PRO HACKIN'

Faculty of Mechanical Engineering
UNIVERSITY OF LJUBLJANA

PRO HACKIN' project report

Study #1: Experience Survey on Product Hackathons in Engineering Design Curriculum

Co-funded by the Erasmus+ Programme of the European Union

FS UNIVERSITY OF LJUBLJANA
Faculty of Mechanical Engineering

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1. Introduction

To collect specific data about the influence of product hackathons on the learning process in engineering design courses, we have gathered feedback from students, trainers (team coaches), and teachers who participated in the project in the three consecutive years. Participants' feedback was used for the validation of the methodology and for identifying key improvement areas, which was then addressed in the following year. In the year 1, a preliminary hackathon setup was defined, during which the success of the hackathons was measured, then in the years 2 and 3 the modifications of the methodology have been implemented, based on the given feedback. Data was collected in the form of interviews (PR2, report 1) and surveys. In this report we will present the findings that highlight the key aspects of implementing hackathons in engineering design courses compared to the conventional (often PBL based) design courses.

2. Data collection and methodology

During the joint product development course students have participated in 3 hackathons related to the posed design challenge, one for each phase of the development process. After each hackathon students were given an evaluation survey to express their opinions and impressions. At the end of the challenge, students were given a general feedback survey about product hackathons in engineering design courses. The final survey comprised 11 questions, which were in the format of scale rating questions, multiple-choice and open-ended questions.

Questions were divided into six key topics to gather comprehensive feedback from the students. These topics included:

- Suitability for specific design phases:
  Students provided feedback on which phases of the design process they found hackathons most suitable for. The survey explored their opinions on hackathon deployment in ideation, conceptual, and embodiment design (virtual prototyping) phases.
- Live versus Online format of the hackathon:
  Students were asked to compare their experiences between live and online hackathons. Participants mentioned aspects such as engagement, collaboration productivity and digital tools.
- Reflection on the learned skills and tools:
  This section aimed to capture the students' reflections on the new skills and tools they acquired during the online hackathons. Questions targeted their skill development, potential applications, and the perceived value of these new competencies.
- Types of Learning Materials:
  This topic addressed different types of scaffolding materials provided for the hackathons. Students dicussed the usefulness, accessibility, and relevance of materials such as design methods, tutorials, lectures, coaches' explanations.
- Comparison with conventional (design) courses in classroom:
  Students compared their hackathon experiences with traditional classroom-based design courses. Answeres covered aspects such as engagement levels, practical experience, learning outcomes, and overall preference.

- Feedback on future potential hackathon implementation:

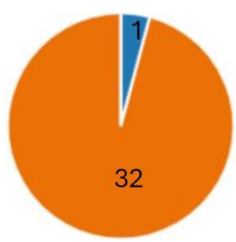
  Students were asked to list the potential areas and contexts where they believe hackathons could be beneficially implemented. This included feedback on other courses and engineering domains where hackathon methodologies could enhance learning, but also their integration with the curriculum.

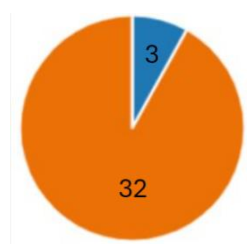
Participants' feedback provided valuable insights into the students' experiences and perceptions, helping to inform future iterations of the course and the integration of hackathons into engineering design education.

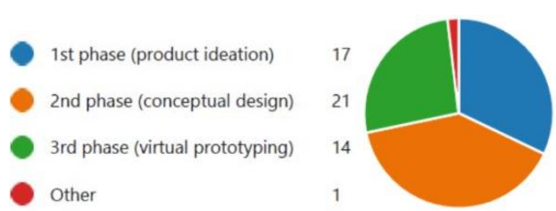
3. Hackathon experience survey results

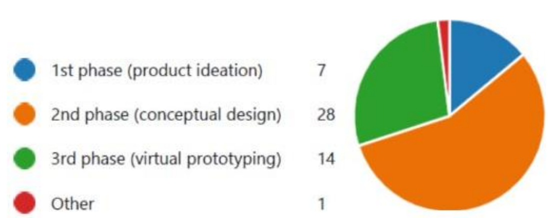
The results in Table 1. show a visual representation of responses for the rating-type and descrete questions, and summarized answers from descriptive questions of the participant surveys, conducted in 2 consecutive years, 2022 (33 participants) & 2023 (35 participants).

Table 1- Hackathon survey responses to rating-type and discrete answer-type question for years 2022 and 2023

<table>
<tr><td colspan="2">1. Did you participate in a hackathon of any type before?</td></tr>
<tr><td>

[2022]</td><td>

[2023]</td></tr>
<tr><td colspan="2">2. In your opinion, which design phase is the most suitable for the hackathon?
a. 1st phase (product ideation)
b. 2nd phase (conceptual design)
c. 3rd phase (virtual prototyping)</td></tr>
<tr><td>

[2022]</td><td>

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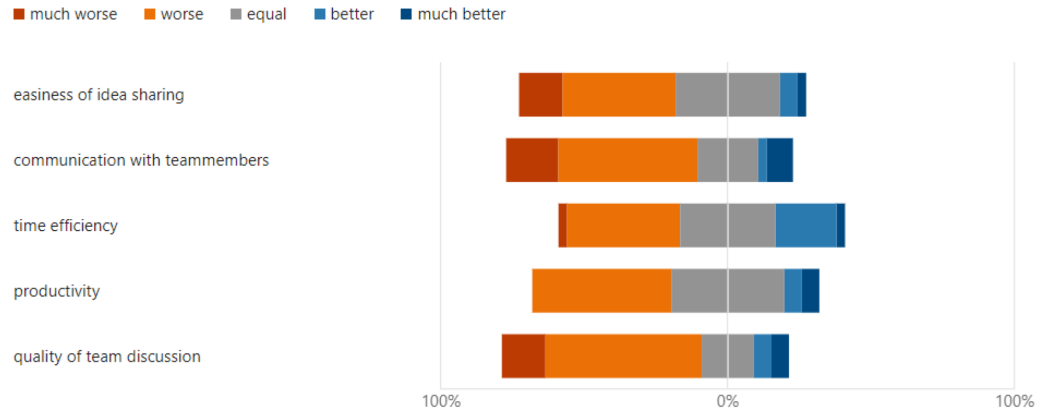
3. Please briefly explain your previous answer.	
• **1st Phase (Product Ideation):** In-person interaction in this phase was perceived to be valuable for team building and getting to know each other and learning to work together, which is crucial at the start of the project. The initial phase would benefit from face-to-face brainstorming and communication, as it allows for more effective idea generation and sharing. However, some point out that research can also be done individually. • **2nd Phase (Conceptual Design):** This phase requires extensive discussion and sketching, which students find to be most productive in person due to the need for real-time feedback and collaboration. Participants highlighted the importance of in-person hackathon for brainstorming, avoiding repetition, and ensuring clear communication among team members. • **3rd Phase (Virtual Prototyping):** This phase was seen as more suited to online work, as it involves detailed CAD modeling and technical tasks that benefit from a quieter, less collaborative environment. While some still found in-person meetings useful for troubleshooting and quick discussions, others state 3D modelling is often better handled with more time and focused online work. [2022]	Divided opinions between participants: some point out hackathons are best for 2nd phase because lot of creativity and active idea sharing is needed, while some say 3rd phase because it requires prompt communication and collaboration for smooth parallel modelling work and engagement from all members. Many agree that concept and idea generation are better suited for live hackathons, while tasks like research and CAD modeling can be effectively done online. • **1st Phase (Product Ideation):** Participants find it suitable for individual work and can be done online. Some point out challenges in online communication when explaining ideas. • **2nd Phase (Conceptual Design):** Perceived to require the most creativity and team communication. Considered best suited for live interaction to foster idea generation and problem-solving. Participants say collaboration is crucial, making it more enjoyable and dynamic. • **3rd Phase (Virtual Prototyping):** Said to benefit from parallel work and clear task division. Some participants find it less suitable for hackathons due to dependency on others' progress. Practical implementation and seeing results in action make this phase engaging. [2023]

4. In your opinion, is it better to have a LIVE (in-person) or ONLINE hackathon? Explain why.	
• **Better Communication and Collaboration**: Most participants found live hackathons better for communication, idea sharing, and collaboration, clarifying that face-to-face interaction makes it easier to explain concepts, brainstorm, and avoid interruptions and cross-speaking common in online meetings. Some participants pointed out that certain tasks, such as explaining complex ideas or using physical demonstrations, are easier to manage in person, making live hackathons more effective for those activities. • **Team Building and Personal Interaction**: Many students emphasized the importance of personal interaction in live hackathons for building stronger team bonds, getting to know each other better, and establishing effective teamwork. • **Productivity and Engagement**: Several participants noted that live hackathons enhance productivity and engagement. Being physically present with the team members led to more active participation and efficient teamwork. • Some participants mentioned the **advantages of online hackathons** like efficient time utilization, collaborative working. [2022]	• **Improved Communication and Collaboration**: Live hackathons facilitate better and easier communication. Participants find it simpler to share ideas and explain concepts in person, with more detail and feedback. Direct interaction leads to more effective teamwork and a smoother workflow. • **Enhanced Team Bonding and Motivation**: The physical presence of teammates boosts motivation and drive to work hard together. Team members feel more connected and engaged during live hackathons. • **Coordination of tasks** and managing team dynamics is more straightforward in live settings. • **Overall Effectiveness and Enjoyment**: Live hackathons are perceived as more effective and enjoyable. The interactive and engaging nature of in-person events contributes to a better overall experience, allowing participants to build strong teams and work towards common goals. [2023]

5. Please rate the ONLINE (virtual) hackathon compared to the LIVE (in-person) hackathon according to:



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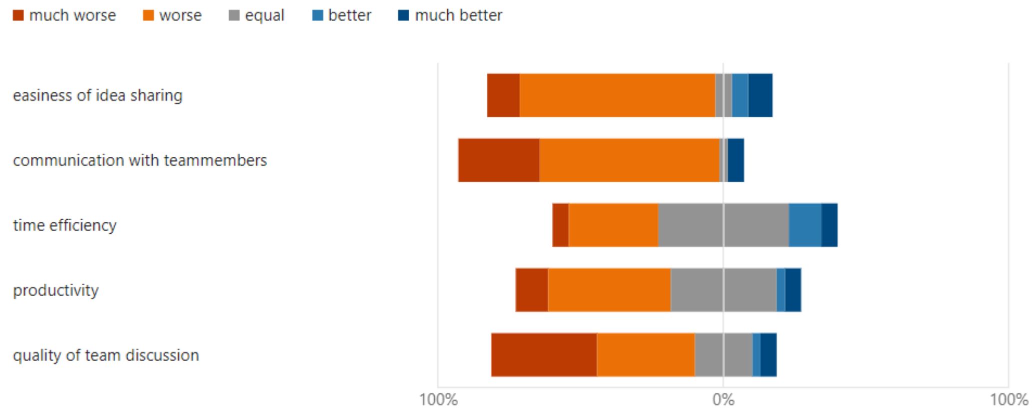
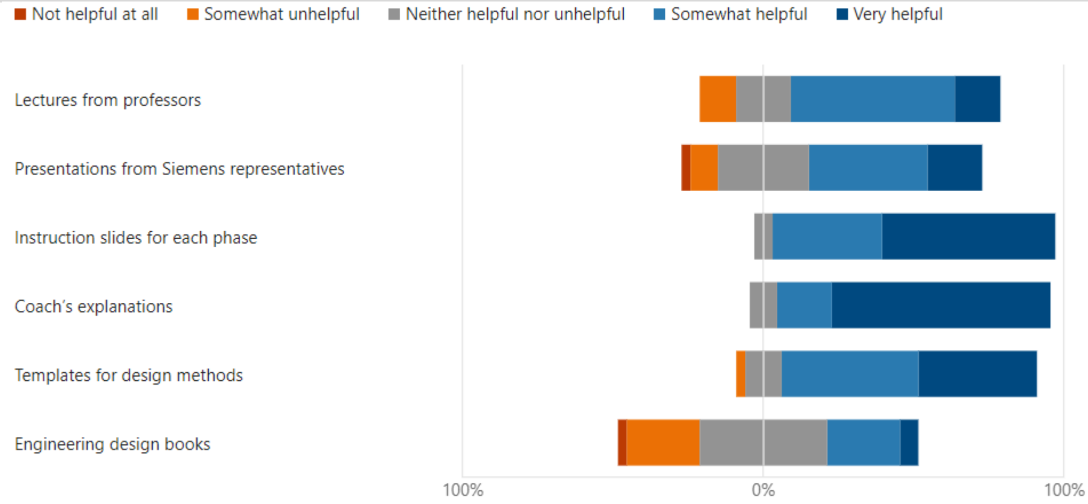


[2023]

6. Did online hackathons help you to learn new skills and tools for the remote work and collaboration in design? Please give examples and elaborate your answer.	
• **Learning and Using New Tools**: Participants discovered and used new tools like Miro, Trello, Onshape, and Simscale, which were useful for planning, brainstorming, idea sharing, collaboration, and managing design projects. Some found the hackathons less beneficial as they were already familiar with many tools from previous experiences during the pandemic. • **Improved Communication and Teamwork**: Many noted improved communication and teamwork skills, learning to use MS Teams efficiently, and effectively splitting tasks. • **Stress and Challenges**: A few participants found online hackathons stressful, with issues in task assignment and maintaining motivation. • **General Benefits**: Overall, participants appreciated the experience, noting improvements in virtual engagement, confidence, and communication, though some aspects like idea generation still benefit from in-person interaction. [2022]	• **Learning and Using New Tools**: Many participants discovered and utilized new tools such as Onshape for CAD and Miro for brainstorming and idea sharing, improving their collaborative capabilities. Examples include better task organization and the practical application of these tools in future projects. However, there were mixed experiences with tools like Microsoft Teams and Trello. While some found these tools helpful, others encountered issues such as inefficiency in simultaneous file handling and preference for alternatives like Google Drive and Docs • **Communication and Collaboration**: Participants reported improvements in communication skills and learning to work effectively in remote teams. This included better task distribution, team management, and efficient online communication methods. • **Problem-Solving Skills**: Participants mention enhanced problem-solving skills and better adapting to new challenges. They learned to find innovative solutions and manage their workload more effectively in a remote setting. • **Remote Work Insights**: Some participants mention gaining insights into the demands and challenges of remote work, realizing the need for better organization and time management. Some expressed a preference for in-person interactions but acknowledged the efficiency benefits of remote work. [2023]

7. How helpful were different kinds of learning materials?



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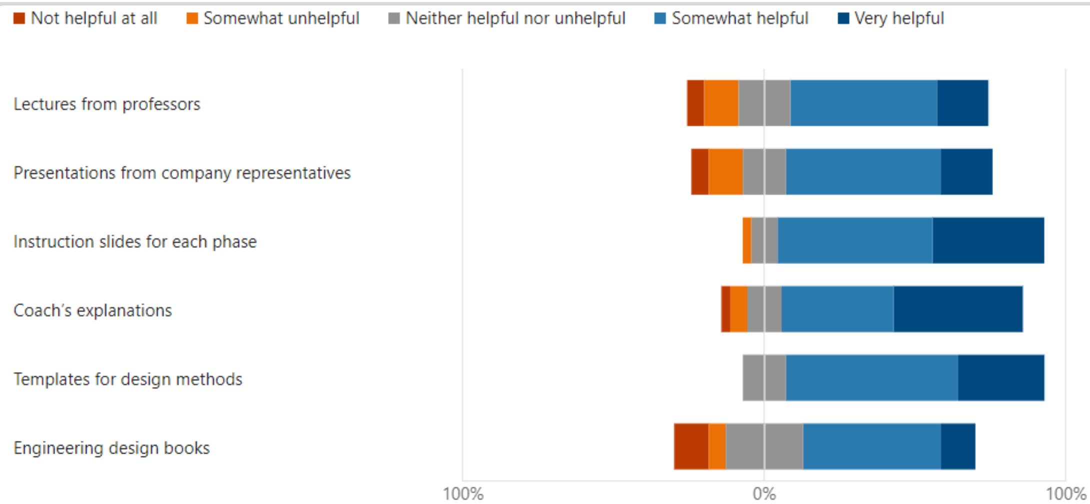

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<table>
<tr><th colspan="2">8. Please explain your answers from the previous question. What would you add or change with regards to learning materials and/or specific design phases?</th></tr>
<tr><td>

While engineering books are helpful, participants preferred shorter, summarized versions or specific relevant chapters due to time constraints.
The input and explanations from coaches and templates were highly appreciated
There was a strong desire for more engagement and clearer expectations from Company representatives.
Participants wished for additional tutorials on practical tools, including OnShape, KeyShot, Blender, Unity, and Lumion.
More interactive and elaborate lectures on methods and design tools, especially for CAD modeling and other technical skills, were deemed beneficial.

[2022]
</td><td>

Participants expressed the need for clearer expectations for each phase hackathon, and for all the instructions to be provided well in advance
Communication with coaches and company representatives was valued, however coaches' coordination should be improved, and they should provide clear, consistent, and specific guidance
Additional training and support on practical tools were desired, e.g. introductory sessions on specific tools like CAD software and Onshape.
It was suggested for lectures to have more focus on technical aspects and practical applications, including modeling, renderings, and visualizations, with examples and case studies from past projects.

[2023]
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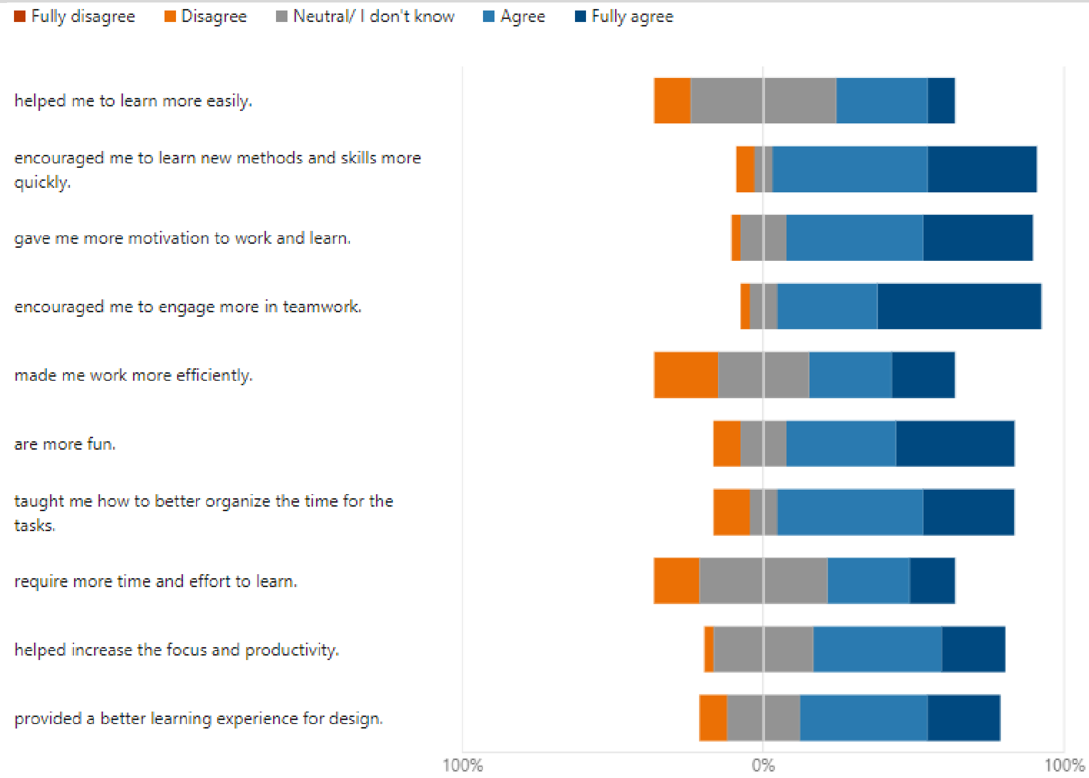
9. Please state your opinion regarding the following statements.
In comparison to the typical (design) courses in the classroom, hackathons:



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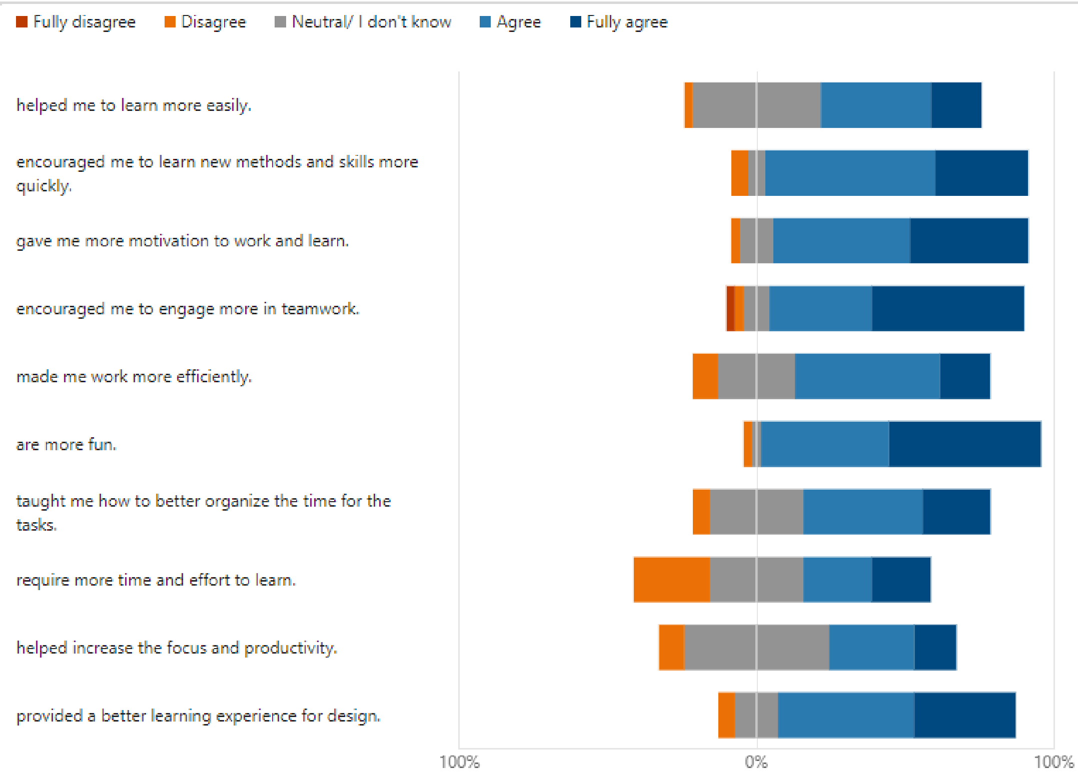

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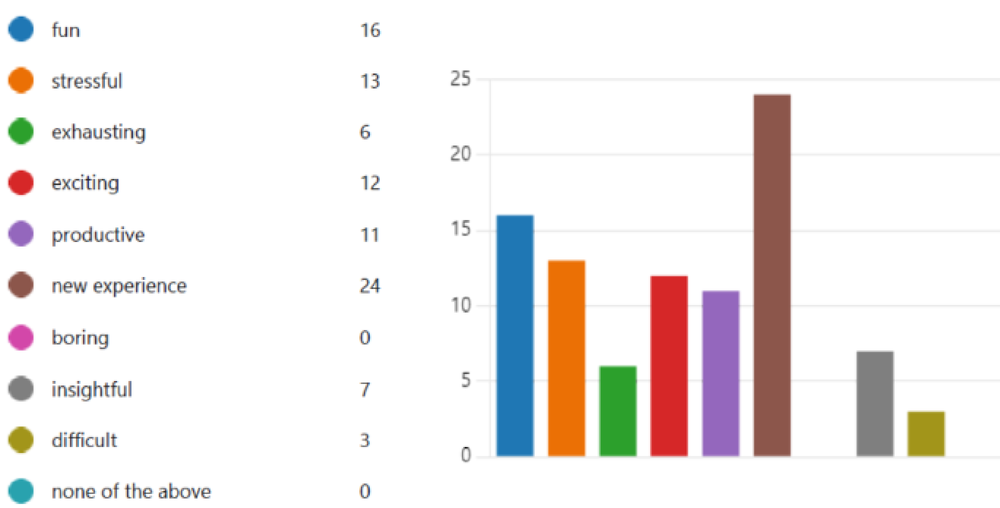
10. (Survey after 1st hackathon) Comparing with the typical university classes, this hackathon for me was (multiple answers possible):



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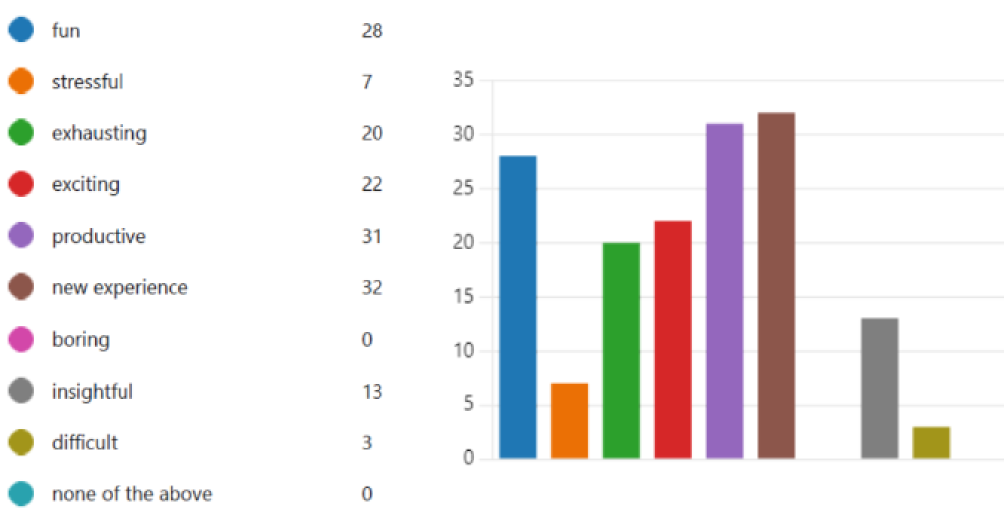

[2023]

11. Would you like to have more hackathons in the study curriculum? Please explain your answer and list potential subjects/domains, e.g. design etc.	
• **Positive Feedback - Engagement and Real-World Preparation**: Hackathons were highly valued for their ability to enhance engagement, teamwork, and real-world skills. Students appreciated the hands-on, immersive learning experience and felt it prepared them well for professional environments. • **Concerns - Pressure and Fatigue**: Many students expressed concerns about the stress and pressure of hackathons, preferring more time to grasp concepts deeply. Some also mentioned that having too many hackathons might lead to fatigue and be challenging to integrate into an already full curriculum. • **Potential Application Domains**: Hackathons were deemed particularly suitable for design and manufacturing subjects. Additional domains suggested included CAD modeling, measurement techniques, 3D printing, prototyping, app development, engineering calculations and data visualization.	• **Positive Feedback – engagement and practical experience:** Hackathons were seen as exciting and enhancing skills in teamwork and problem-solving, as well as increasing motivation and engagement. Hackathons were appreciated for simulating real-world engineering environments and practical experiences, helping students to better understand and apply their knowledge. They offer practical, hands-on experience that complements theoretical knowledge and helps students understand real-world applications. • **Concerns – curriculum integration and balancing workload**: Participants express concerns about the difficulty of integrating hackathons into the regular curriculum due to time constraints, the need for faculty oversight over individuals' work, and the risk of overwhelming students if not balanced with traditional coursework. They suggest one hackathon per semester to avoid overwhelming students and to ensure it complements rather than replaces traditional coursework. Some expressed doubt about their suitability for more theoretical courses. • **Potential Application Domains:** Hackathons are seen to be particularly suited for design and 3D prototyping courses. Participants also suggest engineering subjects involving group and project tasks, such as machine design, fluid dynamics, aerodynamics, and electronics, as well as maintenance and production. Some mentioned opportunities for cross-domain and international collaboration, which are seen as beneficial for broadening perspectives and enhancing teamwork skills.

4. Key findings and conclusions

From the initial question, we can see that very few engineering design students experienced hackathons prior to this project. These results indicate that hackathons in their current form are not a widespread practice in this field.

Most participants agree that the second phase of the product development process, the conceptual design phase, is the most advantageous to conduct through hackathons. This phase demands high levels of creativity and thus benefits greatly from close and active collaboration and communication in various forms, such as sketching, brainstorming, extensive discussions, and real-time feedback. These activities require clarity and need to be time efficient. In addition, this phase is considered to be best suited f or live interaction, which can better foster idea generation and problem-solving.

The greatest benefit for conducting a hackathon for the 1st phase (ideation) was shown to be team building, however, participants believe that in terms of design activities for this phase, user and market research can possibly be done more efficiently individually. Carrying-out the embodiment design (3rd phase) through a hackathon enables for easier team communication and troubleshooting during collaborative CAD activities, but some participants outlined that more quiet time and focus is required. In addition, there were certain time inefficiencies resulting from dependency on others' progress.

With regards to the hackathon setting, live hackathons were preferred amongst participants, especially for the conceptual design phase, as it facilitates quicker, simpler and clearer communication and idea demonstration. They emphasised the improved team bonding through personal interaction, as well as greater productivity, engagement and motivation from all team members. Online hackathons were favoured for efficient time utilization and greater ability to surpass physical distances through the use of collaborative online tools.

Through the hackathons, participants discovered and used new tools like Miro, Trello, Onshape, and Simscale, which were useful for planning, brainstorming, idea sharing, collaboration, and managing design projects. They learned about the tools, and how to apply them. Many found the new tools useful and stated they will use them for the future projects. Participants reported improvements in communication, language and teamwork skills, together with learning to work effectively in remote teams. This included better task distribution, team management, and efficient online communication methods. Students acknowledged usefulness of these skills for the present demands and challenges of remote work. In addition, participants mention enhanced problem-solving skills and better adapting to new challenges.

For the hackathons, the students were provided with different types of learning material and scaffolds. They found instruction slides for design phases, templates for design methods and team coaches' expatiations the most useful. In general, concise summaries with examples and templates were preferred over design books, as they could be immediately applied. Coaches helped the students to understand and improve their use of design methods, and to learn how to apply them in practice and choose relevant ones for their specific problems. The students appreciated inputs from company representatives and field experts, but they desired for more engagement. Proper facilitation on the university staff side can make the communication with the industry more efficient. Participants expressed the need for more tutorials on practical tools, such as OnShape, KeyShot, Blender and Unity, mostly for CAD modelling, rendering and visualization, supported with examples. Additionally, it was suggested that lectures on methods and design tools, especially for CAD modelling and other technical skills, are made interactive and elaborate.

Comparing with the typical university classes, hackathons were perceived as more fun, exciting, engaging and productive, however they were shown to be more demanding, in terms of stressfulness and exhaustion. This is most likely due to them being quite intense and time bounded. Therefore, they should be implemented only a few times during the semester or in smaller scopes, in order to boost productivity and interest, but to avoid overwhelm.

In conclusion, product hackathons were highly valued for enhancing engagement, teamwork, and real-world skills. They provided hands-on, immersive learning experiences that helped students apply their knowledge and prepared them for professional environments. Participants appreciated the practical experience, and the motivation boost that hackathons offered, particularly in simulating real-world engineering scenarios. However, students expressed concerns about integrating hackathons into an already full curriculum, mentioning the stress and time allocation for frequent hackathons. Suggestions included limiting hackathons to one per semester to balance the workload and ensure they complement traditional coursework.

With regards to potential applications in other courses, hackathons were seen as particularly suitable for design, 3D prototyping, and engineering subjects such as machine design, fluid dynamics, design calculations, and electronics. Additional domains suggested included CAD modelling, measurement techniques, app development, and opportunities for cross-domain and international collaboration.