1. Appendix: Conducted Surveys

To measure the perceived efficacy of the hackathon methodology and the individual execution of each hackathon, which is a new pedagogy both for students and educators, several surveys were conducted. For each individual product hackathon a student experience survey and a NASA Task Load Index assessment to measure subjective workload was conducted. At the end of each course a general survey on the perceived suitability of product hackathons within the context of mechanical engineering product development was filled in by participating students. Please refer to the questionnaires below for your reference.

1.1.   Experience Feedback Survey: Hackathon Phase 1

- From which university are you?
    - Single-selection question
- In which team are you?
    - Single-selection question
- Did you participate in a hackathon of any type before?
    - Yes
    - No
- Please rate how helpful the teambuilding was for connecting with the team members?
    - Where: 1 - Poor and 5 - Excellent
- Rate your overall satisfaction with the hackathon.
    - Where: 1 - Poor and 5 - Excellent
- Compared with the typical university classes, this hackathon for me was (multiple answers are possible):
    - Fun
    - Stressful
    - Exhausting
    - exciting
    - productive
    - new experience
    - boring
    - insightful
    - difficult
    - none of the above
- Rate the duration of the hackathon (6 h):
    - Too long
    - Too short
    - OK
- Did you lack time for some activities (user research, market research, search for information, a certain method used, generating visions etc.)?
    - Textbox question
- Did you use MS Teams before the hackathon?
    - Yes
    - No
- Please rate the suitability of MS teams for communication with the team members during a hackathon.
    - Where: 1 - Poor and 5 - Excellent
- Please rate the suitability of Miro tool for ideation during the hackathon.
    - Where: 1 - Poor and 5 - Excellent
- Which of the methods did you use for the user research? Multiple answers are possible.
    - User personas
    - AEIOU
    - Storyboards
    - Empathy map
    - Other
    - None
- Which of the methods did you use for market research during the hackathon? Multiple answers are possible.
    - PESTEL
    - Competitor analysis
    - Market segmentation
    - Product-market fit canvas

- o Other
- o None
- Which of the methods did you use for brainstorming? Multiple answers are possible.
  - o Brainwriting
  - o Braindrawing
  - o 5W and 1H
  - o 6-3-5 brainstorming
  - o Mind-mapping
  - o Other
  - o None
- Which of the methods did you use to create product visions? Multiple answers are possible.
  - o Value proposition canvas
  - o Vision boards
  - o Vision statement
  - o Other
  - o None
- Please rate the team collaboration with regard to communication, interaction and idea sharing.
  - o Where: 1 - Poor and 5 - Excellent
- What is your opinion on the team size (8 members), with regard to communication and collaboration?
  - o too large
  - o too small
  - o good
- Did you split the team into several smaller groups for some tasks?
  - o Textbox question
- Did you have any interaction with your coach during the hackathon?
  - o Textbox question
- Please explain your hackathon in a few sentences.
  - o Textbox question
- Could you explain why the hackathon looked like that?
  - o Textbox question
- What would you change regarding your approach to the first hackathon?
  - o Textbox question
- How was the contribution distributed across the members?
  - o Textbox question

1.2. Experience Feedback Survey: Hackathon Phase 2

- From which university are you?
  - o Single-selection question
- In which team are you?
  - o Single-selection question
- Rate your overall satisfaction with the hackathon.
  - o Where: 1 - Poor and 5 – Excellent
- What could be improved about the hackathon, in your opinion?
  - o Textbox question
- Rate the duration of the hackathon (7 h):
  - o Too long
  - o Too short
  - o Just right
- Did you lack time for some activities (defining requirements, defining functions, searching for design solutions and working principles, creating concepts, concept evaluation etc.)?
  - o Textbox question
- Please rate the suitability of MS teams for communication with the team members during this hackathon.
  - o Where: 1 - Poor and 5 – Excellent
- Please rate the suitability of Miro tool for ideation during the hackathon.
  - o Where: 1 - Poor and 5 – Excellent
- Did you use any other tool (e.g. google sheets, docs, trello, etc.) during the 2nd hackathon? If yes, please write for what purpose.
  - o Textbox question
- Which of the methods did you use during 2nd hackathon for conceptual design? Multiple answers are possible. You can also add other methods, that are not listed below.
  - o Network of problems
  - o Pugh's requirement checklist
  - o Functional decomposition
  - o Morphological matrix
  - o TRIZ

- o Design by analogy
- o AskNature
- o Patent search
- o Other
- Did you split the team into several smaller groups for some tasks?
  - o Textbox question
- How was the contribution distributed across the members?
  - o Textbox question
- Did you have any interaction with your coach during the hackathon?
  - o Textbox question
- Please explain your hackathon in a few sentences.
  - o Textbox question
- Could you explain why the hackathon looked like that?
  - o Textbox question
- What would you change regarding your approach to the first hackathon?
  - o Textbox question

1.3.   Experience Feedback Survey: Hackathon Phase 3

- From which university are you?
  - o Single-selection question
- In which team are you?
  - o Single-selection question
- Rate your overall satisfaction with the hackathon.
  - o Where: 1 - Poor and 5 – Excellent
- What could be improved about the hackathon of the 3rd phase, in your opinion? What would you change?
  - o Textbox question
- How well did you understand the work which had to be done during this hackathon?
  - o I understood completely
  - o I understood sufficiently, there were minor confusions
  - o I partially understood, but it was somewhat confusing
  - o I did not understand what was expected
- Rate the duration of the hackathon (12 h):
  - o Too much time
  - o Not enough time
  - o Just right
- Please explain the answer to the previous question. e.g. Did you lack time for some activities or tasks? Was there too much time and you didn't know what to do? Did you have to wait for some team members to start your task etc.?
  - o Textbox question
- Rate the usability of OnShape for the collaborative hackathon in prototyping/CAD design.
  - o Where: 1 - Poor and 5 – Excellent
- Please shortly elaborate on your previous answer.
  - o Textbox question
- Did you use any other tool (e.g. Ms teams, google sheets, docs, trello, etc.) during the 3rd hackathon? If yes, please write for what purpose.
  - o Textbox question
- How did you prepare for the 3rd hackathon? In retrospect, do you think you should have prepared differently?
  - o Textbox question
- Did you split the team into several smaller groups for some tasks?
  - o Textbox question
- Did you have any interaction with your coach during the hackathon?
  - o Textbox question

1.4.   Product hackathons for design- general survey

- From which university are you?
  - o Single-selection question
- In which team are you?
  - o Single-selection question
- In your opinion, is it better to have a live (in-person) or online hackathon?
  - o Textbox question
- In your opinion, which design phase is the most suitable for the hackathon?
  - o 1st phase (product ideation)
  - o 2nd phase (conceptual design)
  - o 3rd phase (virtual prototyping)
  - o Other

- Please briefly explain your previous answer.
  - Textbox question
- Please rate the ONLINE (virtual) hackathon compared to the LIVE (in-person) hackathon according to:
  - much worse
  - worse
  - equal
  - better
  - much better
  - easiness of idea sharing
  - communication with team members
  - time efficiency
  - productivity
  - quality of team discussion
- Did online hackathons help you to learn new skills and tools for remote work and collaboration in design? Please give examples and elaborate on your answer.
  - Textbox question
- How helpful were different kinds of learning materials?
  - Where: 1 - Not helpful at all, 2 - Somewhat unhelpful, 3 - Neither helpful nor unhelpful, 4 - Somewhat helpful, 5 - Very helpful
  - Lectures from professors
  - Presentations from Siemens representatives
  - Instruction slides for each phase
  - Coach's explanations
  - Templates for design methods
  - Engineering design books
- Please explain your answers to the previous question. What would you add or change with regard to learning materials and/or specific design phases?
  - Textbox question
- Please state your opinion regarding the following statements. In comparison to the typical (design) courses in the classroom, hackathons:
  - Where: 1 - Fully disagree, 2 – Disagree, 3 - Neutral/ I don't know, 4 – Agree, 5 - Fully agree
  - helped me to learn more easily.
  - encouraged me to learn new methods and skills more quickly.
  - gave me more motivation to work and learn.
  - encouraged me to engage more in teamwork.
  - made me work more efficiently.
  - are more fun.
  - taught me how to better organize the time for the tasks.
  - require more time and effort to learn.
  - helped increase focus and productivity.
  - provided a better learning experience for design.
- Would you like to have more hackathons in the study curriculum? Please explain your answer and list potential subjects/domains, e.g. design etc.
  - Textbox question

1.5. Stress Evaluation Questionnaire

- Team Name
  - Single-selection question
- Hackathon
  - Hackathon 1
  - Hackathon 2
  - Hackathon 3
- Name and surname
  - Textbox question
- How do you perceive your involvement in the team/this hackathon?
  - Where: 1 - Low and 9 - High
- Mental Demand - How mentally demanding was the task?
  How much mental and perceptual activity was required (e.g. thinking, deciding, remembering, looking, searching, etc.)?
  - Where: 1 - Low and 9 – High
- Physical Demand - How physically demanding was the task?
  How much physical activity was required (e.g. pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
  - Where: 1 - Low and 9 – High
- Temporal Demand - How hurried or rushed was the pace of the task?
  How much time pressure did you feel due to the rate or pace at which the tasks occurred? Was the pace slow and leisurely or rapid and frantic?

- o   Where: 1 - Low and 9 – High
- Performance - How successful were you in accomplishing what you were asked to do?
  How satisfied were you with your performance in accomplishing these goals?
  - o   Where: 1 - Poor and 9 – Good
- Effort - How hard did you have to work to accomplish your level of performance?
  - o   Where: 1 - Low and 9 – High
- Frustration - How insecure, discouraged, irritated, stressed and annoyed did you feel during the task?
  - o   Where: 1 - Low and 9 - High