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

Hugo Buurmeijer[1*], Piyush Deshmukh[2*], Alice Fuller[3*], Lander Verlinde[2*]

[1]Aerospace Engineering, Delft University of Technology, Kluyverweg 1, 2629 HS Delft, The Netherlands;
[2]Electrical Engineering, Mathematics & Computer Science, Delft University of Technology, Mekelweg 4, 2628CD Delft, The Netherlands;
[3]Rotterdam School of Management, Erasmus University Rotterdam, Burgemeester Oudlaan 50, 3062 PA Rotterdam, The Netherlands;
*Corresponding author: H.Buurmeijer@student.tudelft.nl, P.A.Deshmukh@student.tudelft.nl, Alice.Fuller@essec.edu, L.K.M.Verlinde@student.tudelft.nl

ABSTRACT

We wrote this paper 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, our work 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 understand the ideation processes and outcomes that occurred throughout the project. Feasibility boundaries appeared as a key element in the ideation and idea selection process, suggesting the prime importance of realistic thinking in the case of technological innovation. Expert discussion and validation played a significant role in the navigating of technological uncertainty, helping mostly within the idea validation stage. We did not overlook the importance of technological boundaries in the creation process. We postulate in this paper that the role of attention to those boundaries varies depending on the process stage. Our 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. We stress that expert talks happen to play a great role in the validation of ideas and should occur in the end stages of ideation.

Key words: Creativity; divergent and convergent thinking; suspension of constraints; CERN Summer School.

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INTRODUCTION

Creativity is defined along various lines by academia, with the concept being more often tied to the artistic world than to the one of science. However, creativity is fundamental to any scientific breakthrough and gains in importance in an ever so complex world. Novel ideas are necessary to grasp challenges faced by our society and navigate the complexity of potential solutions. Creative ideation grants individuals the opportunity to remain resilient in the face of complexity and optimise their approach to problem-solving.

Our paper takes the case of the 2021 Summer School, conducted in partnership with CERN IdeaSquare and the Dutch universities of Delft, Amsterdam, and Rotterdam. Throughout summer, our team worked on the ATTRACT PEBBLES technology. Our team of 4 multicultural and multidisciplinary students, went through the entire creative ideation journey in order to turn a complex technological application into a viable business application.

The PEBBLES technology, in a nutshell, is a biosensor that can be used to detect very small concentrations of particles in a fluid (Hagen, S.D.). This technology was initially developed as an efficient pathogen detector. The initial goal of the technology and its application revolved around fungal detection. This project gave the opportunity to analyse the role of team characteristics and ideation processes on creative outcomes when working with technological complexity. Accordingly, we investigate in this paper the following research questions: (1) How to explore and integrate the boundaries of technology using creative thinking? (2) How does the suggested process lead to applications for the Pebbles technology?

The first part of our work addresses creativity and design thinking in order to set the understanding of the broader idea of creativity. We then discuss the method for ideation used during the summer school. Finally, keeping in mind those previous elements, we will look into the results of the project.

THEORETICAL BACKGROUND

One of the older and most known explanations of creativity was given by the ancient Greek philosopher Plato, who defined creativity as a sort of madness, a divine inspiration given by the Muses (Gaut, 2010). Being creative is a gift from the gods, embodied by an

"Eureka!" moment, and not something that you can invoke. This spontaneous view of creativity has not disappeared from society yet, but our framing of the creative process has changed.

The common view nowadays is that creativity can be forged and learnt. The abundant literature on creativity supports the western belief of an engineerable creativity. Contextual factors can influence the creative mind. Accordingly, our paper aims to specify aspects of our ideation process, which influenced creative outcomes.

Modern day research on creativity strongly emphasises the importance of motivation. Persistence is key to creativity. According to psychologist Teresa Amabile, intrinsic motivation strongly contributes to the creative process. Extrinsic motivation on the other hand has been suggested to 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. Creativity is maximised by the combination of internal motivation and external stimulation. Hence the success of design sprints: highly motivated people are brought together in circumstances that allow the flow to keep on going.

In his research, Edward de Bono postulates that creativity is not a talent innate to individuals but rather a skill. Like sports, some might initially be more creative than others, but practice can lead to greater creative outcomes. There are tools in creativity like challenge, concept extraction, random entry, and provocation, which are derived from the benefit of asymmetric behavioural patterns (de Bono, 1967).

We learnt that even though coming up with an idea is important, the said idea has no value until being put in practice. Design thinking hence requires practicality checks by interacting with experts, doing market research, and formulating a business plan. Consequently, we focused a lot of our creative intent on the balance between the innovativeness of the idea and its 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. One of our ideas for instance was to use rats equipped with a biosensor 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.

This is an example of how divergent thinking followed by convergent thinking can lead to creative ideas. Firstly, the borders of feasibility should be ignored to come up with as many ideas as possible. We examine techniques on how to do this in further detail in the next section. Once this broad range of ideas is achieved, the best ideas should be selected. We initially selected the ideas which made us the most enthusiastic, 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 lack of feasibility: deploying a great number of rats in a disaster area came with 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 obvious that an identifiable market was lacking for it. Since an innovative idea needs to have both elements, these ideas were rejected. But this did not mean that those ideas did not contribute at all.

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

The discussion with biology experts about the "talking" trees made us realise that there is no real market for a too complicated way to conserve forests, but there is one for conserving crops (Fig. 1.). There is especially a need to be able to trace fungi in crops, fungi which can be devastating for the cultivation of these crops. We then interacted with an expert in fungal diseases of plants. These diseases wreak havoc in almost every cultivation. We decided to focus on mildew in vineyards, for three reasons we deemed promising. Firstly, mildew is a huge problem for winemakers. For example, one-third of all crops in Catalan in 2020 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, this innovation allows for more sustainable farming. Nowadays, wine farmers use weather stations to predict the conditions in which spurs will attach to the crops and use fungicides accordingly. However, this is not a very precise method and thus fungicides are spread during the whole season. Because of this need for a more efficient defence system against mildew, wine experts were easy to contact to discuss feasibility.

This is a good example of the importance of unbounded divergent thinking in initial stages. The polishing of ideas generated during the converging part can lead to a remaining idea on the sweet spot between feasibility and economic value.

Krysannov builds upon this point of view: 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 our previous 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 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 most importantly, 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 stresses the importance of divergent thinking to avoid tunnel vision while looking at problems: "The creative approach calls for divergent thinking; questioning the constraints, suspending critical judgement, 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. We looked out for the following four: rigidity, overconformity, over seriousness and fear of failing (Ryan, 1977).

Rigidity refers to sticking to one way of approaching a problem or situation, not questioning your assumptions. Our group experienced this when trying to step away from the medical field of application. PEBBLES was designed as a novel pathogen enrichment tool to improve the diagnosis of sepsis, a life-threatening organ dysfunction (Hagen, S.D.). It was therefore relatively easy to think of applications surrounding medical diagnosis.

One of them was the detection of the virus responsible for coronavirus disease 2019 (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.

Overconformity describes holding on to the "tried and trusted" ways of approaching problems. Over seriousness concerns the lack of daring to play around with ideas in unconventional ways. One of the ways we 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. For instance, during one of our brainstorming sessions, the PEBBLES technology was purposefully left aside and a lively discussion about our favourite movies took place.

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

We had been discussing the living trees in Lord of the Rings when the parallel with the communicating forest in Avatar was made (Fig. 2.). 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? The idea of the "talking" trees was born, which we then refined to the idea of detecting mildew in vineyards.

This shows that you don't have to start ideating from the technology itself. Just starting from something 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 suffice.

Another important notion about divergent thinking is that one should focus on quantity of ideas rather than quality. Tom Kelley's book, The Ten Faces of Innovation, describes this as being one of the seven secrets to brainstorming (Kelley, 2005). 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. Furthermore, Kelley recommends using prototyping during the brainstorming sessions to transmit ideas in a clearer way and think of details, including obstacles, that otherwise could be missed. Our 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, our team built a prototype of the final application. The prototype consisted of both a physical part (the sensor) and a web application. For time optimisation purposes half of the group built the physical prototype, while the others conceptualised the web application and interactive interface. The reason why this strategy was adopted was purely practical: only half of our group was physically present in Delft. However, this split turned out to be very useful, since both physical assumptions as well as assumptions for the interface could be tested. While this physical prototyping was nothing more than some glorified craftwork in a lab, it was the first time we visualised our concepts without using words.

This required a new way of thinking about the technology. Where firstly the discussions were about possible problems we could solve, now the discussion was how to shape these solutions in the most marketable way. If our detection system would break immediately because water or insects could enter, it would not be profitable. Trying different ways of solving such problems and then physically constructing the prototype gives new insights in your product. But the same holds when building the interface. Working on the prototype inevitably raised many questions about how exactly the service would work and how we could visualise this. By answering these questions, we fine-tuned the concept through verification of early-stage assumptions.

RESULTS

Our ideation journey allowed us to derive different results. Divergent-convergent thinking, albeit a great approach, proved insufficient. The ideas found appeared 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 interesting but not as great and disruptive as we had hoped. Starting your ideation process with the technology itself hinders creativity and makes individuals more likely to stick to conformity. Therefore, we suggest first formulating the function of your technology as if you would explain it to someone without any expertise in the field. In our case, this was "We know how to detect very small concentrations of particles in a fluid." Especially when the technology doesn't seem that innovative anymore at that stage, we believe it is preferable not to start from the technology itself. This gives a part of the answer to the research question: "How to explore and integrate the boundaries of technology using creative thinking?"

Our first recommendation would be to just ignore the boundaries of the technology. Using imagination and intuition to find out which direction could lead to great applications does not only lead to new and refreshing ideas, but it will also transform the process into a more interesting and exciting journey. Passion is an important drive of creativity. These crazy and probably infeasible ideas can be found using anything: a news article that you just read, a discussion you had with a friend, or – as in the case of PEBBLES – from your favourite film. Using your own fascinations to come up with new ideas will give you more imaginative and innovative ideas, and it will ensure that you will be more enthusiastic.

Furthermore, it follows that working in a diverse team will enrich the ideation process. Bringing together people from different generations and from different academic or cultural backgrounds will bring together different personalities. During the summer school, we experienced first-hand that this only ameliorates the ideas.

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

To answer our first question specifically, we suggest the following steps in ideation:

(i) Understanding: understand your technology as well as possible but formulate its use as broad as possible. Explain it to your grandparents.
(ii) Fantasise: In which fantastic or personal situations would you use this technology? Be as imaginative as possible to generate lots of ideas.
(iii) Reality-check: Check the feasibility with experts.
(iv) Realise: Build a prototype to visualise your ideas and verify your assumptions.

We do recommend acknowledging that technological boundaries exist. The constraints of both the technology as well as the idea should be shaped to eventually find the optimal combination between feasibility and innovation.

As for the answer to our second research question, the use of an optimal ideation process and the understanding of creativity determinants allowed us to generate a very wide range of applications for the PEBBLES technology. The final idea is to use the biosensor to detect airborne fungi that destroy crops, like mildew in vineyards. An idea which answers a true market need in an innovative way. This idea, in its nascent stage, has been validated by field experts and gained the interest of some universities, gauging the quality of our creative output.

DISCUSSION AND CONCLUSIONS

We give an answer to the two previously defined research questions: (1) How to explore and overcome the boundaries of technology using creative thinking? (2)

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

Firstly, when exploring the boundaries, it is essential to fully understand your technology. At this stage, it is best to start from your technology and get an as broad view as possible on its use. Next, when overcoming the found boundaries, we strongly suggest starting from something you are passionate about, followed by checking the feasibility of your fanciful ideas with experts and by building a prototype.

Specifically for PEBBLES, this process proved its use and led to absurd concepts that were modified to the idea of detecting mildew: an innovative, marketable, and sustainable application (Fig. 3.).

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REFERENCES

Boden, M., 1990, The Creative Mind: Myths and Mechanisms, Basic Books, New York, USA.

Bono, E., 1967, Lateral thinking: Creativity Step by Step, Penguin Books Ltd., London, UK.

Gaut, B., 2010, The Philosophy of Creativity, Blackwell Publishing Ltd.

Hagen, F., S.D., Pathogen enrichment from blood by biosensor linked peptides (PEBBLES) – a case study with challenging to diagnose Candida albicans yeast infections, ATTRACT, https://phase1.attract-eu.com/showroom/project/pathogen-enrichment-from-blood-by-biosensor- linked-peptides-pebbles/

Kelley, T., 2005, The ten faces of innovation: IDEO's strategies for beating the devil's advocate & driving

Lee, J., Ostwald, M., Gu, N., 2020, Design Thinking: Creativity, Collaboration and Culture, Springer Nature Switzerland AG., Cham, Switzerland.

Ryan, J.F., 1977, Creative Thinking: A Training Approach, Journal of European Industrial Training, Vol.1 No. 3, Emerald Publishing Limited: Bingley, UK., pp 25-28.

Wallas, G., 2014, The Art of Thought, Solis Press, Tunbridge Wells, UK.

Young, G., 2016, Philosophy of Art - Formal Principles in Art, Encyclopedia Britannica, Chicago, IL, USA.

N. N.,Feb 13, 2021, The catalan vineyard, again without coverage by the mildew, CE Noticias Financieras, English ed., Miami, USA.

Popova, M. 2021. "The Art of Thought: A Pioneering 1926 Model of the Four Stages of Creativity", Brain Pickings.

Toomey, D. (2016), "Exploring How and Why Trees 'Talk' to Each Other", Yale E360, https://e360.yale.edu/features/exploring_how_and_why_trees_talk_to_each_other.

Market Analysis Report (2020), Wine Market Size, Share & Trends Analysis Report By Product (Table Wine, Dessert Wine, Sparkling Wine), By Distribution Channel (On-trade, Off-trade), By Region, And Segment Forecasts, 2021 - 2028, Report ID: GVR-4-68039-353-5, Grand View Research, San Francisco, USA.