A PLAYGROUND FOR NOVICE ENGINEERS AND BEYOND

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ABSTRACT

The Innovation Playground is a living lab for co-creation accessible for all faculties and research programs situated in the main building of The Hague University of Applied Sciences (THUAS). It has shown to play an important role in building social, learning, and professional communities that reach beyond the intended purpose. Due to budget restrictions, the dedicated staffing and accompanying programming were eliminated. In this case, the fourth challenge on operational scheduling and staffing of the workspace, presented in the syllabus (Crawley, Malmqvist, Östlund, Brodeur, & Edström, 2014) is encountered. To avoid throwing the baby out with the bathwater, this paper captures the value of the space and programming for its users and types of usage, primary and auxiliary. It answers the key question: what needs do the Innovation Playground fulfil for all its users? It focuses on uses beyond the educational and users beyond the engineering domain. Cases and spaces of multidisciplinary education beyond the technical domain are rare to find within the CDIO body of knowledge. The CDIO framework is optimized for engineering education, yet the value of these spaces for members across an institute (such as internal research partners and external network) is overlooked with this perspective. The syllabus touches upon the community building aspects as a result of the design-implementation projects (for students and faculty staff). The valuable activities, as expressed by its users, are teaching and learning modes that contribute to community building, such as advanced and simple design-implementation projects, collaborative design projects, extracurricular design projects, tinkering mode and self-guided learning (Young et al., 2005). For non-student users, this community building value is endorsed. Other intangible values for non-student users include a space to conduct and reflect on educational innovation, cross-disciplinary educational collaborations, and expanding networks within and outside of the institute to work with real-world clients.

KEYWORDS

Engineering Workspaces, Learning Environments, Relationships between Academia and Industry, Standards: 6.

INTRODUCTION

The Hague University of Applied Sciences (THUAS) has 25.000 students of about 100 nationalities and around 2000 employees. There are 44 bachelor-degree programs taught across 4 campuses. The faculty of Technology, Innovation & Society (TIS) has become a CDIO member for all its 12 bachelor-degree programs (Hallenga-Brink & Kok, 2016).

Inside the main building of THUAS there is a living lab for creativity and co-creation, called The Innovation Playground. Both the space and programming are intended and accessible for everyone. It has shown to play an important role in building social, learning, and professional communities that reach beyond the intended purpose. As a CDIO member, the technical faculty, (TIS) has multiple engineering workspaces in their section of the building. While spaces are in a more remote part of the building and not often visited by other disciplines, the Innovation Playground space, is situated in the central hall of the building. Right next to the entrance of the canteen, visited and visible to everyone in the university.

Since opening in May 2016, the Innovation Playground has gone through three strategic programming phases. This paper focuses on the second phase, where program directors were installed with the aim to foster innovation and collaboration throughout the university.

Aim

The aim of this paper is to analyze and reflect on the experiences of the Innovation Playground in its second strategic phase through the lens of CDIO Engineering workspaces. It answers the question: *what needs did the Innovation Playground fulfil for its users?*
This paper focuses on needs beyond the educational realm and users within and outside the engineering domain.

Firstly, the outcomes may benefit those who plan to effectively operate such interdisciplinary workspaces. Secondly, the results are of interest for technical faculties who are implementing or rebuilding their engineering workspaces. Finally, the outcomes may be useful for other institutes (within and outside the CDIO network) which aim to facilitate and foster creative multidisciplinary education and research initiatives that connect the technical realm with other domains.

Approach

An initial inventory was made on the current operations of the Innovation Playground, *through the lense of the CDIO Engineering workspaces*. Additionally, a grounded theory analysis was made based on 49 written testimonials about the Innovation Playground from a variety of users about how it added value to their work/study life.
Finally, an interview was held with the managing director of the Lighthouse, an organizational unit under which The Innovation Playground falls. The aim of the interview was to contextualize the strategic phases of which this staffing was part and to uncover the intentions and goals of these strategies.

The qualitative research method of ‘grounded theory’ (Charmaz, 2012) was adapted for the analysis of 49 testimonials. The following steps were conducted.

1. Aligning / triangulating analysis across researchers.
2. Open coding line by line with an emphasis of sticking closely to data. We looked for ‘gerunds + noun’ such as ‘expressing belief’. “Gerunds build action right into the codes. Hence, coding in gerunds allows us to see processes that otherwise might remain invisible.” (Charmaz, 2012)
3. a. Collecting codes into different needs (personal, educational, organizational).
   b. Finding narratives within the codes – writing memos (Birks & Mills, 2015).
   c. Categorisation of narratives
4. Communicating narrative.

Collecting codes and finding narratives, steps 3a, b and c, were iterative steps executed by all three researchers in order to reach a cohesive understanding of the documentation used for

internal communications. The approach taken deviates on this point from the grounded theory approach. Birks (2015) explains how a theory is built through successive data collection and analysis. *"Theoretical integrity is growing when the core categories reach theoretical sensitivity and saturation"*. The limited amount of data on the Innovation Playground prevented testing these categories on new data. Even though the iterative approach was used to form a narrative divided into core categories, it cannot be assumed that this resulted in a theory.

Previous CDIO proceedings have been consulted to compare the current operations to the existing body of knowledge. The outcomes will be compared in the discussion.

A limitation worth noting is the context that inspired the written testimonials. These testimonials were written after learning programming and accompanying staff for the Innovation Playground would be eliminated. There could be a variety of motives for writing a testimonial in this situation, but these intentions were not considered and only the contents of their testimonies were analyzed. Another limitation of the study is that it lacks perspective about the Innovation Playground from non-users.

THROUGH THE LENSE OF CDIO WORKSPACES

Standard 6 in the CDIO approach recommends that students "need to be immersed in workspaces that are organized around the Conceiving-Designing-Implementing-Operating" phases in order to "support and encourage hands-on learning of product, process, and system building, disciplinary knowledge, and social learning". These workspaces are best supported through a Multimodal Learning Environment (MLE) (Crawley et al., 2014).

The following guidelines, with criteria for the development of these workspaces, have been summarized by Fortin (2008) as follows:

- The term MLE must integrate traditional student work areas, team-based project workspaces, computer-driven collaborative design rooms, manufacturing and prototyping laboratories, and facilities designed for extracurricular activities.
- CDIO workspaces are designed to support the entire curriculum.
- The new space must facilitate student learning of personal and interpersonal skills, group activities, social interaction, and both collocated and distributed team communication.
- The workspaces should be efficiently connected to other common student facilities, e.g. the library, storage facilities, machine shops, etc.
- An MLE can be built from scratch in a totally new building or can be an adaptation of existing physical layouts (redesign) or can be a combination of both (hybrid).

CDIO workspaces at THUAS

At the faculty TIS several MLEs can be identified that meet these needs and where advanced design-implement projects can be executed. Facilities such as project studios and living labs are at the students' disposal for authentic learning experiences, experimenting, and prototyping (Hallenga-Brink & Kok, 2016). As mentioned in the introduction, the Innovation Playground intended to function as an MLE for the entire THUAS, serving all faculties. These include the faculties: Business, Finance & Marketing; Public Management, Law & Safety; Health, Nutrition & Sport; IT & Design; Management & Organization; Social Work & Education; Technology, Innovation & Society; plus an Academy of Masters & Professional Courses, each ranging between 4 and 12 programs. Furthermore, THUAS has 27 research groups aggregated into 4 research platforms: The Next Economy; Good Governance for a Safe World; Connected Learning; and Quality of Life: People and Technology.

The Innovation Playground

The Lighthouse is the center for debate and culture at THUAS. This center offers programming and facilities near the central hall to support their goal to connect across programs and disciplines. Within this center the Innovation Playground fulfills two goals:

1. 'Classroom of the future', offering a space to teachers to experiment and setups and technologies to explore.
2. Bring together and showcase innovative forces, people, initiatives in a visible central place to foster links, associations and collaboration

The workspace has known three strategic phases of programming and staffing. Phase 1 (05/ 2016-12/2016) on opening it was staffed by 1 staff member, primarily with the operation of space in mind and adhering to the first goal. In phase 2 (01/2017-11-2018) the role of program coordinators evolved and became more in line with the second goal. Phase 3 (12/2018-ongoing) is characterized by having no program coordinators intended to create shared ownership and responsibility of coordination and activities. The description below is related to the second phase.

Manifesto of The Innovation Playground

***We Play**: Innovation starts with experimentation. Nothing is set in stone. Curiosity, openness, and failure approach are crucial for new discoveries. We shun dogmas and prefer to be daring and inquisitive. We welcome all things different and odd.*

***We Create**: Innovation starts with an idea. When we bring that idea to life via the process of creation. We allow ourselves to discover, to be surprised, and to experiment. The process of creation makes an idea tangible and is therefore a prerequisite for Innovation.*

***We Show**: Innovation starts with sharing. Sharing outcomes and methods furthers new insights and ensures progress for future projects. Although we promote intellectual ownership of projects, we support the Open Source / Creative Commons mentality.*

***We Unite**: Innovation comes from diversity. We embrace all people and all ideas. Our activities are open for all. We believe that different viewpoints make for a broader design space and enables us to construct new perspectives and new possibilities.*

***We Matter**: Innovation is substantial. It cannot be achieved in bite-sized portions. Ideas need dedication and focus to mature, grow and prosper. A meaningful result can only be achieved when no stone is left unturned and no question is left unasked. Therefore, time and attention are a necessity.*

Written by Carmen Hutting & Chris Heydra,
program coordinators of the Innovation Playground

In January 2017, coordinators for the Innovation Playground were hired. The program coordinator's vision for the Innovation Playground aligned with the educational institution's vision, which focuses on world citizenship, internationalization, and networking. See also Hallenga & Kok (2016) for more background on this vision. The program coordinators' vision entailed a thematic approach for the MLE, which connected activities throughout the institute. Themes included: circularity, sound, food, and art. Their manifesto can be found below.

The space offers working spaces for 32-45 people on both higher and lower tables. The pitching corner can expand to seating for max 70 people. Most of the furniture is easy movable which allows for a flexible space, easily setup to the needs of the activity or usage mode. The wall on the bottom of the floorplan is made of glass, has large doors that can open and connects directly to the central hall of the university. The back walls are painted with chalkboard paint, to be used by anyone. Figure 1 and 2 below give an impression of the setup of the space. Table 1 describes more in detail what happens inside the space.

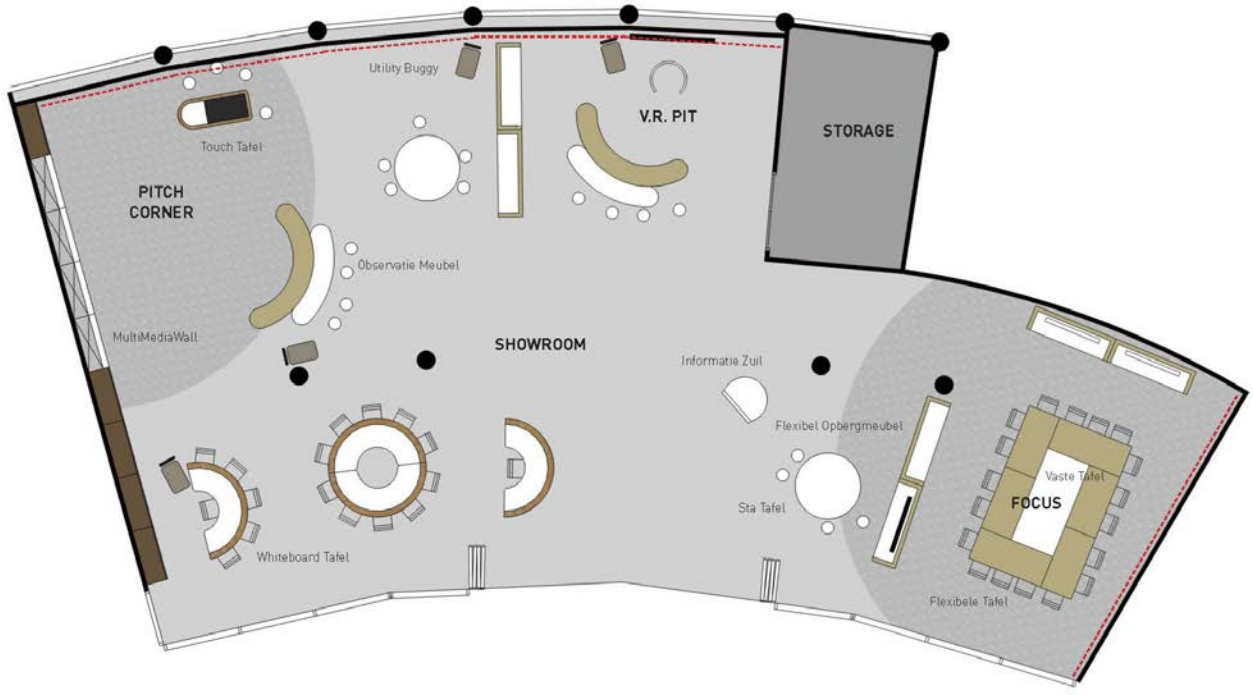

Figure 2: floorplan of the Innovation Playground

Figure 1: images of activities, focus area (l) and pitch corner (r)

Community building as central value

Table 1 shows how the detailed modes were present in the Innovation Playground. The community building detailed modes from the CDIO syllabus are highlighted.

Major modes	Detailed modes	Innovation Playground operations
Product and system designing and building	Advanced design-implement project	Not present
	Simple design-implement project	• 10 week long-curriculum specific projects. • Hackathons, pressure cooker workshops, etc.
	Collaborative design project	• Kick off of projects in this space • A commissioned interdisciplinary project within a theme was hosted every 10 weeks.
	Extracurricular design project	• Extracurricular activities, from 1 day up to 10 weeks. • *Playtime* was hosted once a week, a low threshold activity afternoon often kickstarted with a thematic lunch movie.
	Test & operate mode	• Technology to test and experiment: a VR pit, a green screen, ±4 cameras to operate, 2 movable screens and a video wall and table screen. • IoT building and programming hardware is present.
	Tinkering mode	• Creative office stationery, chalkboard walls, paper, and between 2-6 large Apple computers where present. • Students and staff used it as an extension of their habitats, bringing their practice to a shared collaborative space. • Students worked together to understand and experiment with IoT hardware. • Offering 32-45 spaces for working on high and low tables + benches. • A strict open door policy, where everyone can join everything.
	Linked Projects	• A commissioned project within the theme was hosted every 10 weeks. Several programs could be connected. Several courses within a program could be connected. Research programs were mostly not linked. • Workshops were often guided by IP staff. They actively suggested cross-links between projects and subjects.
Reinforcement of disciplinary knowledge	Class lab / experiment	• 2-3 curriculum-specific educational program projects ran parallel and shared the space throughout the week. Results of these projects were visible for all users.
	Teaching in labs	• Some courses were taught in this space or a lecture was situated here when opened up to a bigger audience.
	Self-directed learning	• Students and staff who came in to study their own disciplinary knowledge found motivation from the people and the space. • Initiatives for activities by teachers and students were supported by the staff and space. This varied from brainstorm sessions to movie nights to quire sessions.
	Lecture / presentation in labs	• A video wall and 2 movable screens made kickoffs and presentations common in the space. Presentations and workshops happened parallelly.
	Interactive electronic class mode	• In classes, students were asked to bring their own laptops.
	Distance learning mode	• A few 1 day projects were initiated that experimented with a live link to another location outside of THUAS.

Knowledge discovery	Undergraduate research project	Not present, internships were offered.
	Graduate research project	Not present
Auxiliary uses	Research design support	• There was a strong link with the research groups who hosted regular and incidental activities. Those with an interdisciplinary nature were welcome. • Research projects were kickstarted in this space. The flexible setup of the space gave ample room for interdisciplinary design and research workshops.
	Income generating mode	• The space was also rented out to internal and external parties – often outside of the regular opening hours – 10:00-17:00
	Outreach mode	• The space was located in the central hall of the main building and often visited by parties and external visitors, to showcase innovative projects. • Expos happened at the end of each semester where students showcased outcomes and products of projects • The program supported extra activities not aimed at university content, but did create awareness. For example a piano that anyone may play on at any time, jam sessions and (home made) beer tasting.

Table 1. Teaching and learning modes in the innovation playground

The CDIO syllabus explains how community building is an emergent mode that occurs when the major modes of use have drawn the students to the workspace, engaged them, and allowed them to interact (Crawley et al., 2014). The table additionally shows how detailed modes, such as 'Tinkering' and 'Self-directed learning' contributed to community building. The community building aspects are elaborated on in the section 'needs expressed by its users'

Reflection on challenges encountered

Taken from the challenges that Young et al. (2005) describe in their paper, the CDIO syllabus elaborates on four challenges experienced with engineering workspaces and stakeholder reactions. Below is described how these are encountered in the context of The Innovation Playground.

1. *The need for a workspace design driven by curriculum and usage modes.*

The location and programming were not curriculum driven. The thematic programming allowed for programs to fit their educational activities within the themed context. There was a limited number of programs who could benefit from a structural place in the programming, as can be seen from the *simple design-implement* and *class lab/experiment* modes in table 1. The workspace design was driven by the openness and flexibility to meet the needs of *all curricula*, not just one. This was a limitation because the space did not play a central role in any curriculum.

2. *Planning for flexibility in usage modes and evolution over time.*

Usage modes were well adhered to by offering flexibility in the space and allowing multiple activities to run simultaneously. The space and interior were intentionally designed to evolve over time and be flexible for a wide range of usage types. Large adjacent storage areas were used to adapt the space to its various needs. Material and machines were bought when the themes and

activities called for it. This allowed for natural growth in the material. As an example; throughout the theme 'sound' the number of instruments in the room steadily grew. A piano and guitar remained in the space several months after the theme had ended.

3. *Safety concerns and extended access, and operational issues.*

To support the operations of the Innovation Playground, students took on volunteer roles, became interns, and sometimes got paid jobs directly supporting the space. Regularly visiting students and staff were added to the key-list, which allowed them to access the space within the regular opening hours of the university (between 08:00 and 23:00).

4. *Operational scheduling and staffing of the workspace.*

As attractiveness of the space grew, scheduling activities became more difficult. There was tension between the Innovation Playground's own programming and the requests of curricula to use to space. Early on, a strict policy was established that only activities that matched the current theme were allowed to utilize the space. However, this resulted in too little involvement from all academic programs. A looser policy was later adopted which resulted in a crowded playground where not all curriculum requests could be fulfilled. It required diligent efforts by program coordinators to oversee the use of space, alongside academic instructors. While they managed the space usage, program coordinators also suggested relevant resources and helpful network connections to Innovation Playground users.

NEEDS EXPRESSED BY ITS USERS

Through the analysis of the testimonials, we were offered a unique inside perspective of frequent users of the playground, among them students, teachers, researchers, team leaders, program committees, and external partners. For the analysis, we used the qualitative research method of 'grounded theory' (Charmaz, 2012). The narrative below is the result of the final steps of analysis. The narrative can be read in the first column, an expression of each element can be found in the second column.

Innovation playground offers…	
a home space	*the need for a physical location that acts as a safe home base for both students and faculty, Dutch and internationals.*
to global citizens	*a firsthand experience into an open, explorative environment needed for driving curiosity in a globalized world.*
Who are looking for…	
human connection	*the need for a fertile environment for starting relationships and growing networks with colleagues and students, in and outside of faculties.*
belonging	*There is a need for a positive and engaged community that supports new endeavors, treats everyone equally (faculty, students, all studies) while still valuing individuality.*
personal development	*There is a need for a launching pad that inspires change and growth on a personal level.*
Who are experiencing…	
unique atmosphere	*Experimental, curious, playful, inviting, and comfortable. It makes for a unique environment for learning, where education can occur that does not have a place anywhere else in THUAS*

magic of discovery	*A mode in which you allow yourself to be surprised, driven by curiosity, and sparked by creativity. It takes form in venturing miraculous projects and doing innovative things.*
boundary crossing	*Venturing creatively and across boundaries into complex wicked problems.*
becoming a professional	*In an environment where all people are considered equal in their contribution, students feel invited to be part of the experience.*
Who are finding…	
educational test field	*a place where teachers have room to experiment with learning methods and forms with actual students.*
localizing expertise	*Involving people from within and outside of THUAS into educational and research activities/programs. Tapping into a network and experiencing their (and your own) willingness to contribute.*
fostering networks	*Bringing to life what it means to be a network university in a practical and purposeful way.*
Who are seeing…	
embodying vision	*There is a need for concrete realization and manifestation of the organizational vision ('Let's change') and strategical (WIN) themes.*
incongruency	*When decisions are not in line with a vision, it is felt. Action contradicting policies weakens the trust in and connection to our narrative.*
dissonance	*Too often decisions in the organization are made with little regard to the educational rhythm, the need to support education continuously, or guidelines within the organization.*
And experiencing…	
campus facilities	*Facilities at THUAS are valued low in the NSE scores, there is a need for better facilities.*
external relations	*External partners (research and educational) express their appreciation for a place and programming like this. They are brought into the Innovation Playground and connected directly to students, staff, researchers, and new ideas.*

Table 2 Narrative of needs in categories

The outcomes suggest community building aspects are especially valued by Innovation Playground users. We also see that the value of the space and its programming goes beyond the educational opportunities it offers to the students. Teachers notice fertile grounds and find peers to experiment with, reflect on and evaluate educational forms, which are often cross- or interdisciplinary.

To regard only the users of the innovation playground is an isolated perspective; the testimonials are embedded in a context and also serve as a reflection on the current state of the university's facilities and its vision. The two final categories in the narrative address this.

DISCUSSION & CONCLUSION

The CDIO framework standard 6 offers insight into how to design facilities to fit with the phases c*onceive, design, implement, operate,* and situate them in the building and in relation to each other. Standard 5 offers insight on how to embed these working spaces into curricula of engineering education through design-implement experiences. The different usage modes and challenges of the engineering workspaces are discussed. A see-saw effect appears when wanting to adhere to standard 5's call to be curriculum driven. Focusing on one curriculum made it challenging to stay open to all programs. The vision of the Innovation Playground set out to create their own thematic

programming. Since there were so many curricula to adhere to, the space was not inherently driven by them. Through the themes, a connection was often found for various programs which allowed them to facilitate their educational programs within these contexts. The themes allowed for and invited cross- and interdisciplinary work, something that is much desired, yet difficult to facilitate, in the educational practice of this institute.

The outcomes of the testimonials and analysis of the activities result in seeing that the community building activities are highly valued by the students and staff. This is in line with what Young et al. concluded; that the workspaces play a central role for building communities amongst students (2005): (…) *Students use the spaces to study disciplinary courses and for social functions. The workspaces can also provide facilities for student clubs devoted to tinkering, model-building, and other extracurricular projects. This accounts for both the students and staff members using an MLE.* Even though the curriculum activities might have persuaded the students into this space, it is the community building activities that invited them to explore beyond their discipline and regular activities. The extra-curricular activities that were organized felt like a home space to the students.

There are two facets relevant to the research findings that are underexposed in the CDIO framework and guidelines. The first is to what extent a place like the Innovation Playground offers room for reflection and educational innovation among teaching staff. Staff indicated this space was an enrichment to their educational development process, with the added bonus that students interacted with other disciplines.
The second facet involves the audience beyond the engineering domain. Previous conference case descriptions of engineering working spaces offer insight in how these spaces contribute to the learning outcomes specifically for engineering education. Unfortunately, they lack insight on how to design MLE's relevant for creating a context beyond engineering education. A larger context offers opportunities and encourages behavior that aligns with the extended CDIO syllabus on Leadership & Entrepreneurship.

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BIOGRAPHICAL INFORMATION

We, three THUAS residents, researched the needs that environments like the Innovation Playground fulfil. Through this research we are experiencing and understanding the full and actual value of the Innovation Playground. It was executed by us voluntarily, we were not paid or asked to do this, just intrinsically curious to the magic of this place.

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