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***ORIGINAL ARTICLE***

# The push and pull between innovation and feasibility: reflections on an ideation process during a CERN IdeaSquare Summer School

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***ABSTRACT***
This paper was written as part of a summer school project in collaboration with CERN IdeaSquare, TU Delft, and the Rotterdam School of Management. Using the example of the PEBBLES technology, the following elaborates on the exploration and integration of technological boundaries to the creative thinking process. Diving into the foundations of different views on creativity allows us to better comprehend the ideation process which occurred throughout the summer school project. Feasibility borders appeared as a key element to the ideation and idea selection process, suggesting the role of realistic thinking in the case of technological innovation. Expert discussion and validation play a significant role in the creative process in technological uncertainty, helping mostly with idea validation.

The importance of technological boundaries is not to be overlooked. However, this paper defines that the role and attention spent on those boundaries varies depending on the process stage. This paper encourages innovators to formulate ideas prior to exploring the boundaries of the technology in order not to impede the richness of the creative thinking process.

*Keywords: Creativity, divergent and convergent thinking, suspension of constraints, CERN Summerschool*

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## INTRODUCTION

Creativity is defined along various lines by academia. The concept is associated to a greater extent with the world of art than the one of Science. However, creativity is at the centre of any scientific breakthrough and gains an ever so significant importance as the complexity of our world increases. Novel ideas are necessary to frame the complex nature of emerging discoveries and technologies. Creative ideation in essence grants individuals the opportunity to remain resilient in the face of complexity and optimize their approach to problem-solving. The idea that creativity plays a determining role in the handling of complexity will be a cornerstone of our argumentation. This paper specifically takes the case of the 2021 Summer School conducted in partnership with CERN IdeaSquare and the Dutch universities of Delft, Amsterdam, and Rotterdam. Throughout an intense summer schedule, this team worked on the ATTRACT PEBBLES technology. The PEBBLES team, consisting of 4 multicultural and multidisciplinary students, went through the entire creative ideation journey in order to turn a complex technological application of CERN IdeaSquare (PEBBLES) into a viable business application. The PEBBLES technology is a biosensor that can be used to detect very small concentrations of particles in a fluid. This technology was initially developed as highly accurate pathogen detector for fungal sepsis but was then proposed as a detector for mildew in vineyards. This project and its context constitute the perfect setting for the analysis of the role of team dynamics and ideation process on creative outcomes, mostly when factoring in the technical complexity of the application. Accordingly, this paper investigates the following research questions:

How to explore and integrate the boundaries of technology using creative thinking?

How does the suggested process lead to applications for the PEBBLES technology?

The first part of the paper will address creativity and design thinking to set the understanding of the broader idea of creativity. Secondly, the method for ideation used during the summer school is discussed. Finally, keeping in mind those previous elements, we will investigate the results of the project.

## THEORETICAL BACKGROUND

Creativity has intrigued humans for thousands of years. One of the oldest and most known explanations of creativity was given by the ancient Greek philosopher Plato. He said that creativity is a sort of madness, a divine inspiration given by the Muses (Gaut, 2010). Being creative is a gift from the gods, encountered with a "Eureka!" moment, and not something that you can

enforce. This spontaneous view of creativity has not disappeared completely from society yet, but our perspective on the creative process has changed.

The most common view nowadays is that creativity can be forced and learnt. The large number of books written on how to be creative supports the belief of western society in the engineerable nature of creativity. The idea is that contextual factors can influence creativity. Therefore, this paper will aim to define precise aspects of the process our team has been through which influenced the creative outcomes.

A lot of research has been done on creativity. An important element that keeps returning for being creative is motivation. Without persistence, being creative is a much harder task. According to psychologist Teresa Amabile, being intrinsically motivated increases creativity by a lot, however, extrinsic motivation has been suggested to be equally important to the extent that it can greatly influence creative outcomes (Gaut, 2010). This suggests that personal factors are not the sole determinant of the creative potential of a group or individual. The combination of both internal motivation and external stimulation is ideal. That is why design sprints can be so successful: highly motivated people are brought together in circumstances that allow the flow to keep on going. The summer school was a perfect example of how to create the optimal climate to ideate. With multiple workshops, we discovered different techniques for creative thinking that are treated in this paper.

Edward de Bono discusses that creativity is not an inborn talent innate to individuals but rather a skill just like any other sport that some might be better than at others but there is always room for improvement. Lateral thinking involves breaking a routine line of thought and is based on an understanding of the brain as an asymmetric pattern making system. Using multiple tools like challenge, concept extraction, random entry and provocation are all logically based on the behaviour of asymmetric patterns (de Bono, 1967).

Another interesting view on creativity is the one of Margaret Boden: creativity is having an idea that has never been thought of before. She suggested splitting creativity into two divisions: H-creativity and P-creativity (Boden, 1990). On the one hand, H-creativity stands for historical creativity: no one else has thought of the idea before. On the other, P-creativity stands for personal creativity: it is the first time that a given person thinks of this idea. This division gives a first indication of where design thinking differs from being solely creative. While many may believe that to have a great innovative idea one should have a great H-creative idea, a P-creative idea can be enough. As taught during the CERN Summer School, coming up with an idea is a very important part, but this idea does not have any value until being brought into practice. Design thinking is hence also about interacting with experts (Fig. 1), doing market research, and eventually knowing how to sell your product. Consequently, we focused a lot of our creative intent as a team on the balance between the innovativeness of the idea and the feasibility. This manifested itself in the later stages of brainstorming when the different ideas had to be submitted to a feasibility test to determine whether those were worth pursuing. An idea for instance was to use rats equipped with biosensors programmed to detect human pheromones in rubbles of earthquakes or natural disasters. The idea, albeit very creative, did not pass the threshold for feasibility and was eliminated on those grounds. The idea also showed some limitations in terms of the potential market.

This is a clear example of how first divergent and then convergent thinking can lead to great ideas. Firstly, the borders of feasibility should be ignored to come up with as many ideas as possible. Techniques on how to do this are examined in further detail in the next section. Once this broad range of ideas is achieved, the best ideas should be selected. In our project, the ideas which made us the most enthusiastic were firstly selected. The team was very fond of the idea of detecting people using rats and the idea of interception the communication of trees via their roots. However, neither became the final application. The first idea was rejected because of its feasibility. While saving people is a noble cause and has a lot of value, deploying a great number of rats in a disaster area brings too many practical issues. The idea of the talking trees meanwhile seemed pretty feasible and did not need much more than our biosensor. But after talking with experts, it quickly became clear that there was not that much of a market for it. Since an innovative idea needs to have both elements, the ideas were rejected. But this did not mean that those ideas did not contribute at all.

The discussion with biology experts about the talking trees made us realise that there is a need to be able to trace fungi in trees and crops. These fungi can be devastating for the cultivation of certain crops. That is how the idea of detecting mildew in vineyards was established. This is a classic example of how crazy ideas can be valuable. Polishing those ideas during the converging part can lead to a remaining idea on the sweet spot between feasibility and economic value.

**Fig. 1.** Discussing with experts helped to stretch ideas without making them infeasible.

Building upon this point of view, Krysannov proposes a more suitable definition of creativity: creativity is the combination of novelty and appropriateness (Lee et al., 2020). The idea should have some novelty because otherwise there is no innovation. However, it is equally important that the idea provides a solution to something, otherwise, it does not have value. In our context, there was no use in pursuing a creative idea if, from the start, there were no marketable prospects for the application.

## METHOD AND DATA

From the previous development of a definition of creativity stems the need to qualify the processual nature of any creative endeavour. Creativity is a process, which as mentioned above is strongly impacted by some contextual factors. In essence, the creative process is the evolution of an idea into its final form through a progression of thoughts and actions (Popova, 2021). Graham Wallas is one of the first to outline a step-by-step process in his book The Art of Thought. He describes the creative process in four (successive) stages: preparation, incubation, illumination, and verification (Wallas, 2014). However, other literature suggests that these stages are not successive or that the stages themselves are different (Young, 2016). One important part is that these four stages have constant overlap, they do not exist in isolation from the rest, as Wallas explains.

Building upon the work of Wallas, it was Alex Osborn who introduced the term 'brainstorming'. He suggested bringing together a group of people, a mix from different domains, and give them a question to solve. He imposed some rules: the more ideas the better, the crazier ideas the better and do not be critical (Osborn, 1979).

This view on the creative process was refined so that it consists of multiple iterations of first divergent thinking, followed by convergent thinking. In his article Creative Thinking (A Training Approach), John Ryan advocates for more divergent thinking during the creative process to avoid tunnel vision while looking at problems: "The creative approach calls for divergent thinking; questioning the constraints, suspending critical judgment, going outside the normal." Thereafter, one should evaluate and verify the generated ideas by using an analytical/convergent approach. Ryan mentions several problems that can occur during the divergent thinking approach. In this paper, the following are particularly relevant: rigidity, over conformity, over seriousness and fear of failing. Rigidity refers to sticking to one way of approaching a problem or situation, not questioning one's assumptions (Ryan, 1977).

**Fig. 2.** The Ents - the talking trees in Lord of the Rings - were an inspiration during the ideation process.

The group experienced this while trying to step away from the medical application(s) of our assigned technology. PEBBLES was designed as a novel pathogen enrichment tool to improve the diagnosis of sepsis, a life-threatening organ dysfunction caused by a dysregulated host response to infection. It was therefore relatively easy to think of applications surrounding medical diagnosis. One such application the group thought of is the detection of the virus COVID-19 in front of the entrance of big events. In this way, you take advantage of the fact that this technology allows for rapid detection and is flexible in terms of what can be measured.

Very much related, over conformity describes holding on to the "tried and trusted" ways of approaching problems and over-seriousness concerns the lack of daring to play around with ideas in unconventional ways. One of the unconventional ways the group used was applying ideas from familiar movies to our problem statement, forcing the group to take a more playful standpoint with respect to the ideation process.

Concretely, during ideation, it was hard not to think of conventional applications for the technology. The constraints felt too big to ignore. However, during a brainstorming session, the PEBBLES technology was just left aside and a lively discussion about our favourite movies took place. Star Wars, Lord of the Rings and Avatar were all reviewed. While Star Wars didn't have a clear link with biosensors, the other two movies had.

We had been discussing the living trees in Lord of the Rings (and talking Ents in Figure 2) when the parallel with the communicating forest in Avatar was made. Fantasising about this, one of the members suddenly remembered an article on communication between real trees (Toomey, 2016). What if the biosensor could detect that and help draw information from such communication? The idea of the talking trees was born.

This shows that you don't have to start ideating from the technology itself. Just starting from a certain thing that you are passionate about and then trying to shape the thing and the possibilities of the technology until they meet at a feasible point can be a valid tactic as well.

Another important notion about divergent thinking is that one should focus on quantity of ideas rather than quality. In the book The Ten Faces of Innovation (Kelly

et al.,2005), Tom Kelly describes this as being one of the seven secrets to brainstorming. In our process, we incorporated this by coming up with at least 100 possible domains for our application. This forced us to think of less evident domains. He also advises to number your ideas, as this motivates, sets a pace, and adds structure. Furthermore, Kelly recommends using prototyping during the brainstorming sessions. This is also something the group experienced because it allows you to communicate ideas in a clearer way and really makes one think of details that he otherwise could have missed. During the summer programme, the group attended a lecture by a CERN guest speaker about this topic. This highlighted the main objectives of prototyping and how one can most effectively use prototyping to their advantage. More importantly, the group built a prototype of the final application. The prototype consisted of both a physical part (the sensor) and a web application. This was done to make optimal use of the resources: half of the group could perform off-line tasks using the TU Delft facilities, who built the physical prototype. The other half of the group attended online, hence they built the web application. Working on the prototype inevitably raised many questions about how exactly the service would work and how we could visualize this. By answering these questions, we fine-tuned the concept: the concept became more well-defined and several early-stage assumptions were checked.

## RESULTS

Using the above ideation processes, the team came up with different results. The divergent-convergent thinking approach was a great approach but was not enough. The ideas that were found felt a bit too obvious. From a machine that can test for multiple pathogens by blowing in it or taking a blood sample to a mechanical nose to detect explosives, the ideas were not bad at all, but not as great as hoped. The insight that starting from the technology itself gives too many constraints to fully ideate, can be liberating. This gives a part of the answer to the research question How to explore and integrate the boundaries of technology using creative thinking?

The first thing this paper suggests is to just ignore the boundaries of the technology. Using their imagination and intuition to find out which direction could give great applications does not only lead to new and refreshing ideas, but it will also make that one is passionate about their ideas. This crazy and infeasible idea can be found using anything: a news article that one has just read, a discussion one had with a friend, or – as in the case of PEBBLES – from one's favourite movie. Everyone has their own fascinations and curiosities. There is most definitely something that will give you the spark for a great idea.


**Fig. 3.** A poster to present our idea to the experts.

Our love for movies brought us to the idea of talking trees and using animals with a sensor to map inaccessible regions.

The second part to answer the research question is to acknowledge that these boundaries nonetheless exist. The constraints of both the technology as well as the idea should be shaped as explained above to eventually find the combination between feasibility and innovation.

As for the answer to the research question: How does the suggested process lead to applications for the Pebbles technology? The market, feasibility and innovation of the idea can be evaluated. The final idea for PEBBLES is to use the biosensor to detect airborne fungi that destroy crops, like mildew in vineyards.

Regarding the market and innovation, this seems like a great idea. Firstly, mildew is a significant problem. One-third of all crops in Catalan were destroyed by this fungus (CE Financieras, English Ed., 2021). Secondly, there is a market. The wine market alone is estimated at around $420 billion annually (Market Analysis Report, 2020). Lastly, innovation. Nowadays, wine farmers use weather stations to predict the conditions in which spurs will attach to the crops and use fungicides then. However, this is not a very precise method and thus fungicides are spread during the whole season. Since fungicides basically are pollution, this technology can be a real innovation to diminish the use of these toxic chemicals.

So, the important remaining question is: "Is the solution feasible?" Talking with experts in fungi, oenologists, and wine farmers, we experienced a great interest in this solution. Of course, there are still numerous things to be investigated, but multiple universities have already offered their help in testing and further developing a prototype.

## DISCUSSION AND CONCLUSIONS

This paper tried to give an answer to the research questions How to explore and overcome the boundaries of technology using creative thinking? and How does the suggested process lead to applications for the Pebbles technology?

Before overcoming the boundaries, one must of course explore them. Hence starting from within the technology is a great idea. In the case of PEBBLES, the constraints were clearly that it is a medical technology with a specific objective. Once one has clear insight into the boundaries, one can think of overcoming them. This paper suggests not to start from the technology, but from something the innovator is passionate about. Next, the idea can be shaped such that it fits within the boundaries of the technology.

This is naturally not the only way to come up with ideas. One could just start from within the technology and come up with great ideas. However, in the case of PEBBLES, the team felt too constrained by the boundaries of medical applications. There was a real need to drop all the constraints and stop thinking about problems with possible applications.

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