This section explains and shows the team advancements and milestones further developing the concept of the assigned application during the week in Geneva at CERN IDEAsquare.

The first day in Geneva, on Sunday July 24th, started with a tour at Ideasquare. Subsequently we continued working on the technology and from the twelve sectors that we chose, we had to generate more ideas for applications. For everyone to contribute to each sector we started by writing down four sectors on four pieces of paper and moving them circularly so that everyone adds something new and everyone was always involved:

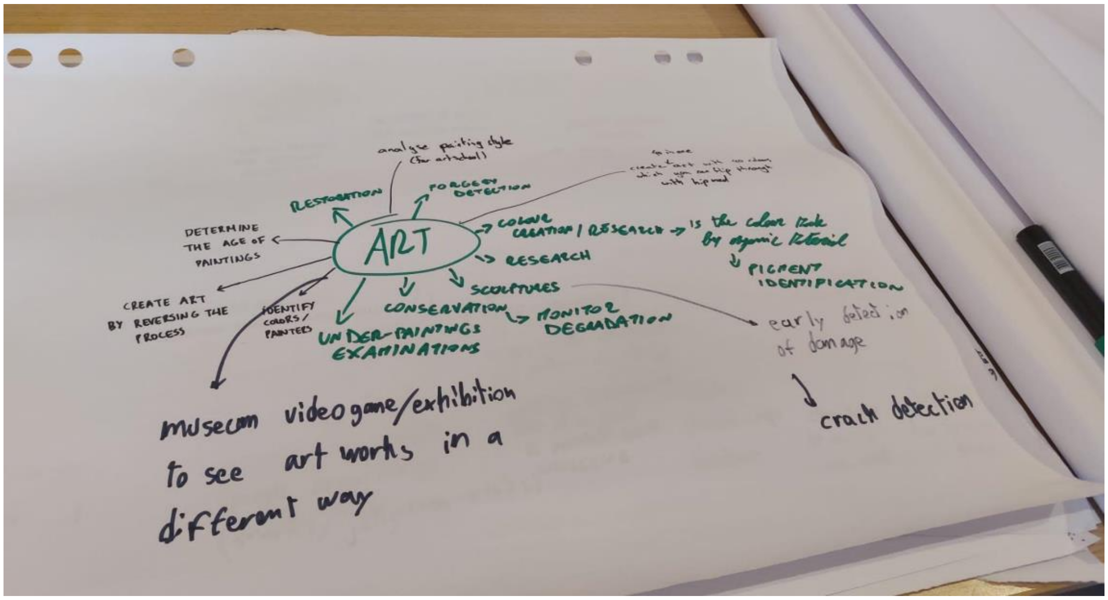


Figure 6: Example of new ideas for a potential sector

On Monday we had to evaluate the 12 domains regarding their feasibility, market potential and the positive impact created by solving a problem. This helped us to eliminate at least half of them at first. Then we had to choose only two sectors and an application for each. We also determined the tasks-pains-gains, as well as the pain relievers, gain creators and solutions. We also thought about the ripple effects of a specific application of our technology and if certain applications could help solve some of the United Nations' SDGs.

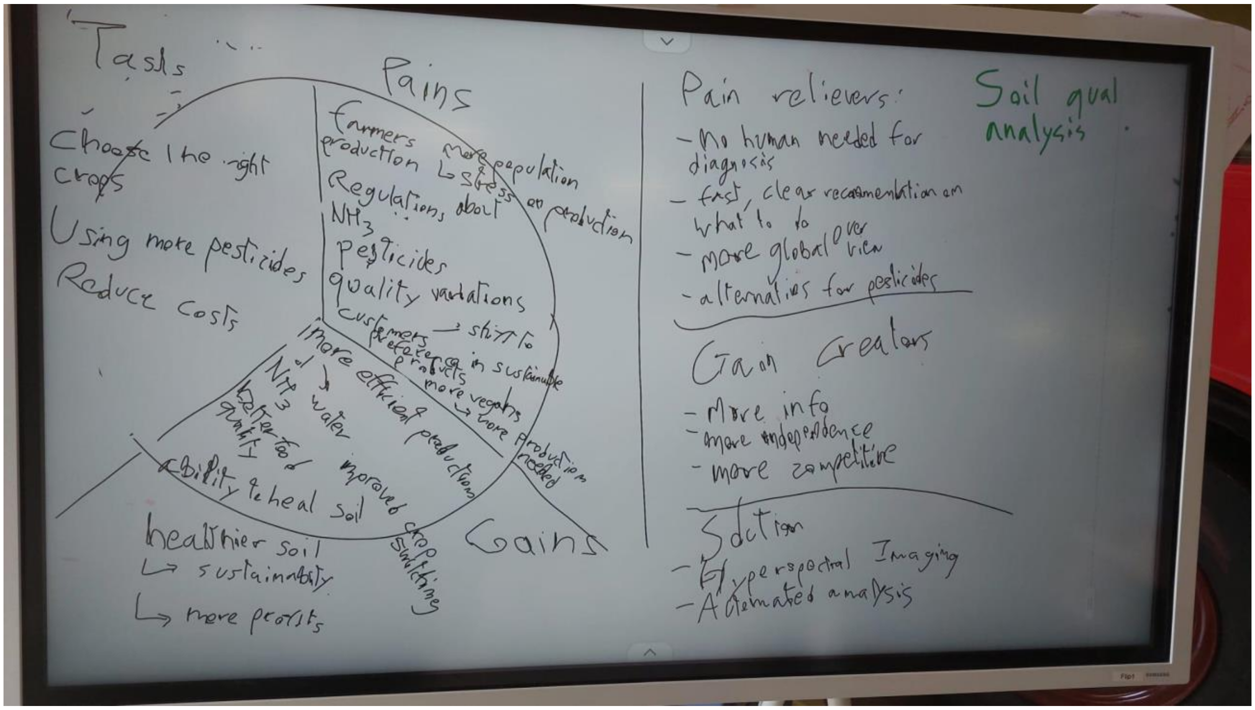
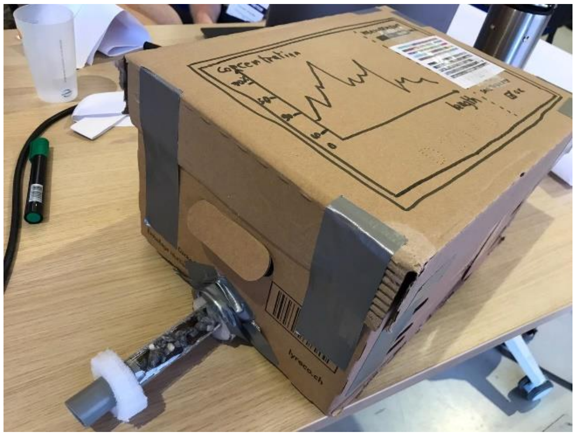


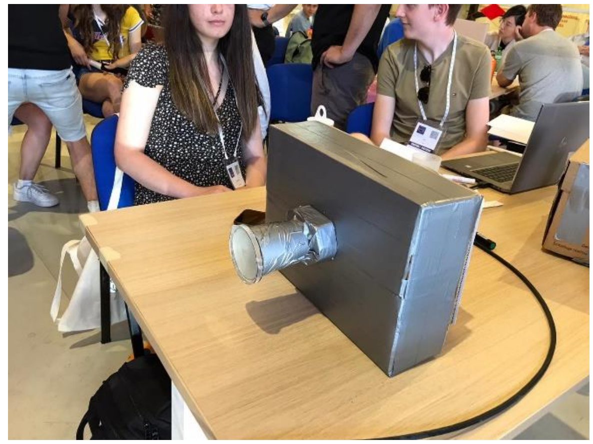
Figure 7: Task - Pain - Gain Framework

Two members of the team elaborated more on the application, made a sketch and presented the concept to the illustrator to make a new visualization of our concept.

On Tuesday, after the visit to the CMS and the antimatter factory, we attended Romy's lecture about the Nuclear Energy sector and also solved some cases in groups about unsolved problems in the industry. After the lecture, we formed teams and tried to give solutions to various problems, such as the safe and efficient transportation of radio medicine. We applied methodologies that we have previously learned and the participation of people from Ideasquare in the teams gave us new insights into their way of thinking.

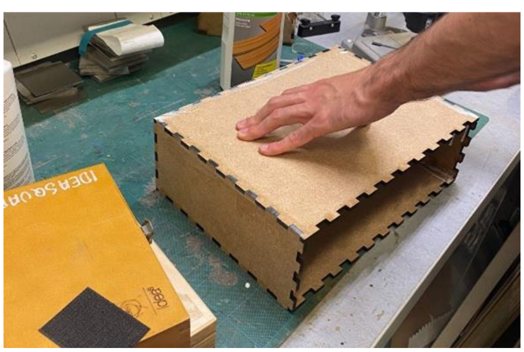
Wednesday started with the 'Lean Canvas Session', understanding the lean model canvas and trying to apply it. After that, we attended the lectures of Pablo and Hans about exponential thinking, prototyping and value proposition design. We managed to build two very simple prototypes in a short amount of time with what was available in Ideasquare.





At the end of the day, we talked to Pablo about our two applications. His feedback was very crucial because he immediately rejected the soil application since it wasn't feasible at all. So we proceeded with the art domain.

On Thursday, we started with designing an improved prototype and planning for the day. We managed to build the prototype by only using the available components at CERNIdeasquare. The box was made of wooden pieces using the laser cutter and the lens was made out of cardboard tube and glass. We added a handle for transportation, and made a small electric circuit with LEDs that was the light of the camera. As a user interface, we used a tablet where we developed the basic functionality of the technology to show to people. The camera was attached to a tripod with a 3D printed piece which we built that day.



To validate and test the prototype, Giorgio had a 45-minute call with Marco Luzi, an art collector, professor, and expert with experience monitoring the health of ancient art pieces. The team used insights from this call mainly to conduct primary market research and secondly to validate the concept that we developed around our assigned technology to monitor art. Joachim called nearby art museums to ask them if they were open to testing the prototype. Giorgio and Joachim went in-person to the three main museums in Geneva but the restoration experts were not available on such short notice to test the prototype.

During the last day of the week in Geneva, July 29th, we recorded the technology/prototype video, completed the poster and presentation slides and prepared for the pitch.

The team always strived to work efficiently and effectively focusing also on the quality of the deliverable. This "team culture" that we developed during this programme resulted in being recognized as the team with the best pitch and with the best prototype amongst all the teams participating at the CERNIdeasquare Summer School.

3. Developed Concept

This section explains the problem that the team identified and the potential solution that the application of the assigned technology can offer as well as an assessment of the positive impact

3.1 Defined Problem

For most museums or art collections, art restoration has high costs and takes a lot of time. For restoration, paintings need to be shipped to special laboratories and the whole process could put a painting out of display/use for an extended period and be expensive ($10-15k for large paintings). Damages and restoration also lead to a decrease in the painting's value. Furthermore, restored art pieces do not possess the same materials as the original piece, in some cases leading to faster deterioration than before. Frequent monitoring of paintings is thus of utmost importance to avoid all these costs and problems related to restoration by detecting deterioration before it is too late and thus preventing irreversible damage.

Currently, detecting deterioration and monitoring the health of artworks is done through several techniques, but these all have their problems. For the case of paintings, looking at them with the naked eye using the visible light spectrum is useful in picking up global damage but cannot pick up small details. To pick up more details, experts resort to other techniques such as Ultraviolet Fluorescence (UVF), which uses ultraviolet light to detect previous restoration and varnishes. However, the UV light used can damage the painting's often used organic components and lead to photochemical destruction. Many techniques using infrared (IR) light also exist, such as IR reflectography, IR fluorescence or IR transmitted, but these can also be harmful to the paintings as IR light is a form of radiant destruction and has been observed to damage paintings. X-rays are also used, such as in X-ray radiology to detect heavy metals in paintings and X-ray fluorescence to detect chemical compositions. However, X-ray techniques take a lot of time and need to be done in a special laboratory, which is often a hassle for the paintings' owners. Another problem is that the effects of exposure to these different lighting conditions are not always known. For example, some paintings by Van Gogh have been irreversibly damaged due to LED lights which contained too much green and blue light.

Similar problems also exist for contemporary art, where new techniques and materials are used. This type of art is relatively new and little is known regarding the pace of deterioration and specific environmental characteristics needed for proper conservation (e.g. Temperature and Humidity) and the effects of exposures to the different light wavelengths.

Finally, sending paintings to labs is expensive and risky (could be damaged during transport) and art collectors and museums are sometimes against moving their art pieces frequently. In addition, for museums and valuable paintings, there could be different rules and regulations that prevent frequent lab monitoring.

3.2 Solution Described

HIFAM uses the HipMed technology providing a very high colour resolution that could detect the smallest changes in the painting. The technology is based on the analysis of the full-colour spectrum, from 400nm to 800 nm, for each pixel. The hyperspectral camera can take 40 points in the spectrum instead of only three (red, green and blue) that most of the current optical devices use, making the spectral information and the detection of characteristics not visible to the human eye available. By analyzing the full-colour spectrum, we make art monitoring an easy and not invasive process so that the most frequent deterioration problems can be prevented (e.g. cracking, flaking). Our technology can be used everywhere so that the art piece does not need to be moved and does not use invasive techniques like X-rays.

The use of HIFAM is easy and simple compared to the other existing methods of art monitoring. Firstly the art museum or the private art collector calls HIFAM to monitor their paintings. The camera is transported to the painting, so the paintings do not move and are always on display. The monitoring takes place in the same lighting conditions and at the same distance from the painting. This can be achieved by shielding the painting from all light sources other than the light attached to the camera. This light source is the same for all the measurements. The placement of the camera with respect to the painting is guided by non-invasive lasers, which allows for consistent placement. Also, calibration is being performed.

Pictures of the painting could be taken as frequently as the owners wish and are being stored on the Cloud to manage data storage. The evolution of the painting can be tracked and by comparing the images using machine learning algorithms, the smallest differences can be detected.

3.3 Impact

HIFAM makes it possible to detect deterioration on time. This way we can avoid expensive restorations and understand better whether the environment where the art is stored is appropriate. This will lead to smaller and less frequent risky restorations. This way the art pieces will be preserved longer and unnecessary damages, due to risky art monitoring methods, can be prevented. With our technology, the paintings won't have to be removed for testing.

This gives museums more control over how and when they want to exhibit their paintings. This control in turn will lead to fewer disappointed visitors since they will be less likely to miss out on their favourite painting due to it being tested for deterioration in a lab. It is easy to imagine how this increased control will lead to better experiences, which improves the museum's reputation. Above all, our technology will help museums and collectors to monitor art more frequently which will help to fulfil their duty to preserve cultural heritage and maintain the financial value of art pieces at the same time.

The art market is very big. In 2021 all sales of art and antiques by dealers and auction houses are estimated to have reached a total value of $65.1 billion [1]. With so much money being involved it is no wonder that people want their paintings to be in top condition. Art consultation/assessment by MD Art Conservation (small American business) is for free but The Conservation Center (the largest private art conservation laboratory in the USA) charges $100 [2]. These assessments are done by the naked eye. It is also possible to use additional assessment services like x-ray which can cost between $400 to $1,000 [2]. These are only the costs of assessing the state of the painting. According to Peter Himmelstein, a conservator that works for small institutions and individuals, the restoration of small paintings with average damage costs $800 to $1,000, while the restoration of larger paintings with damages can cost $10,000 to $15,000 [3]. It is therefore no surprise that art collectors and museums try to prevent damage and deterioration at all costs. Some museums for example changed their light source to LED to prevent the darkening of the unstable yellow paint used in Van Gogh paintings (among others) [4]. However, some of the LEDs used only accelerated the deterioration and caused the yellow paint to become green [4]. This case shows the importance of art monitoring. If the painting would have been monitored better, this accelerated deterioration process could have been stopped earlier.

Estimations:

- 5% of sales goes into restoration
- Price of HIFAM is approximately 2x the price of a typical SLR (regular) camera used for restoration ($1000[3])

- 40% less restoration costs when better monitored (because you can change conditions+restore on time)
- We can capture %1 of the market
- 0.05x65.1x10^9x0.4x0.01=$15 million saved annually

4. Individual reflections

This section introduces the individual reflection and thoughts of the team members and will conclude with a team reflection on this course and the experiences made.

Giorgio Serafini:

A first reflection focuses on **People and Team.** I was curious to work in a team of people from different studies to understand their way of working and improve my managerial skills. After the initial period of lectures, we started to be more confident with each other and therefore it started to be easier to share ideas and thoughts with the team members. At the same time since the personality traits of each team member are different, I always wanted to know what the opinion of each team member was when deciding something. After the week in Geneva, I am happy to say that it was a pleasure working with my teammates since I learned a lot from them.

Secondly, reflecting on the **Innovation Process,** I would say the course was well-structured to learn and put into practice all the steps of the process from idea to prototype. One thing I would say is that even if it was well structured it was not well-balanced since we spent a lot of time brainstorming ideas and searching for potential applications in different sectors, but then we had little time to reach out to experts to receive feedback on our concepts. I would have preferred a larger allocation of time to receive feedback from experts and take some ideas from them. I believe that receiving feedback early in the process from an expert will make everything more efficient since he/she will be able to “kill” some ideas and the team then could have focused only on further working on the best ideas or potential applications.

In terms of **Tools/Methodology** used, being already an International Business Administration graduate, I did not find the lectures to add a lot of value while, on the other hand, I found the team’s activities very useful. Furthermore, I found prototyping very useful since at the beginning I had the idea that building a prototype meant building a “working product”. On the other hand, I learned that there are different types/stages of prototyping and each of them has a precise goal. Therefore in the first stage, building a working product is not even needed.

Overall, I believe that working in a team of people without a “business background” was a great experience which will be useful in my future career since I believe it is very representative of a real company or multinational, where managers need to relate to people with diverse academic and social backgrounds.

Luka Jelić:

A first reflection focuses on **People and Team.** This is only the second time since I started my bachelor's degree that I have worked in an interdisciplinary team. I remember that the other time I had some trouble explaining abstract things to business students. I expected to encounter the same difficulties this time, but to my surprise, I did not. Due to the focus of the program mainly being on coming up with applications for the technology and less on the feasibility (at least at first), I think that everyone's knowledge and expertise were very useful and we could communicate our ideas. We never had any real problems with understanding each other or explaining things. It was sometimes a bit difficult to decide on something, because of different opinions within the group. We were however always able to decide without any real conflict. I think that I have learned a lot from my teammates and about communicating within a diverse team.

Secondly, reflecting on the **Innovation Process,** it went pretty well in the stages of coming up with ideas. We came up with many sectors and applications in various ways. At a certain point, however, we had trouble coming up with new ideas. Then when it was time to converge to fewer ideas, we didn't know much about the feasibility or market of our applications and we had very little time to decide on which applications we wanted to focus on.

In terms of **Tools/Methodology** used, a lot of the tools and methods were new to me. Some I deem to be less useful, like making a dinosaur on the ground and walking in circles. While other methods and tools were in my opinion very useful, like using a story to come up with ideas or free association. I have also learned a lot of useful tools to assess if an application of a certain technology can be made into a business. For example, asking myself (and people in the field!) how big the pain is that I believe I can relieve and how much people would want to pay for it. Or writing down the value proposition. Or check if the technology would help solve any SDG.

Overall, I believe that this experience was very useful to me. I have learned much about working in a diverse team and I have also learned very useful tools and methods in case I ever want to start a company.

Joachim Bron:

First, reflecting on the **People and Team,** this was the first time working in a fully interdisciplinary team, i.e. not only with other engineering students. I found the teamwork went very smoothly all along the summer school, despite the differences in backgrounds and ways of approaching tasks. It was interesting to see how everyone could bring knowledge, ways of doing and thinking manners from their fields and incorporate that into the teamwork to ultimately benefit the team, just like pieces of a puzzle. I also noticed the importance of clear communication such as always deciding together as a team and keeping everyone involved. I also learned to sometimes just discard my own ideas when my teammates believed another idea was better, and so to learn to trust them.

Regarding the **Innovation Process,** I learned a lot about looking at problems from other points of view such as from that of the end user. I learned to always keep a global overview of what we are solving, without sometimes worrying too much about the "engineering" part and the workings of the product. I also learned that it is important to keep the financial and business side of things in mind such as the market size and where we would be located on the value chain, as this ultimately translates into feasibility. I liked the divergent-convergent approach, which is something I had never heard of but enabled us to come up with great ideas and make tough decisions toward realistic applications. One minus point is that we had too much time brainstorming and not enough time to reach out to experts in my opinion, which turns out to be one of the most important steps in the process. One of my favourite memories now is when Pablo completely broke down one of our ideas due to its feasibility, as this showed me that one always has to keep feasibility and the user in mind; this was ultimately positive as it helped us build from the ground back up and select our final idea.

Tools/Methodology: Many tools were new to me and reflecting on them, I found them extremely useful. Free association helped us brainstorm from another point of view while coming up with as many ideas in a certain amount of time helped us broaden the possible domains as much as possible. I also enjoyed the prototyping phase, as this helped get a better view of the final product and go from an idea to a touchable/displayable concept and taught me that it isn't needed to have a fully working product in the early stages of innovation.

Overall, the whole experience was wonderful. I learned about working with people from other disciplines, all while bringing my own little piece to the grand puzzle. Most importantly, I learned that innovation is messy, exciting and requires breaking ideas and building them back up, and that one always has to keep the business and user aspect in mind as well as keep a global overview of the problem being solved.

Evi Nikoloudaki:

A first reflection focuses on **People and Team**. This was my first time working in a small and interdisciplinary team. To my surprise, even though we came from different backgrounds we could communicate well without having any conflicts. Everyone brought their own ideas that the others couldn't think of and that led to a diverse and broad range of thinking. One person's weaknesses could be another person's strengths and by helping each other we could achieve the best outcome. Also spending more time with the team significantly helps with bonding and this results in being more open about the ideas, and better communication and makes the whole process much easier.

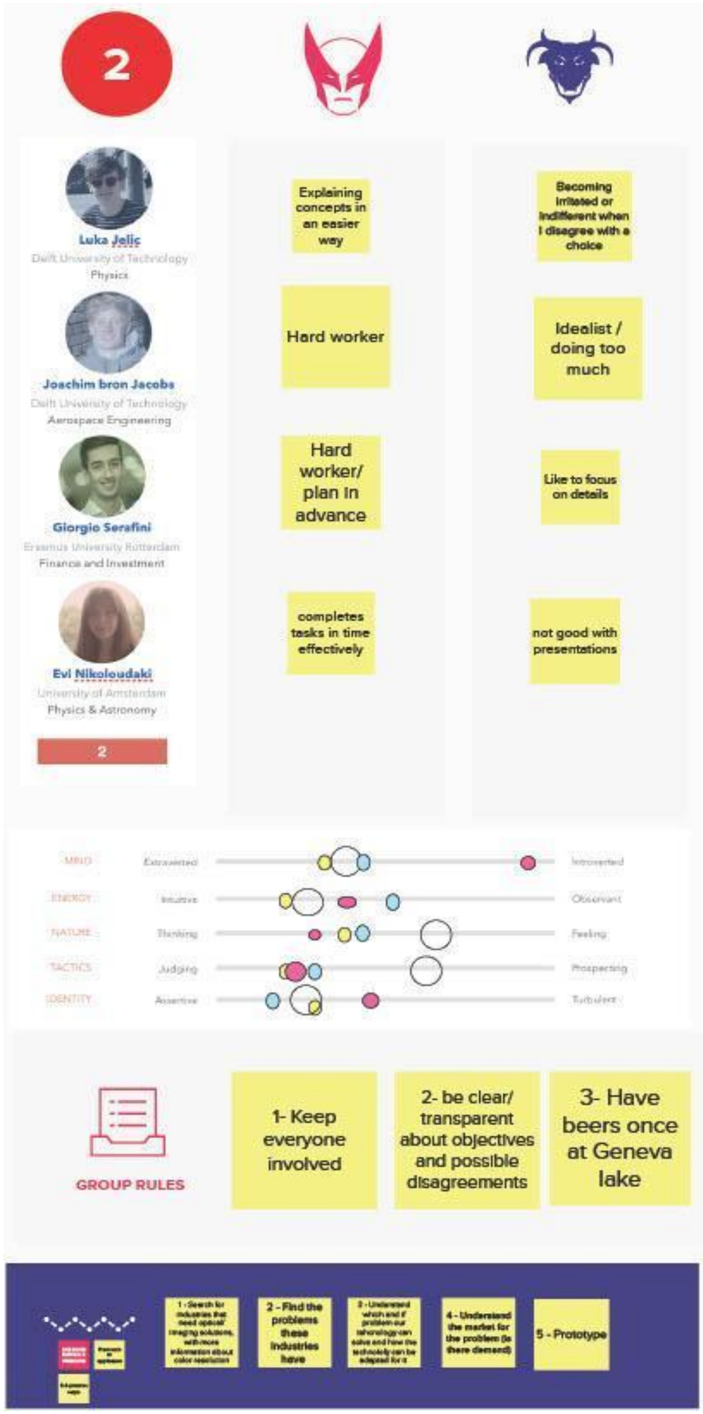
Secondly, reflecting on the **Innovation Process**, I learned that at first, we have to be open-minded and not restrict ourselves to technical limitations. Feasibility is also important but it comes at a later stage. Feedback is what I found to be the most important since either positive or negative, as I've experienced, it could change what we thought to be promising for example. In my opinion, researching is very crucial. We didn't have that much time for that in the beginning and as a result, at the final selected domains, we found out that our ideas for applications already existed.

In terms of **Tools/Methodology** used, before taking the summer course I didn't know they existed for idea generation, except from brainstorming and I have struggled with coming up with new ideas in previous courses. They definitely helped and made the process much easier and I will use them in the future. It was also very useful that after the lectures we got to apply these methodologies.

Overall, it was a unique experience that taught us so many new things. It was really nice working in a diverse group of people and talking with experts and I hope someday that I could apply everything I've learned.

Appendix

Appendix 1: Team Members’ characteristics and personality traits



Appendix 2: Picture of the Technology’s Final Poster presented during the final Pitch event.

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