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A music festival as innovative living-lab learning in engineering education

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INTRODUCTION

Innovation and entrepreneurship is high on the education policy agenda and consequently also in engineering education. The Technical University of Denmark (DTU) does a significant effort to establish a variety of opportunities by encouraging their students to work with project development and entrepreneurship. As a part of their education, DTU students is offered the opportunity to work with the organizers at Roskilde Festival (RF) with a broad range of real-life engineering design challenges (RF is a large music festival with about 100.000 visitors and 32.000 volunteers).

This paper outlines the collaboration framework between DTU and RF; a living-lab learning platform developed between the two organizations. More than 650 engineering students have participated between 2010 and 2017. The collaboration provides a unique context for students to conceive, design, develop and implement their own ideas. Our research is based on analysis of data and results from student projects aggregated between 2010 and 2017. In this paper we have a special focus on projects exploiting a commercial potential and present cases of student entrepreneurship realized through festival projects. Furthermore, we have analyzed the characteristics of the cross institutional setup that supports, coordinates and facilitates the platform.

1 ROSKILDE FESTIVAL – A PLAYGROUND FOR ENGINEERING EDUCATION

DTU has innovation as one of the top priorities [1], and the development of an innovative culture among the students is part hereof. With this in mind, learning environments with different external partners engaging students to work with engineering problems in practice are encouraged. One of these partners is Northern Europe's largest music event, Roskilde Festival (RF).

Large scale festival events require an array of professional skills that includes a variety of engineering disciplines. At RF temporary settlements that last for a few weeks are established and large numbers of visitors occupy this artificial city. A great demand on many aspects of engineering is thus present, for example concerning acoustics, waste, sanitation, infrastructure, interactive art installations and crowd safety solutions, amongst others. The festival can be described as 130.000 enthusiastic, mostly young people, on a very limited space, causing severe stress on the infrastructure in that all kind of facilities and services are used in a hard, challenging and sometimes untraditional manner. These extreme conditions make the festival an excellent place to test and experiment on new products and services.

RF runs for eight days in the beginning of July. It has been running continuously since 1971, and during its operation the festival area temporarily becomes the 4th largest city in Denmark. The majority of the visitors and volunteers camp on specific camping grounds at the festival site. The festival site and the camping area with the belonging infrastructure are built every year on an empty green field with only very scarce permanent infrastructure, e.g. drainage (in total the area is about 400.000 square meters).

The festival is a non-profit organization and employs only about 50 full time employees. This makes the festival heavily dependent on contributions from volunteers. While 800 volunteers are working all year around, this number raises to about 32.000 volunteers during the festival. Approximately 80.000 partout (300\$) and 20.000 (150 \$) single day admission tickets are sold every year [2].

2 EDUCATIONAL PERSPECTIVES AND PRINCIPLES

The overall goal of the collaboration is to establish an attractive living-lab learning environment challenging the students in innovative thinking and engineering work. Key issues are problem-based and project-based learning which are important learning objectives in engineering education across all disciplines. Furthermore, it is essential that the students learn to understand the importance of customer requirements, and therefore the student projects must be of interest to the festival, consequently a prerequisite for all projects is a project 'anchor' person within the festival organization. According to Lehmann et al. [3] modern engineering challenges is a combination of social, societal and technical issues. A music festival is a chaotic environment to maneuver and we find it a perfect playground to cater the challenges described by Lehmann et al.

The learning platform is an opportunity for all study programs at DTU and not limited to specific engineering disciplines. Therefore the platform by definition has to embrace a variety of disciplines and didactical principles as well as students at undergraduate and graduate level.

As part of the platform DTU offers regular courses relevant to the challenges encountered at the festival. Apart from these regular courses, the festival collaboration is mainly carried out through so called special courses, i.e. courses designed to specific student interests.

3 METHODOLOGY

The authors of this article have been engaged in the collaboration as coordinators from respectively DTU and RF meaning that we both are actors and researchers at the same time. This gives us on one hand the advantage that we have experienced the challenges in the collaboration, but on the other hand are we also aware that our personal engagement can influence the research.

Our research is based on:

- Analysis of data and results from student projects aggregated from 2010 until 2017. This includes topics, study lines, number of students.
- Surveys among students participating in the collaboration addressing evaluation of support and results.
- Survey among start-ups' teams addressing support for the processes leading to student-driven start-ups.
- Analysis of the institutional setup supporting and facilitating the platform, including meetings and on-going dialogue with key stakeholders. Evaluation and processing of lessons learned have been on-going joint activities between DTU and RF from the start of the collaboration in 2010 until today.

A key element in the collaboration is selection of student projects for the coming festival. The process starts with an open call for project ideas at DTU as well as RF, where informal feedback, sparring, and pre-screening sessions are offered. From this pool of ideas the students are invited to prepare project plans describing aim, relevance, methods, results, economy etc. for their project. This preliminary phase normally results in a pool of relevant and well-described project proposals, and from this, the coordinators from DTU and RF in common select the projects to the coming festival.

4 RESULTS

4.1 How to organize the collaboration – the institutional setup

Essentially the outcome and value creation of the partnership is the student's learnings, as well as the usefulness, projects bring to the festival. Furthermore, the collaboration has resulted in the development of an institutional setup or platform, which facilitates the collaboration (Figure 1). The blue boxes refer to the CEO level and the red boxes to tasks and processes at the operational level. Student activities are indicated by the green box. The student projects are carried out under supervision from academic staff with domain and scientific expertise; furthermore an organizer from the festival is assigned to ensure alignment with the festival's interests. At DTU two project coordinators (engineering students) are responsible for daily operations, where core activities are to promote the collaboration and provide feedback and sparring on project scope and relevance to the students. A project manager at DTU Administration is responsible for the administrative and economic aspects of the collaboration. We have experienced that it is important to have an open-minded contact and dialogue between the DTU coordinators (engineering students) and the RF Student Platform (festival volunteers). We have placed these two groups in the center of the figure to emphasize their role as essential facilitators for the collaboration.

To the best of our knowledge this platform is novel as a living-lab platform and we reflect on the institutional setup which facilitates the platform. We consider these observations and reflections as important findings, and we believe that they can be of value to others with the ambition of establishing similar activities.

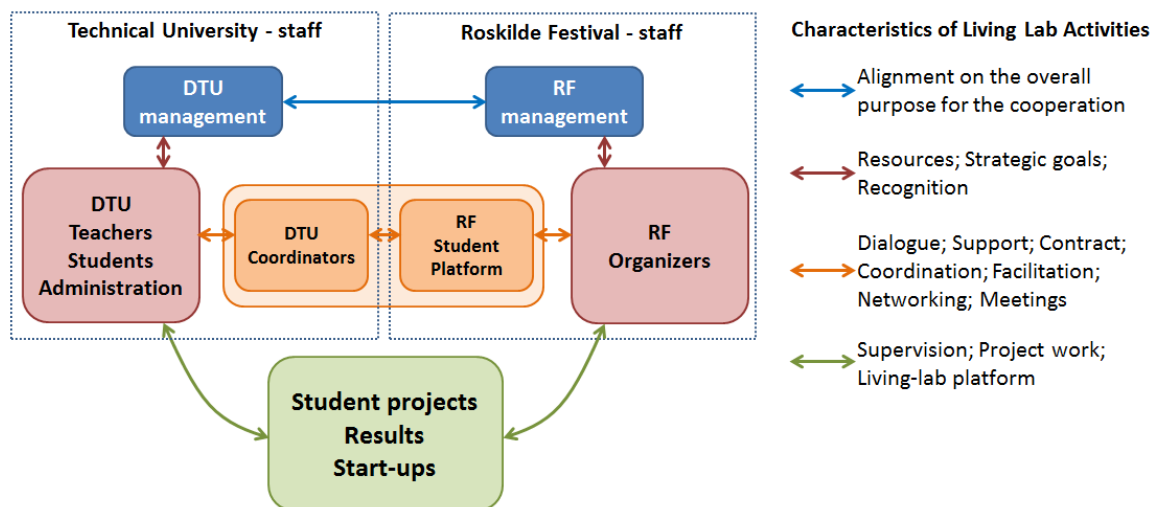


Figure 1. Institutional setup and overall tasks, services and processes of the platform.

4.2 Student participation and study programs

Many students have been interested in the collaboration, and survey results show, that the majority will recommend fellow students to join the collaboration. RF is a strong brand among young people in Scandinavia, and many of the students have previously been festival guests. Descriptions of student activities can be found at the website for the collaboration, [4]. Table 1 outlines the number of participants, projects, study programs, teachers and RF contacts. Figure 2 presents an overview of student projects categorized according to disciplinary themes of interest for the festival, especially sustainability (socially and environmental) and waste management.

Table 1. Student projects, participant's RF contacts and DTU teachers (2010-2017).
The asterisk indicates estimated numbers based on limited historical data.

Year	Participants	Projects	Study programs	RF contacts	DTU teachers
2010	20*	2	Not recorded	Not recorded	Not recorded
2011	20*	7	Not recorded	Not recorded	Not recorded
2012	130*	20	Not recorded	Not recorded	Not recorded
2013	99	25	14	21	21
2014	101	23	17	22	12
2015	90	21	19	10	17
2016	87	19	22	16	12
2017	83	21	21	16	15

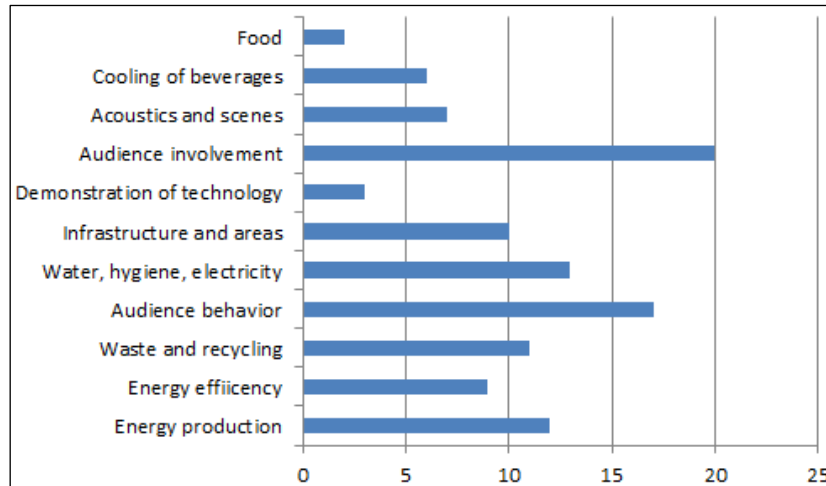


Figure 2. Categorization of number of student projects in disciplinary themes (2012-2017).

We believe that the collaboration offers relevant and diverse 'real world' cases for engineering education from various disciplines. Analysis of the data reveals that the festival collaboration is very attractive among students from 'Design & Innovation', and we believe that it is due to the problem-oriented and project-based approach to learning that is being taught at this specific study line. From 2013 to 2017 the collaboration has included students from 27 out of the 63 programs that the university offers (Table 2). Due to the nature of the festival, students from acoustics, electrical, environmental, civil and mechanical engineering disciplines are regularly participating in the festival projects.

Table 2. Overview of top 10 study programs (2013-2017).

The category 'other' includes students from 17 different study programs. Students that have participated with administrative support functions are not included.

Study program	Number of students
Computer science and engineering	9
Environmental engineering	32
Physics and nanotechnology	10
Biotechnology	15
Civil engineering	27
Production and construction	20
Electrical engineering	55
Acoustic science and technology engineering	49
Design and innovation	128
BEng mechanical engineering	8
Other	107

4.3 Student driven start-ups

With inspiration to the work by Ruth Graham ([5] and [6]) focusing on university environments that promotes entrepreneurship and innovation cultures, a positive outcome of the platform is its ability to incubate student driven start-ups. Graham highlights that interlacing entrepreneurship and innovation as part of the university strategy combined with management support in concise activities is a core driver for successful implementation. Another central aspect is the role of student led entrepreneurship community, which is highlighted as an increasingly prominent driver for successful implementation. Concrete experiences from this platform are well in line with the work presented by Van Rijnsoever et al. [7]. They show that incubators-incubation can provide a systematic method for business assistance to early stage start-ups. This among others through a network broker mechanism which help to expand a start-up's network, e.g. by providing referrals or organizing networking events.

We have experienced that the festival attracts entrepreneurial-minded students and ten projects have resulted in student driven start-ups (Table 3).

Table 3. Student driven start-ups listed according to their year of first presence at RF.

Project & year	Description and website link
Bio-fuel Generator 2011	<i>Deep frying oil for electricity production.</i> Diesel generators and fuel supply system designed to utilize old frying oil from the food stands at the festival.
Volt 2012	<i>Mobile charging as a service system.</i> Power banks are offered to festival participant as a subscription service.
Cutlab 2012	<i>Modular and collapsible seating.</i> A CNC milled system named 'kubio' to create flexible seating installations.
Dropbucket 2013	<i>A disposable cardboard waste bin.</i> Used at festivals and events to encourage participants not to litter. Winner of Red Dot Design award 2015.
Peefence 2013	<i>Flexible urinal system.</i> A low cost urinal which is easy to install and flexible in terms of applications. Winner of Danish Design Award 2018.
Sitpack 2014	<i>A foldable seat.</i> Prototypes of the foldable seat were tested with festival participants and the product was later crowdfunded
Papernote 2015	<i>A digital-physical snowdrop letter.</i> Interactive digital fabrication concept for the production of personal snowdrop letters at the festival.
Allumen 2017	<i>Algae that produce light from bioluminescence.</i> The effect is used utilized for concert and arts projects.
Containdom 2017	<i>New type of packaging for condoms,</i> which allows for the packaging to be utilized as a disposal container before the condom is discarded.
Glød 2017	<i>Portable lantern</i> made by partially recycled parts with an interactive functionality where colors and light changes according to sounds nearby.

The open literature stresses the importance of collecting feedback from stakeholders early in a product development process, e.g. Ulrich and Eppinger [6]. We have learned, that the unique needs of the festival and its visitors, allow the students to innovate for niche markets, which are often very difficult to penetrate without insider knowledge and close collaborations with the stakeholders. Our survey among the start-ups teams have resulted in the following findings:

- The majority of the projects had the first encounter with potential customers at the festival. The teams responded that this experience was highly important and effective in their learning and marketing of the products and services.
- The living-lab test environment at the festival was evaluated to be highly beneficial in obtaining valuable technical insights about the products/services. Insights reported to be an inspiration to directly changes of the design.

- There is room for improvement in connecting the festival platform to the overall innovation eco-system at DTU. There seems to be a lacking support in how to take the project further after exceeding the support from the platform.
- Finally, it is valuable feedback from the teams, that they will recommend the collaboration to peers with a similar motivation for student driven start-ups.

5 LESSONS LEARNED – CONTRIBUTIONS TO LIVING-LAB LEARNING

5.1 Overall format of the collaboration

The CEO support from both organizations has been crucial; in form of resource allocation (man power, money) and responsiveness together with clearly visible recognition of the collaboration. In short the management style can be characterized as bottom-up, appreciative, vision-driven and emphasizing students as festival co-creators. At DTU and RF the daily management and operation of the collaboration has been anchored in overarching support sections and not at a specific university department or festival division enabling organizational robustness and room for new ideas.

5.2 The necessity of flexibility and agility of the living-lab platform

Students have different interests and experiences and therefore it has been important to offer different learning activities. Further, it is of importance to the university that the majority of the students can earn merit for their work when participating. This variety of requirements has been ensured through four different ways to participate. It is crucial that the students have supervisors at the university in order to ensure fulfilment of educational requirements and to ensure high quality project work.

Table 4. Four different learning activities in the collaboration

Type	Characteristics	Merit
Courses dedicated to the festival (e.g. waste, acoustics)	Continuous support from dedicated research staff to take responsibility for the course.	Yes
Project on festival case in existing university courses	A fit must be identified between a specific festival case and the learning objectives in an existing course.	Yes
Dedicated special course	A special course in collaboration with academic staff at the university. Project outcomes are defined in dialogue between students, academic staff and the festival.	Yes
Extracurricular project or support team	Students can engage in the festival collaboration without any relations to merit giving activities. They can work on specific projects or support functions.	No

5.3 The role of the project coordinators

For the DTU coordinators and RF Student Platform important tasks are to establish and maintain network/relations within both organizations. It is an all year ongoing activity as the planning of a festival event takes one to two years. In order to keep a broad all year attention to participate in the collaboration the DTU coordinators and RF Student Platform are aware of the impact of storytelling and therefore successful and especially innovative and entrepreneurial projects are published in internal media within the two organizations. In order to keep a close contact between the DTU coordinators and RF Student Platform meetings are regularly arranged discussing activities concerning evaluation, follow-up, new projects, planning etc. The DTU coordinators and RF Student Platform play an essential role on four dimensions: i) they understand the core values of both organizations and they can act as interpreters in the dialogues between the two organizations, ii) they facilitate and coordinate the

identification and scoping of the projects, iii) they contribute to establish an attractive knowledge sharing living-lab learning platform, and iv) they provide practical and professional support to the projects. We see the DTU coordinators and RF Student Platform as key actors in the collaboration, and referring to the work by Wenger ([8] and [9]) and Kimble et al. [10], we understand their function as coordinators similarly to the role of boundary brokers. Boundary brokers can introduce elements of one practice into another. Brokers are members of multiple communities and are able to make effective connections between them; they make coordination possible by opening up new possibilities for learning and exchange. Furthermore, the broker's role is essentially that of an interlocutor.

6 CONCLUSION

We have experienced, that the infrastructure of a non-profit music festival with an international brand is a great playground for implementing and testing engineering solutions. The DTU-RF partnership is in line with the current trend of establishing attractive learning environments where students, as part of their education can collaborate with external partners. We have identified some essential characteristics which are important for the collaboration to flourish. We think these findings can serve as pointers and inspiration for other institutions with similar interests.

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