PRO HACKIN'

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Appendix 2

PRO HACKIN' project report

Reflection on the potential integration of product hackathon into curriculum courses

Contents

1. Introduction

Based on this previous course experience, many lessons could be reused and implemented in courses of a similar type (project-based learning). As was indicated by our initial literature search, there is a lack of knowledge about the techniques and tools which enable the rapid creation of high-quality design solutions in educational settings. Secondly, there is a lack of educators' experience in defining first the appropriate design task and then structuring and conducting the hackathons towards innovative solutions. Therefore, we believe this and related studies could shed light on different aspects of introducing, organising and conducting hackathons.

The results presented in this exploratory study show some promising findings. Based on feedback from both students and educators, including product hackathons in the engineering curriculum can have numerous benefits. Students can gain new knowledge, acquire various hard and soft skills throughout these hackathons, and even improve their competencies relevant to working at a "fast pace". Also, they will gain skills needed in modern work environments characterised by international collaboration in diverse teams, visual collaboration, remote offices and virtual development tools (in case of online settings). The intensive collaborative design-thinking format encourages networking, resourcefulness, and productivity and supports new product innovation. Educators further deepen their knowledge and skills concerning how to successfully implement product hackathons and integrate them into the regular courses and curricula. Additionally, the industrial partners will gain different design ideas on specific problems as a part of these hackathon-like events.

By considering various aspects of hackathon-like events (e.g., alignment with the learning outcomes of the courses; definition of workspace settings (online, hybrid or onsite); scope of challenge; provided tools and technologies; time schedule; learning support (feedback), etc.), educators will be able to tailor these events and customise them based on their settings and course/curriculum regulations. However, different university regulations (or even defined at a national HE level) could restrain potential modifications to existing courses and the introduction of similar initiatives. As such, these hackathon-like events could be only included as an extracurricular activity, outside the curriculum to which students will be exposed during their studies. The other available option includes offering hackathons as a part of new university courses (compulsory or obligatory). For that reason, educators should check the regulations to become familiar with and review the opportunities for implementing these initiatives.

Similar studies will allow the consortium to gather more data and feedback regarding the effectiveness of the proposed methodology. Furthermore, they will additionally promote and disseminate the project results. Also, this study could inspire and motivate other researchers to continue the endeavour of investigating the role of hackathons in engineering design education (and engineering in general). Further studies will inform future improvements to PR3. As the methodology becomes more consolidated, it will serve as a foundation for proposing new best practices and suggestions for instructing hackathon-like events in courses and curricula.

Due to the many different implications for education, we expect a high impact within the engineering and design education community. Therefore, the project results will be of high interest to educators in Europe. To ensure broad dissemination, the project partners will publish the results via a variety of channels, including the website, social media and scientific publications to reach the interested public at large.

In the following subsection, we provide the list of similar courses from the participating universities in which these insights have been or will be implemented. The introduction of hackathon-like events into existing courses could validate our findings further and help us better understand the specificities of these implementations in various universities.

2. Potential integration of hackathons in the curriculum

This section reflects on the possibility of integrating hackathons at courses of similar type (involving project-based activities) in four project consortium institutions. Therefore, in the following section, candidate courses are briefly described:

2.1. TU Wien courses

Course: “**Virtual Product Development”**

Description

Students work in groups of 3 to 5 members and get a product development challenge from the TUW Racing team, TUW Space Team or from an industrial partner. They have to work on concept finding, concept decision, detailing in CAD and simulation with FEM and/or kinematic analysis.

Properties

- Semester hours: 2.0
- Credits: 2.0
- Type: UE Exercise
- Format: Hybrid

The main focus of the course

- Techniques and tools of virtual product development (calculation, simulation, DMU, FMU)
- Illustration of process chains (CAD / CAE, CAD / CAM)
- High-end visualisation, virtual and augmented reality in product development (kinematic analysis, tolerance analysis, collision analysis)

Learning outcomes

- Apply product development methods
- Use various CAx methods
- Use neutral exchange formats
- Develop simple products themselves
- Incorporate product requirements into product development

2.2. University of Ljubljana courses

Course: “**Design methodology**” (slo. Metodika konstruiranja)

Description

The course was done in the summer semester of this year by approximately 140 students. The students worked in teams of 2-4, and they had to find their own design challenge and bring it during the semester to the detailed design phase. There were two main reporting periods, and according to students, they worked in hackathon mode during the last few days before the reporting. At the beginning of the semester, the students were given the principles of Product hackathon methodology as part of the lectures.

Properties

- Semester hours: 30h lectures, 30h exercises, 40h independent work.
- Credits: 4.0
- Type: Lectures and exercises with project work in teams
- Format: Live

The main focus of the course

- Design methodology
- New product development
- Design processes
- PD Planning
- Concept generation
- Embodiment design

Learning outcomes

- Understand the importance of products
- Know the development process
- Know the engineering design process and stakeholders in the process
- To understand the role of design ergonomics in the engineering design process
- Understand user needs and engineering specifications
- Learn basic creative design methods and techniques
- Learn the guidelines for embodiment of concepts
- Understand the role of prototyping in the engineering design process

2.3. University of Zagreb courses

Course: “**Computer Integrated Product Development**” (hrv. Računalom integrirani razvoj proizvoda)

Description

The course aims to introduce students to the integrated product development process principles and their role in the company's business strategy. The emphasis of the course is on the organisation and operation of engineering teams, the use of computer tools and advanced computer technologies in all phases of the collaborative development process, information management, management methods complexity, smart products development, the introduction of a product-service system paradigm, and quality assurance and intellectual property protection.

Properties

- Semester hours: 30h lectures, 30h design exercises, 110h independent work
- Credits: 7.0
- Type: Lectures and exercises with project work in teams
- Format: Live

The main focus of the course

- Use of digital engineering tools in different phases of product development phases
- Familiarise with techniques for virtual product development
- Work and collaborate in engineering teams

Learning outcomes

- Analyse state-of-the-art knowledge for the development of complex technical systems and services
- Critically reflect on existing solutions of technical systems and services
- Propose and implement innovative ways of solving technical problems in the development of technical systems and services
- Select and use contemporary computer technology in the development of technical systems and services
- Manage complexity in the development of technical systems and services
- Create and evaluate a business plan for the development of technical systems and services

2.4. Politecnico di Milano courses

Course: "**Creativity for sustainable design**"

Description

This course aims at providing the fundamentals of creative thinking and its stimulation in order to optimize the use of natural resources (raw materials and energy) in design and decision making activities. To this purpose, the course includes the execution of exercises and other design activities that require the application of methods, tools and techniques for the analysis of technical problems and the synthesis of solutions. These will be generated by means of a holistic approach that considers the relationship between the technical solution and other social/biological/technical systems and aims at minimizing the potentially harmful effects on the environment during the whole life cycle of the solution. The course is organized into theoretical and practice lectures that also include co-creative sessions to address simple design topics of industrial relevance. The theoretical lectures present all the topics of the course. The practice lectures enable the application of the contents taught during the theoretical lecture to practical problems of industrial relevance for in-class activities, both individually and in teams. The evaluation of the achievement of the intended learning outcomes will require the execution of a group project that might be carried out in the forms of hackathons, where the team members will need to play a variety of design roles.

Properties

- Semester hours: 20h live lectures, 30h exercises; 75h independent work
- Credits: 5.0
- Type: Lectures and exercises with project work in teams
- Format: Live

The main focus of the course

- Creativity and its dimensions (4Ps of Creativity -Person, Product, Process, Press-; Sub-dimensions and definitions; Creative stimuli, fixation and incubation in creative design; Creativity tests and related metrics)
- Systems Life Cycle fundamentals (Definition of System; Technical System; System life cycle; System Dynamics; Context analysis (PESTEL); Stakeholder and related needs analysis; Persona method)
- Approaches for problem management in creative design activities (Modeling techniques for the analysis of processes and the identification of energy and raw materials supply (EMS/IDEF); Modelling techniques for the analysis of organizational processes (BPMN) for the identification of resources to run a company/business; Creation of metrics for flow-oriented analysis and estimation in business processes)
- Approaches to highlight problems of environmental sustainability (Definition of sustainability, sustainable development goals and related targets; Linear to Circular economy transition – Identification of supply chain development opportunities; Life Cycle Assessment (LCA) for the identification of environmental problems; Life Cycle Assessment (LCA) to compare competing solutions)
- Technological opportunities (materials and processes) for the development of more sustainable solutions (Eco-profiles of raw materials of industrial relevance; Sources of information and selection criteria for raw materials; Manufacturing processes and related environmental impacts; Sources of information and selection criteria for manufacturing processes)

- Stimulation of creativity (Roles for the design teams; Collaboration: language and content barriers in multidisciplinary teams; Creative methods vs creative stimuli, landscape and selection criteria)
- Heuristics for the ideation and development of more sustainable solutions (Eco-Design principles/Design for Environment guidelines/prescriptions; Transitions/integrations; Raw material reduction/substitution)

Learning Outcomes
Theoretical and practice lectures will make it possible to:

Remember and Understand:
- The creativity metrics
- The constructs of modelling techniques for the representation of products and processes in their life cycle
- The phases of a Life Cycle Assessment
- The approaches for problem reformulation and the identification of design solution opportunities
- Heuristics for the creative solution to technical problems of sustainability
- The primary sources of creative stimulation and their intrinsic organization

Apply, Analyse, Evaluate and Create:
- Analyse an industrial context of reference to define challenges and objectives for environmental sustainability
- Evaluate their own design processes to estimate the effectiveness and the efficiency of creative thinking
- Analyse existing/competing solutions' environmental impact along their life cycle for the identification of problems of environmental sustainability that require creative solutions
- Analyse technical problems and create alternative formulations of the same for the identification of more convenient and environmentally sustainable solving strategies
- Evaluate the relevance of multiple sources of inspiration to stimulate the creative generation of original solutions
- Apply problem-solving heuristics to create solutions that overcome the analysed problems of environmental sustainability

By showing different course examples where hackathon-like events could be introduced, it could foster the involvement of a broader set of third parties compared to PR2 (i.e. beyond special interest groups on engineering education), such as courses dealing with open innovation and collaborative design at other institutions.