INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
6 & 7 SEPTEMBER 2018, DYSON SCHOOL OF DESIGN ENGINEERING, IMPERIAL COLLEGE, LONDON, UNITED KINGDOM

# COMMUNITY OF TECHNOLOGY, UNLEASH YOUR POWER TO EDUCATE - "A NEW ORGANISATIONAL APPROACH TO INTEGRATE COMPETENCE, KNOWLEDGE AND SOLUTION DRIVEN PATHWAYS"

**Braam WILCO, Mirjam VAN DEN BOSCH, Stefan PERSAUD and Peter TROXLER**
School of Engineering and Applied Sciences, Rotterdam University of Applied Sciences

**ABSTRACT**
Trends and driving forces around us are moving fast in multiple directions. Technical developments in the fields of circular economy, internet of things, bio-based products, robotics, energy and materials are influencing and reshaping our transactional and contextual environment. To create integrated knowledge and practical solutions within these complex environments, the need for multidisciplinary and flexible collaboration is growing. This means that a broad range of disciplines have to work together and integrate their knowledge and competences to achieve interdisciplinary practical solutions. Educational systems need to reorganise to prepare students for work in the complex and dynamic context of the future. Therefore, educational systems must absorb, facilitate and stimulate this mechanism of integration. Useful models for developing an educational integration are Wenger's model of the Seven Principles for Cultivating Communities of Practice [1] and the Quintuple Helix model by Carayannis [3] Combining these principles and models into practice, the School of Engineering and Applied Sciences needed a different view of how to structure and organise our educational processes, competences, knowledge and resources. In this paper, we describe how we restructured our collaboration within the existing educational system. We studied the effects and outcomes of several principles within the context of the School of Engineering and Applied Sciences.

*Keywords: Community of Practice, Community of Technology*

## 1 SCHOOL OF ENGINEERING AND APPLIED SCIENCE

The School of Engineering and Applied Science (EAS) is one of twelve Schools at Rotterdam University of Applied Sciences. Its eight bachelor's degree programmes are Automotive Engineering, Biology & Medical Laboratory Research, Chemistry, Electrical and Electronics Engineering, Healthcare Technology, Industrial Design Engineering, and Mechanical Engineering. The programmes are situated on three different locations in the city of Rotterdam. The education is competence driven. Research is knowledge driven and practice-based [4]. Solutions are innovation driven and must have uniqueness and create value for stakeholders. The objective of the School is to educate future-proof and self-conscious engineers who can develop innovative solutions for the local economy.

## 2 NEW TRANSACTIONAL AND CONTEXTUAL ENVIRONMENTS

The city of Rotterdam and her surrounding environment is changing in multiple directions due to the rapid technical developments in the fields of circular economy, internet of things, bio-based products, robotics, energy and materials. These changes are influencing and reshaping the transactional and contextual environment of education, research and society. The triple helix learning environment model [5] defines three entities within the institute: research, education and business. In this model, the development of the student is central, this can be considered micro level. For developing a shared value between education, research and innovation, we need a triple helix model on organisational level (meso/transactional context). To understand the trends and driving forces within the contextual environment at a macro level we use the quintuple helix model [3]. We developed the TECH Community of Practice for EAS that consists of five Communities of Technology (CoT) [6] based upon Wenger's model of Communities of Practice (CoP) [1], and Social Learning Theory [2]. The

elements community, identity, experience and practice, are well applicable for of the contextual situation of Rotterdam. The CoT is an organisational vehicle that creates multidisciplinary and flexible CoP collaboration between educational pathways, research pathways and solution pathways. The objective is creating integrated knowledge and practical solutions within a (context rich) learning environment. Therefore, educational systems must absorb, facilitate and/or stimulate this mechanism of integration of education, solution and research pathways. According to Wenger's CoP [1] a shared vision, community building and shared decision making are critical success factors.

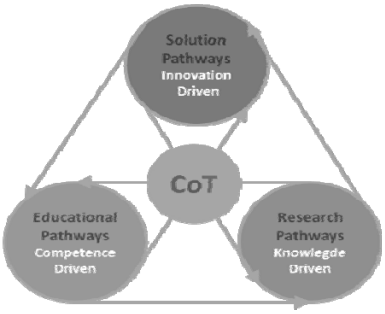


*Figure 1. Community of Technology model, Triple Helix at organisational level [6]*

## 3 EVOLUTION TO COMMUNITY OF TECHNOLOGY

In 2015 the School of EAS was the initiation base of our first Community of Practice in the field of Research, Innovation and Education (EASCoP). The idea of EASCoP was born from out the need to structure the reinforcing integration of our Solution Pathways (SP), Research Pathways (RP) and Educational Pathways (EP). In the first year of EASCoP the community grew from 6 to 21 members, representing all eight programmes of the institute (table 1). During the development of EASCoP, five technology domains (Robotics, Smart Products & Systems, Biobased & Circular, Process & Energy, and Advanced Structures) were collectively established in 2016. Labeling and structuring EASCoP in five technology domains created a clear interface towards other disciplines inside and outside the school. This positive mechanism led to the new name TECHCoP in 2017. During the development of TECHCoP it also emerged that more technology domain specific gatherings were needed. This need was translated to the development of five autonomous Community of Technology's (CoT: Robotics, Smart Products & Systems, Biobased & Circular, Process & Energy, and Advanced Structures). We defined technology as tools, knowledge, skills and competences needed to develop applications (product and/or service) that create value in human life.

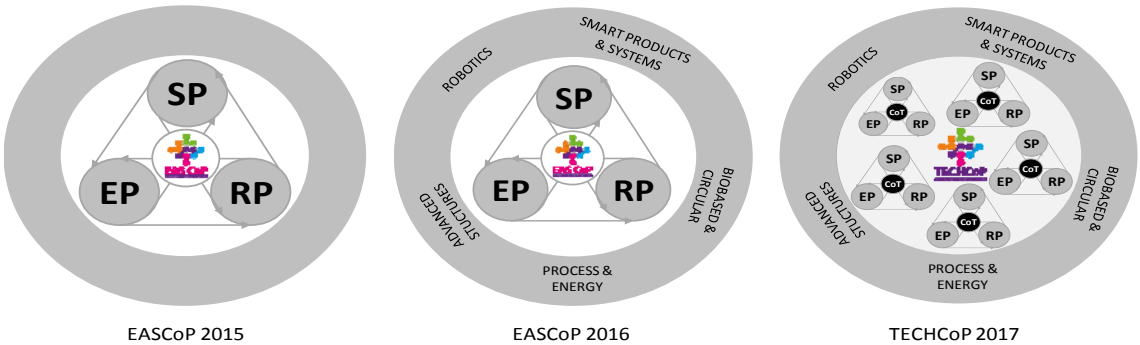


*Figure 2. Community Evolution [6]*

*Table 1. Quantitative Community Evolution*

| Community Evolution (Number of..) | EASCoP 2015 | EASCoP 2016 | TECHCoP 2017 |
|---|---|---|---|
| Community members | 21 | 36 | 67 |
| Multidisciplinary research tracks | 12 | 17 | 21 |
| Students participating in research tracks | 108 | 152 | 162 |
| Formal gatherings | 12 | 15 | 26 |
| Participating educational programmes | 7 | 10 | 13 |
| Participating schools (Rotterdam University) | 3 | 4 | 5 |
| Participating research centres | 2 | 4 | 5 |

# 4 COMMUNITIES OF PRACTICE (WENGER)

For the initiation, design and development of our Community's we used the Seven (design) Principles for Cultivating Communities of Practice as a guidance, "The goal of community design is to bring out the community's own internal direction, character, and energy" [1]. This goal is causally related to the organic growth and aliveness of communities. The seven design principles of Wenger are not a recipe but more an embodiment of our understanding how these elements of design work together. We will discuss how we applied each principle in the context of our school.

## 4.1 Design for Evolution

We continuously restructured the organisation of the CoP's, using the existing projects by students, lecturers, researchers and the networks of companies. One exemplary project is the Circular Lounge project. In this project students and lecturers from Industrial Design Engineering and Chemistry collaborated. The company involved, Van Gansewinkel, is a Dutch waste management company. They gave access to their network of partners: plastic manufacturers, plastic recyclers and designers. The focus in the project changed over time, and different groups were put in the lead. Sometimes the design students studied solutions for injection molding of recycled granulate and other times the focus was on chemical bonding of polymers. This created legitimate participation for every subgroup. The core members invited other people to participate as well to sustain fresh input and to drive the project forward. The continuous reshaping, redefining and recreating brought participants together in a shared perspective needed for the drive. The key factor for managing the developments in the right direction was being involved and at the same time creating space for development. Meeting each other regularly at central meetings but also coincidental at the coffee machine, knowing where others' projects were going and where your own project was going. It was about letting go of the existing hierarchical structures within the school, creating an inclusive atmosphere and shepherding the group in the right direction.

## 4.2 Open a Dialogue between Inside and Outside Perspectives

When designing a good community, two factors play a key role: the insider's perspective for discovering the community identity and the outsider's perspective to see possibilities of the community's potential. To facilitate the collective experience of community members we organised monthly meetings with all CoP members. In these meetings members shared existing projects and focused on structuring and creating an overview of all active projects. Dialogue and discussions were held for discovering similarity or relationships between trends and driving forces for each project. Twice a year we organised a CoP-café where results were presented to inspire and share. These meetings facilitated the connection of individual pathways (EP, RP and SP) to group initiatives and relating the benefit of the CoP to personal networks. An example is the Swarming Robot project in which different disciplines were involved – mechatronics (Mechanical Engineering), embedded systems (Electrical Engineering), algorithms (Computer Engineering), housing and locomotion (Industrial Design Engineering). To help community members see the possibilities or the potential of what the community could achieve, CoP members mapped out and prioritised the driving forces and trends based on research by experts. This resulted in a shared definition of the five technology domains. What still needs to be done is discussing the technology domains with external experts. This could provide feedback for every pathway: EP redefining curricula, SP recreating benefit, RP regenerating knowledge.

## 4.3 Invite Different Levels of Participation

For good community architecture, one needs to invite many levels of participation: core members actively participate in discussions, project and identify topics, active members attend meetings regularly and are attached, and peripheral members rarely participate and have no authority or have lack of time. People surrounding the community show an interest in the community. In our CoT's we have created opportunities to participate freely at an appropriate level. Unfortunately, this has not resulted in a balanced configuration of all community members. Only a few senior researchers participated in the CoT's as core members. In our school there were enough active members but a shortage of core members. For taking the role of core member we also noticed a competence gap in terms of leadership with active members to make the transition to core members. Some CoT's needed more development or maturing. Possibly, they needed more time to adapt the idea of core and active members within the CoT's. What also needs to be developed is that all members make their objectives for participation more explicit. Although many active members participated in a CoT, they had a strongly inward focus. This lowered the sharing of thoughts, insights and opportunities outside the CoT meetings. One positive outcome was that many participants acted as peers to each other. We found that it remained difficult for potential CoT members to breakout of the chores of existing educational organisational systems, schedules, structures and hierarchies to participate freely. What could help potential members overcome these barriers would be to create more autonomy, let active members shine, take ownership, foster, and nurture a culture of growth mindset [7].

### 4.4 Develop Both Public and Private Community Spaces

Dynamic communities have many ways of connecting in both public (meetings, web) and private spaces (one-to-one networking). To create connections in the public space, we started by organising monthly meetings for the entire EASCoP which later became quarterly meetings for each separate CoT. For connecting the entire CoT's together, we organised a TECHCoP meeting with TECHCoP-café twice a year for sharing, inspiring and networking. To create overview and structure of the entire TECHCoP we were developing a digital platform, KUMU, which was an interactive website that documented all the CoT related research projects and their relations. What could be helpful for deepening relationships is developing situations where people can explore cross-links and distillate the several types of community members. An obstacle was the physical distance between locations. Some locations of our school are 20 minutes travel time apart. This lack of just-in-time and co-incidental (informal / not planned) contact between several disciplines / actors reduced building trust, co-creation and personal connection. However, the school would need more public and private spaces as enablers for community building. We are currently developing more public, open labs with core and active members, where all kind of members can meet and experiment (example: robot lab, aqua lab, circular hub, energy lab). A challenge is the function of these open labs. They must be usable for everybody but must not be claimed as "theirs" by anybody, they must provide an open access but need to be recognisable as CoT-labs, and they should act as a technical and organisational enabler for the education, solution and research pathway.

### 4.5 Focus on Value

Participation in the TECHCoP CoT's was (and still is) voluntary. Therefore, value creation on organisational, team and member level would be necessary. During the evolution of our communities the search for shared values was a never-ending process. The community dialog resulted in a shared vision to regroup our CoP based on five CoT domains. This is in line with Wenger's principles: "as the community grows, developing a systematic body of knowledge that can be easily accessed becomes more important" [1]. Every CoT developed their own technology sub domains autonomous (table 2). This process helped the CoT's to build their own and shared identity and reason for existence. We noticed that within our school, it was a challenge to facilitate "small everyday interaction" [1] due to physical and perceived distance between different educational departments and programmes. In the future we would have to encourage and facilitate CoT community members to meet informally more often. These informal meetings would enable non-linear mechanisms that would reinforce trust, idea generation and community building. During the development of our CoT's we noticed a few critical elements leading to positive developments. In the first place, we created value for community members to use structure and reposition existing (research) projects (current problems).

*Table 2. Technology Subdomains*

| TECHCoP CoT's | Technology Subdomains | | | |
|---|---|---|---|---|
| Robotics | Awareness Vision | Intelligent Control | Swarming & Connectivity | Simulation & VR |
| Smart Products & Systems | Sensors & Embedded | Energy Harvesting & Use | Interaction & Human Interface | Data & Diagnosis |
| Biobased & Circular | Bio-based Molecules | Bio-based Materials & Chemistry | Circular Materials | Circular Design & Products |
| Process & Energy | Power Generation | Process Intensification | Energy Efficiency | Energy Infrastructure |
| Advanced Structures | Materials | Structural Design | Production | Simulation |

The connection between existing (research) projects and the five technology domains was very helpful for creating overview. We also used existing educational pathways to connect the different disciplines required for projects. This probably was the most successful contribution to create support and engagement from different courses and to ensure access to needed disciplines. For a research project on swarming robots, we involved three courses in to ensure continuity in knowledge generation and access to (technical) disciplines. It was quite a challenge to create alignment between the different transition paces of these courses, finding and facilitating the sweet spots (incremental versus radical).

### 4.6 Combine Familiarity and Excitement

"Successful communities offer the familiar comforts of a hometown, but they also have enough interesting and varied events to keep new ideas and new people cycling into the community" [1]. A community is a neutral place. From the beginning, we made it very explicit that all community members were peers. The use of existing (research) projects and educational structures created a familiar setting for the community members. Almost all regular CoT meetings took place at the knowledge hub at the university library. This knowledge hub, together with a close by coffee corner, became a familiar TECHCoP base. A new level of energy (excitement) within the community emerged during a meeting on technological trends. Mapping and prioritising trends brought people from different courses and disciplines together, resulting in transdisciplinary understanding of technologies and their applications. This formed the foundation for the five CoT's and related multi-disciplinary research projects. In addition, to celebrate, share results and inspire we organised a TECHCoP-Café twice a year. This (informal) event was accessible for everyone (students, teachers, researchers and companies). In the future, we would want to create more mental and physical space and freedom for community members to participate. In addition, we would want to stay on top of trends and driving forces and make this foresight and visioning process more dynamic (TrendLab). We could also utilise the opportunity to create a more familiar and exciting community setting at our labs. These physical places could be initiated or transformed into real community labs (CoT-Labs) with their own identity.

### 4.7 Create a Rhythm for the Community

"The rhythms of the community are the strongest indicator of its aliveness" [1]. Each of the five CoT's had their own rhythm in development and (in) formal gatherings. In the beginning of the academic year, we planned and communicated most of the community meetings and events. An annual planned overview was deemed crucial for (optional) community participation because lecture schedules are planned tight and well in advance. This created the possibility for community members to neutralise overlap. As mentioned above it was quite a challenge to create alignment. It equally was a challenge to find a time for physical community meetings, given the constraints of courses and their schedules. Within our school, it took us two years to free up Thursday or Wednesday afternoons (15h00-17h00) accordingly. We found that of the three pathways, the educational pathway was the least flexible. To keep all members attached to the rhythm of their CoT, we created a digital platform, KUMU, a website where every CoT could update their developments and future activities. It was important to keep knowledge up to date, therefore active and core members were required to take ownership.

Because the TECHCoP had many (internal and external) events, there was a risk of "hyperventilation" – decreasing focus and increasing competition between events. Therefore, in the future, we would want to limit the number of events per CoT per year.

## 5 CONCLUSIONS

After three years, developing TECHCoP within the School of Engineering and Applied Sciences we can conclude that identifying three pathways with their own value drivers (Competence, Innovation and Knowledge) has created a clear understanding of different perspectives and objectives. It has enabled a discussion of shared value creation and of where and how CoT's can achieve mutually positive reinforcement. We would need more physical places for informal gatherings, shared familiar and exciting public spaces to facilitate small everyday interaction, easy to use but not hard to take possession of, with their own open recognisable identity. From our point of view, this would be one of the most critical organisational enablers for future CoT developments. This means developing and repositioning our labs with actively involved community members. CoT's would also need allocated time and a flexible, organic growth model. Their development would be continuously searching and reshaping their structure – in contrast to the faster rate of change of the solution pathways, the lower speed of the research pathway and the rather rigid and inflexible (planned and fixed) education pathway. Empathically managing expectations of each pathway would be critical for sustainable CoT development, ideally resulting in an alignment of rhythms of each pathway for explicit value creation and proposition. We would need to invest more in development and availability of skillful and reputable community facilitators, core community members who could shepherd the CoT. The required set of competences is typically not always available yet amongst engineers, there is an evident gap of competence. This is a subject underemphasised by Wenger but for our and a general context of design, a critical success factor. However, if properly acknowledged, these competences could easily be developed. Within the community, members build up organic relationships. Sometimes, this is in contrast to the formal and hierarchical position community members have within the organisation of their own pathway. The focus on peer relationships reshapes the way community members are interacting with each other and we need stay aware of the importance. Within the university, other schools are beginning to participate in the CoT's, too. For example, CoT Robotics has participants from the School of Communication, Media and Information Technology and the Rotterdam Mainport Institute. While extremely promising in terms of transdisciplinary cooperation, the challenge remains to synchronise rigid educational schedules across schools. Working on projects with companies (and their quick-paced solution pathway) can make the CoT's shortsighted and reactive. The community would need more interactive validation between the three pathways on the level of the Quintuple Helix building on a pro-active community attitude towards trends and driving forces. Overall, one of the major challenges for developing CoT's is shifting the community members from safe relationships within more rigid educational, business and research structures to new open, voluntary and loyalty-based relationships within a more flexible, ever changing organic structure. And vice versa. This new organisational approach to integrate competence, knowledge and solution driven pathways in CoT's is a sustainable way to unleash the power to educate.

## REFERENCES


[1] Wenger E., McDermott R. and Snyder W. *Cultivating Communities of Practice: A Guide to Managing Knowledge,* Harvard Business School Press, 2002

[2] Wenger, E. , *Communities of Practice: Learning, Meaning, and Identity,* Harvard University Press, 1998

[3] Carayannis E., Barth T.D. and Campbell D.F.J. The Quintuple Helix Innovation Model, *Journal of Innovation and Entrepreneurship,* 2012 1:2.

[4] Andriessen D., *Praktisch relevant én methodisch grondig?* Openbare les Hogeschool Utrecht, 2014.

[5] Blom S., van den Bosch M., Flipsen B., Persaud S.M. Engineering students become sustainable practitioners by combining profound learning and sustainable education, *Engineering Education for Sustainable Development, Cambridge, UK.* 2013.

[6] Braam, W. and Persaud, S. *Value Creation along Pathways of Education, Research and Solutions.* White paper, Rotterdam University of Applied Sciences. 2017.

[7] Dweck, C., *Mindset: The New Psychology of Success,* Random House USA, 2006