IMPLEMENTING CDIO IN TWELVE PROGRAMS SIMULTANEOUSLY: CHANGE MANAGEMENT

Suzanne Hallenga-Brink, Oda Kok

The Hague University of Applied Sciences, Faculty of Technology, Innovation and Society.

ABSTRACT

Since March 2015 the Faculty of Technology, Innovation and Society (TIS) of The Hague University of Applied Sciences (THUAS) is a CDIO member with all its twelve programs: Mechanical Engineering, Engineering Management, Mechatronics, Electrical Engineering, Building Engineering, Civil Engineering, Climate and Management, Industrial Design Engineering, Industrial Design Engineering [Open Innovator], Engineering Physics, Mathematics & Applications, and Process & Food Technology. This paper describes the implementation of CDIO at TIS and discusses methods, opportunities and challenges of such a large endeavor. The CDIO standards have been coupled to the faculty and program policy plans, based on a comparison of CDIO and the Dutch/Flemish compulsory NVAO accreditation standards. The self-evaluation process has exposed differences between the programs, which has lead to grouping them in a fast track (already working with CDIO), a drawing board track (implementing CDIO in a future new curriculum design) and a quality track (using CDIO to improve the quality of the current program). Each track has its own needs and challenges, and thus requires a different approach and will show a different speed of adaptation. Other factors also plea for a more customized implementation process. Challenges discussed are the varying level of understanding of CDIO, combining CDIO with educational blueprints such as 4C/ID or design thinking, technical bachelor of applied sciences programs versus engineering ones and the motivational drivers for change on faculty staff member level. Working in a professional CDIO learning community leads to ownership of CDIO. Despite being a top-down decision, the adoption of CDIO in the twelve programs takes place bottom-up, ensuring continuous education improvement.

KEYWORDS

Change management in an organization of professionals, large scale CDIO implementation, NVAO, all standards.

INTRODUCTION

The Hague University of Applied Sciences is 28 years old, a merger of fourteen schools in the region. It houses about 25.000 students of about 100 nationalities in seven different faculties, where about 2000 employees work. In total there are 44 Bachelor degree programs. The university also offers thirteen masters, several part-time, dual and associate degree options, and over 60 post-bachelor courses, trainings and master classes. The main campus is in The Hague, with satellites in Delft (Technology Campus), Zoetermeer (ICT Innovation) and The Hague Sports Campus. The faculty of Technology, Innovation and Society (TIS) is

located both in the main campus and in Delft and has twelve programs, see table 1. Each is lead by a Head of Program and is grouped in one of five clusters, run by a Program Manager. THUAS' IT programs are part of another faculty.

Table 1. Clusters of the twelve programs of the Faculty of Technology, Innovation and Society (TIS) of The Hague University of Applied Sciences (THUAS).

TIS Clusters	Programs
Cluster BK, CT, CLE	Building Engineering (BK), Civil Engineering (CT), Climate & Management (CLE)
Cluster IPO, IDE	Industrial Design Engineering (IPO, 4 years bachelor program in Dutch), Industrial Design Engineering [Open] Innovator (IDE, international 3 years bachelor program in English)
Cluster PFT, TN, TW	Process & Food Technology (PFT, international 3/4 year bachelor program in English), Engineering Physics (TN), Mathematics & Applications (TW)
Cluster TBK, E, MECH	Electric Engineering (E), Mechatronics (M), Engineering Management (TBK)
Cluster W	Mechanical Engineering (W)

The aim of the Faculty of TIS is to provide high-quality, innovative education by establishing links between teaching, practice and applied research. For this purpose, TIS forms durable networks with local, national and international companies and institutions. Education and research is developed in co-production with students, external partners and the University's research groups. Facilities such as project studios, living labs and the H/Betafactory are at the students' disposal for authentic learning experiences, experimenting and prototyping.

DRIVERS FOR ADOPTING CDIO

Organizational drivers

The decision to implement CDIO was based on mid-management enthusiasm to adopt the framework for its merits in lifecycle thinking and its accrediting standards in two of the programs of TIS. The Engineering Management program (TBK), which is located in Delft, redesigned its curriculum based on CDIO principles, after presenting at the CDIO Boston conference in 2013. In The Hague in the meantime, Process & Food Technology (PFT) also used CDIO as their educational framework. At that time both programs belonged to different faculties. When TIS was formed during the reorganization of THUAS in 2014, the role that CDIO had played in the two separate programs led to the management's ambition to adopt CDIO as the designated educational innovation framework for all programs. The framework could function as a bridge between the different program cultures now united in one faculty, and as a common language in assessing the quality of the educational programs.

Strategic WINQ goals

Apart from an internal benchmark tool, there was also a need to benchmark the programs in an international setting. At THUAS all students are offered the opportunity to develop their international competences, as THUAS intents to be the most international University of Applied Sciences in the Netherlands. Besides Internationalization, THUAS has chosen World Citizenship, Networking, and Quality (WINQ) as its strategic goals for the coming years (THUAS, 2014). Strategic alliances and efforts within the faculties need to be in line with WINQ. With World Citizenship the university aims not only to qualify students for a profession

but also to reinforce them as concerned, conscious, critical, and inquisitive human beings. To be innovative, knowledge has to circulate in an open connection between education, research and the professional practice. As a higher education institution, THUAS can play an important networking role in such open innovation networks (Hallenga-Brink & Vervoort, 2015). While working towards all these goals THUAS seeks to fortify a university employee culture of continuous improvement in quality. With WINQ in mind, the worldwide span of CDIO appealed, as well as the learning community approach and networking opportunities with other universities it provides. Adopting CDIO was a step forward for TIS in regards to both the Internationalization and the Networking goals. With sustainability, ethics, cultural differences and international communication embedded in the CDIO syllabus 2.0 (Crawley et. al., 2011), adopting CDIO would also contribute to the world-citizenship of TIS' students. And CDIO could function as a qualitative quality management system, in addition to the more quantitatively directed national accreditation system NVAO, by regularly self-evaluating on the CDIO standards (Crawley et. al., 2014).

Educational drivers

Next to the managerial and strategic drivers, educational drivers were equally important to adopt CDIO. In the application (Hallenga-Brink, 2014) TIS stated: "…*In all our ambition CDIO is a valuable standard for our engineering education; one that fits our vision. Its syllabus helps us to truly support students in the development of their professional identity. Its structure is highly effective for quality evaluation and improvement of our bachelor programs. And CDIO offers a concise framework for new curriculum development, helping us to take 'active learning', which has been on the university's agenda for some time now, to the next level…"* Belonging to a university of applied sciences, the engineering programs of THUAS have historically always been geared towards delivering engineers who can engineer and working closely together with future employers of the students. However, also from a historic point of view, undergraduate engineering education has also focused mainly on the disciplinary knowledge and skills, the professional expertise. With the emerging notion that students need 21st century skills to be employable to the many models of what these 21st century skills exactly are (Mishra & Kereluik, 2011), the search began what pivotal elements a curriculum of the 21st century would need: cross-curricular key skills, learning through experience, learning outside the direct academic context, blended learning etc. CDIO offers both an educational framework based on good practices of many international universities and universities of applied sciences, as well as a learning community to continuously improve this model. To add to the (applied) engineering education research within the CDIO network TIS wrote: *"… we also feel we can bring something to the CDIO network, for instance our experience with design-implement education in authentic learning environments, positioning the university as a (innovation and learning) network hub in society and using integrated learning didactics. …"* For example, THUAS' lector Frans Meijers led research by his research group on developing professional identity of students in higher education (Meijers, 2008). He identified three main conditions for developing a professional identity: learning should take place in an authentic setting, students should have the opportunity to choose part of their study activities according to their personal developing goals and there should be a professional, reciprocal dialogue between students and teachers about their development. The CDIO framework and the results of this research reinforce each other.

Based on these strategic, managerial, organizational, and educational drivers, the decision was made to move forward and apply for CDIO membership for all twelve of TIS' programs. No exception was made for the 2 technical Bachelor of Applied Science programs within the faculty, as one of them, PFT, had already implemented CDIO and other CDIO members also

had such programs in the network. After applying officially, in March 2015 TIS was accepted.

METHODS OF IMPLEMENTING CDIO AT TWELVE PROGRAMS AT ONCE

Not project manager, not program manager, but process director

It was a top-down decision of the management team to apply for CDIO membership. Implementing changes according to the CDIO standards is a complex process within one program, let alone twelve at the same time. Opposition, doubts, criticism and discussion were all expected, and a bottom-up approach was chosen to deal with this. The driving forces in the two programs who already applied CDIO principles were assistant professors who did not have the means nor interest in this organizational and educational change management endeavor. Therefore, an educational sciences specialist with engineering background was appointed as process director for one and a half day per week to guide the process of application and implementation in all twelve programs. The implementation process was intentionally not labeled as a project, which has a clear goal, timeline, deadline and deliverables as result. CDIO is not something you do once and finish completely. It was also not labeled as a program, as that suggested it would run parallel to the efforts the study programs would put into designing, redesigning and improving their curriculum. For it to truly land and become daily practice the implementation process needed to take place within the course programs internally, with ownership from within the program, and bottom-up.

Mapping causes of opposition

When changing a curriculum, the easiest position to be in is if there is a high urgency and a high preparedness felt within the organization (Kamp & Klaassen, 2013). When internal concerns need solving and everybody feels that need, making sure everybody remains involved is enough and the organization can get to work. When there is a high urgency but low preparedness leadership commitment is an important starting point. And when there is a low urgency but high preparedness, capacities of employees can be explored and facilitated in a bottom-up approach. In the case of implementing CDIO at TIS, all three variations were seen. The process director first observed developments and attitudes per program on all levels. Opposition to the implementation of CDIO could be lead back to three causes as described by Mars (2006): urgency, incomplete information and the uncertainty for one's position that changes brought along.

Urgency

The decision to become CDIO was taken top-down, and overall management commitment was good on paper. The self-evaluations for the application helped to establish if there was a high urgency within the programs, and the results varied. One could argue that high scores on the self-evaluation lead to a low sense of urgency. But scores could be high depending on who one would ask. For instance, active learning had been a focal point of the university for a while already. This lead to beliefs that 'we already do this' (low urgency), as well as to beliefs that CDIO was a good way to finally 'really' implement active learning in the programs consistently (increasing urgency). In that sense the choice for CDIO lead to doubts within the teams on the urgency of that choice. 'Who says we should do this?' 'Do we need this change, aren't we doing well enough?' 'Shouldn't we first finish the last change?' 'Aren't there more important things to keep us busy?' etc. And doubts can lead to opposition (Mars, 2006).

Incomplete information

Another factor increasing opposition that Mars mentions (2006) is incomplete information. Not only doubts on urgency have a negative effect, but also doubts on the solution and doubts on the process. Because CDIO is quite an elaborate framework, incomplete information and partial interpretations are a high risk. Two of the twelve programs already worked with CDIO, but each had a different interpretation of the merits of the framework, and the teams had different attitudes towards it. Hence they could not automatically 'spread the word' to other programs. Doubts prevented some staff members from diving deep into the idea and knowledge behind CDIO, thinking 'this probably won't help' 'it is a fad' 'we already do this' 'old wine in new bags' 'too ambitious'. And sometimes there just hadn't been enough time to become well informed yet. Maybe the whole thing would blow over, so was it worth investing already?

Uncertainty about one's own position

A last factor for opposition (Mars, 2006) is the uncertainty about one's own position that a curriculum change driven by CDIO could cause. Not every staff member was convinced the changes done in the name of CDIO would have a positive effect on their daily activities. From filling in the first self-evaluations it was evident that ideas about 'activating education' or 'integrating personal and interpersonal skills in a course' were defined on different levels by different teams or individuals. CDIO sheds a different light on teaching competences and set the bar differently. Would lecuers be able to keep teaching as they were used to and believed to be a good way? This lead to doubts about the process: 'nobody asked us' 'the wrong people are in the task force' 'we don't have the means for this' 'there is already so much we have to do'.

Finding the value of CDIO

Having doubts and factors for opposition mapped, these could be addressed in the implementation approach. It is good to be aware of causes for opposition, be prepared for them and anticipate them. But focus should not only be on solving the negative. While a sense of urgency is a pushing force towards commitment, formulating ambitions can be a pulling force (Mars, 2006) that helps to put the dot on the horizon and prevent false consensus. Aspects such as planning, interaction and leadership are important in a change process because they can lead to commitment and being connected. In the end, implementation and change happen best when the people doing it have found an intrinsic motivation to commit to it. And for that everybody needs to find out what the value of CDIO is for them personally. And these values are bound to be different.

Leadership: Ready? Set! Follow!

In order to create support and ownership of CDIO in all layers in a bottom-up approach, it was still important that management showed clarity, support and facilitation. Their intentions on CDIO were formulated in the 2015 faculty-wide policy plan and spread to all programs in posters and leaflets:
1. We educate people to Conceive, Design, Implement and Operate in an integrated way.
2. We intensify collaborations within our local and international networks of schools and businesses.
3. We facilitate coproduction between students, researchers, teachers and businesses.
4. We coach people to articulate personal learning goals.

5. We help people to develop a unique professional identity.
6. We prepare people for an international career.
7. We create a healthy work-life balance for our people.
8. We reflect on what we do and try to do it better.

This set the dot on the horizon. However, there was still a risk of false consensus, when everybody thinks they chase the same goals, but interpretations vary considerably.

To go around that problem the role of the process director was to detect surfacing needs during the process and facilitate on demand. Rather than presenting teams with one solution to fit all, in other words one truth, in a 'follow, follow, ...lead' approach based on neuro-linguistic programming (Derks & Hollander, 2015) the different personal and team drivers for change were accepted and taken into account. Consequently, the needs would differ and they were clustered using spiral dynamics theory (Koenders & Nientied, 2011). Based on needs for safeguarding/emphasizing what is already there (purple), rules and structure (blue), focusing on result and success (orange), collaboration (green), concepting and experimenting (yellow), striving for a holistically better educational system (turquoise) and any combination of those, plans of action could be formed together or independently. As a result, not only different priorities in CDIO standards could be picked due to the self-evaluations, but different ways to get there that fitted each team best could form as well. For instance, in 'we reflect on what we do and try to do it better' the word better has quite a different meaning in the different teams, depending on their color(s).

Planning: All aboard, but each in their own pace

When implementing CDIO in twelve programs at the same time, one needs to keep in mind that each program is in another phase of its development. The programs vary from 26-year-old, settled programs that were once pioneers in their field such as Industrial Design Engineering, to young pioneers such as Mechatronics. Some have small numbers of students or compact teaching staff, enabling flexibility and quick decision making, whereas others have hierarchical structures in place, and longer process trees. Programs differ in intensity of contact hours for students with all effects on teaching work load and room for secondary tasks for staff. Thus each program has different needs and priorities, and asking the same implementation pace of all programs is unrealistic to a certain extent. To deal with the differences three tracks were identified:

• *The Fast Track*: these programs have already implemented CDIO, and needs to keep going. The basics of CDIO are known, they want to make the next step, work on fine-tuning their (teaching) skills, etc. They need to evaluate their efforts so far and adjust and get in sync with the other programs on faculty wide CDIO aspects.
• *The Drawing Board Track*: these programs are in the process of redesigning their curriculum and all time and energy besides the daily practice goes there. Only in the new curriculum will they teach via the CDIO principles. Standards and syllabus can already be included in the plans, but only on paper. There is no direct need for hands-on working with CDIO for learning purposes, unless they like to experiment in their 'old' program for 'prototyping' purposes.
• *The Quality Track*: these programs are in the middle of a curriculum without the need for a big redesign, so CDIO will be used as a quality improvement tool on incidental basis.

Challenges with the tracks were that in some TIS clusters there were different tracks, so the 'one cluster approach' was not possible. And within a track, the value of CDIO could be and still was viewed differently. For instance, people in the drawing board track with orange types of needs would get impatient for direct results. To be in the quality track and have blue needs could lead to a desire for more thorough rules for the whole program straight away, or to be

in the fast track with purple needs could mean although being forced to do it still falling back to 'the old ways' whenever possible.

A roadmap was formulated to be included in the policy plans of both the faculty and the programs, defining possible actions to be taken by teachers, heads of programs or faculty management. For teachers, items such as increasing one's knowledge of CDIO, actively participating in the CDIO professional learning community, developing or improving an active learning course, involving students and/or the professional field in quality improvement of the course, and sending in conference abstracts were included. Management can take time to celebrate successes, facilitate CDIO experiments with support of the Betafactory, research platforms and supportive university units, make CDIO known to the university's board of directors, add CDIO in PR materials etc. And for Heads of Program the roadmap included actions such as integrating the roadmap in the program plans, steer curriculum commissions towards the use of the CDIO syllabus as a blueprint, look for partners within the CDIO network for exchange and (research) projects, and include CDIO in critical reflections of the program. As an a la carte menu each program can pick the actions and order of the actions to include in their smart goals for the coming year(s). Per cluster the exact roadmap for implementation of CDIO will differ, depending on the context and progress of each of its programs.

Interaction: Towards a Professional Learning Community

Besides the process leadership and the varied program planning, for individual needs for two-way communication with each other about the value of CDIO and its different interpretations, a social learning context was set up. Since 2014 TIS is developing towards a professional culture with result responsible teams. In this endeavor the concept of the Professional Learning Community (PLG) is an important way of facilitating continuous improvement of daily practice. According to Verbiest (2002) PLGs are built on:
• Personal capacity: comprising individuals' ability to construct, reconstruct (revise, adjust) and apply knowledge in an active and reflective manner, making use of up-to-date scholarly and practical theoretical insights.
• Collective capacity: comprising the ability of a group or collective to (re)construct and apply knowledge. This presupposes a shared vision of learning and shared vision of the role of the teacher. Is also implies shared practices amongst teachers.
• Organizational capacity: consisting of cultural and structural conditions supporting the development of the personal and interpersonal capacities. Supportive, stimulating and shared leadership is also an important aspect of this organizational capacity.

In these communities, students, staff and management are working together on the development of a common purpose. A CDIO PLG was formed to address the influence of incomplete information on the willingness, but also and not in the least to dive deep into the implementation process. This process started and continues with visiting the CDIO meetings and conferences with different interested staff members each time, teachers, mid-management and management alike (and in the near future students as well). These visits help to become inspired personally and consequently help spread the 'oil stain' within the faculty afterwards. Next prominent CDIO speakers were invited to the university to introduce staff members to the basics of CDIO as well as give hands-on workshops on active learning and assessment. An experimental CDIO workgroup was initiated by the internal staff development team for ten enthusiastic, early adopting teachers from different programs to work on improving a course on CDIO aspects. An intervision set-up was chosen to provide for support and reciprocal learning for the teachers in their experiments. The next step was to develop a ten week course in active, blended learning for all teaching staff of the faculty (with

a 32-hour work load), in line with the CDIO principles. This 'learning path' is designed by an educational advice company in collaboration with the faculty. From May 2016 onwards this course will be given four times a year for all TIS' teaching staff. Also, the process director functions as a help-desk on demand for the whole faculty; for example, as a sparring partner in the work sessions for the curriculum development of the new Built Environment program (a future merger of the programs Civil Engineering, Building Engineering and Climate and Management), as an advisor for the reconstruction project group (for the main building) on standard 7 'workspaces', but also individually for teachers on their courses. Online key CDIO documents are accessible for all staff.

Aligning with existing frameworks, methods and approaches

Nobody wants to do double work, and during the implementation of CDIO it is therefore important to look at existing frameworks that are compulsory or have been chosen to work with within the faculty. On program level for instance, Mechanical Engineering chose 4C/ID as their educational blueprint for the new curriculum (Merriënboer et. al., 2002) right at the same time as CDIO was decided to be implemented. What is needed is insight in how the two models overlap, add to or contradict each other. In the experimental workgroup a small start was made to gain these insights. At Industrial Design Engineering [Open] Innovator (IDE), many parallels were seen between the CDIO syllabus and standards, and what was the basis of their curriculum: design thinking. There is a strong link between a design thinking curriculum and a CDIO curriculum in the integrated, interdisciplinary approach, teaching students to take contexts into account while solving problems and innovating and including stakeholders in a co-creational way during the process (Hallenga-Brink & Dekelver, 2016). For them the standards added a tool for good quality 'housekeeping' in the organization of the curriculum, and merging the CDIO syllabus with the competence profile of both IDE and the Dutch Industrial Design Engineering (IPO) proved to be a smooth operation.

But also on a higher level, the Accreditation Organization of the Netherlands and Flanders (NVAO) prescribes quality standards for the national accreditation of higher education which the faculty has to abide by. A comparison was made between CDIO and the NVAO accreditation standards, see table 2, partly based on the experiences of PFT. Transparency on this topic was important for the internal change process and led to integrating the CDIO standards into the tools the faculty uses to audit and control the programs such as policy plans, critical reflections and management reports.

Table 2: Relationship between CDIO and NVAO standards

NVAO	Focus	Associated CDIO standards
What is the program aiming for?		
1: The **intended learning outcomes** of the program have been concretized with regard to content, level and orientation; they meet international requirements.	> The intended learning outcomes fit into the Dutch qualifications framework (bachelor level).	
	> They tie in with the international perspective of the requirements currently set by the professional field and the discipline with regard to the contents of the program.	CDIO standard 1 CDIO Context: educating Engineers who can engineer. (Adoption of the principle that product, process, and system lifecycle development and deployment -- Conceiving, Designing, Implementing and Operating -- are the context for engineering education).
	> So far applicable, the intended learning outcomes are in accordance with relevant legislation and regulations.	

With what curriculum?

2: The **orientation of the curriculum** assures the skills development in the field of scientific research/the professional practice.	> The curriculum has demonstrable links with current developments in the professional field and the discipline.	CDIO standard 3 Integrated Curriculum: A curriculum designed with mutually supporting disciplinary courses, with an explicit plan to integrate personal and interpersonal skills, and product, process, and system building skills.
3: The **contents of the curriculum** enable students to achieve the intended learning outcomes.	> The learning outcomes have been adequately translated into attainment targets for (components of) the curriculum.	CDIO standard 2 Learning Outcomes: Specific, detailed learning outcomes for personal and interpersonal skills, and product, process, and system building skills, as well as disciplinary knowledge, consistent with program goals and validated by program stakeholders. + CDIO standard 8 Active Learning: Teaching and learning based on active experiential learning methods.
	> Students follow a study curriculum which is coherent in terms of content.	CDIO standard 3 Integrated Curriculum: A curriculum designed with mutually supporting disciplinary courses, with an explicit plan to integrate personal and interpersonal skills, and product, process, and system building skills. + CDIO standard 4 Introduction to Engineering: An introductory course that provides the framework for engineering practice in product, process, and system building, and introduces essential personal and interpersonal skills.
4: The **structure of the curriculum** encourages study and enables students to achieve the intended learning outcomes.	> The teaching concept is in line with the intended learning outcomes and the teaching formats tie in with the teaching concept.	CDIO standard 5 Design-Implement experience: A curriculum that includes two or more design-implement experiences, including one at a basic level and one at an advanced level. + CDIO standard 7: Integrated learning experiences that lead to the acquisition of disciplinary knowledge, as well as personal and interpersonal skills, and product, process, and system building skills.
	> Factors pertaining to the curriculum and hindering students' progress are removed as far as possible.	CDIO standard 8 Active Learning: Teaching and learning based on active experiential learning methods.
	> Students with a functional disability receive additional career tutoring.	
5: The curriculum **ties in** with the **qualifications of the incoming students.**	> The admission requirements are realistic with a view to the intended learning outcomes.	

With what staff?

6: The **staff** is qualified and the size of the staff is sufficient for the realization of the curriculum in terms of content, educational expertise and organization.	> The factual expertise available among the staff ties in with the requirements set for professional or academic higher education programs. > This includes content, educational and organizational aspects.	CDIO Standard 9 Faculty CDIO skills: Actions that enhance faculty competence in personal and interpersonal skills, and product, process, and system building skills. + CDIO Standard 10 Faculty Teaching Competence: Actions that enhance faculty competence in providing integrated learning experiences, in using active experiential learning methods, and in assessing student learning.
	> Size of personnel is sufficient for offering program.	

With what services and facilities?

7: The **accommodation and the facilities** (infrastructure) are sufficient for the realization of the curriculum.	> Accommodation is fit to offer program.	
	> Facilities are fit for offering program.	CDIO standard 6 Engineering Workspaces: Engineering workspaces and laboratories that support and encourage hands-on learning of product, process, and system building, disciplinary knowledge, and social learning.
	> Tutoring matches student needs.	
	> Student information fits student needs.	

How does the program intend to safeguard quality?

9: The program is **evaluated on a regular basis,** partly on the basis of assessable targets.	> The program monitors the quality of the intended learning outcomes and the learning outcomes achieved through regular evaluations.	CDIO standard 12: A system that evaluates programs against these twelve standards, and provides feedback to students, faculty, and other stakeholders for the purposes of continuous improvement.
	> Includes the curriculum, the staff, the services and facilities, the assessments.	
	> The outcomes of these evaluations constitute the basis for demonstrable measures for improvement that contribute to the realization of the targets.	

	> Program committees, examining boards & staff are actively involved in the program's internal quality assurance.	
	> Students, alumni and the relevant professional field of the program are actively involved.	
Is the program achieving its objectives?		
10: The program has an adequate **assessment system** in place.	> The tests and assessments are valid and reliable	CDIO Standard 11: Assessment of student learning in personal and interpersonal skills, and product, process, and system building skills, as well as in disciplinary knowledge.
	> The tests and assessments are transparent to the students.	
	> The examining board of the program safeguards quality interim and final tests.	
11: The program demonstrates that **intended learning outcomes are achieved.**	> The level achieved is demonstrated by interim and final tests and final projects.	
	> Level achieved is demonstrated by the performance of graduates in actual practice or in subsequent programs.	

CONCLUSION

Relatively early in the implementation process management made it clear professional development opportunities would be offered to improve or continue to work on quality, decreasing feelings of uncertainty about positions. All programs were asked to do the self-evaluation as an active learning exercise of getting acquainted with the framework. Three questions were added to the self-evaluation format to spark adoption: What value does CDIO hold for your program? What standards does your program want to prioritize working on in the coming year? And what contributions from the faculty do you need for this?

The value of CDIO was found in international networking and positioning, providing students with 'something better', a hands-on quality management checklist, a common language amongst the programs to facilitate interdisciplinary education and a grip for structure. The feeling of urgency varied per program, as expected. There were also questions raised instead of an answer found, for example by Engineering Physics who have a Bachelor of Science program and first wanted to investigate the impact of CDIO in their well established research-based curriculum. This investigation is a work in progress.

The overall self-evaluation can be seen in figure 1. Priorities were identified for the faculty as a whole. Unsurprisingly standard 1 was the weakest, as most programs were still unaware and unequally involved in CDIO so far. Standards 9 and 10 were also considered priority, as they had lower average scores. Because active learning was a focus of the university already, standard 8 was filled in self-consciously and also needed attention.

Desired contributions from the faculty to facilitate the implementation of CDIO were congruent to the set-up as described. Time, flexibility, central organization including a FAQ point (someone who can help a team on CDIO implementation and can share examples and experiences of colleagues) were core choices in the process. The need for CDIO key persons in every program was not filled in top-down, but bottom-up as people became more and more involved. The next phase will be to form a taskforce group around the process director, whose function is intended to become obsolete in the near future as the oil stain spreads. A reflective session was organized in February 2016 with the Heads of Program and/or those highly involved in CDIO, where the experiences and perceptions of the implementation process so far were discussed, not the results on standards and syllabus

implementation. Results showed a need to do the next self-evaluation and this time focus on sharing all the gathered proof on each standard within the team and with management, to increase understanding and awareness of CDIO.
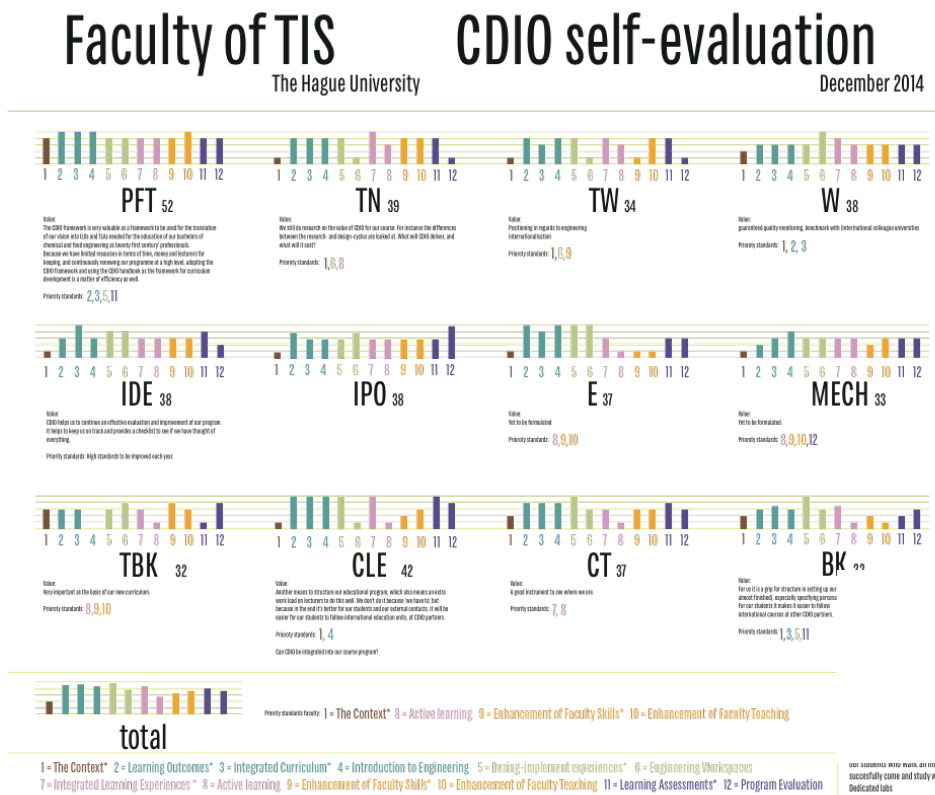

Figure 1. The first self-evaluation of all twelve programs of TIS.

There was also a call for vision; vision on joint practice opportunities (including teacher internships) within the faculty, and on enhancement of knowledge and skills of personnel with explicit commitment for standard 9 and 10, such as courses or training in active learning, and assessment of active learning. These are addressed in the PLG CDIO. One of the challenges ahead is to keep the information flow going. Having two locations, different team cultures, and daily distractions asks for more than an online repository of CDIO documents. The learning path on active blended learning is a good bottom-up step, but the formation and continuation of internal collaboration and reciprocal learning between the programs is important to keep all programs aboard. In a professional culture change management cannot be reduced to smart targets and one solution for all. In the faculty PLGs are starting on other themes as well. The management of the faculty is aware that they need to remain sharp in their stimulation, facilitation and guidance of this way of working, learning and improving together for the benefit of this and other PLG's.

Despite being a top-down decision, the CDIO adoption process at TIS is directed in a bottom-up way, aimed at the different personal motivations for lecturers and management alike. Although it may not always be in simple, equal for all, measureable targets, progress is fluidly but certainly made and CDIO provides TIS with a tool for its desired continuous educational quality improvement.

REFERENCES

Crawley, E.F., Malmqvist, J., Lucas, W.A., & Brodeur, D.R. (2011). The CDIO Syllabus v2.0: An updated Statement of Goals for Engineering Education. *Proceedings of the 7th International CDIO Conference*, Copenhagen.

Crawley, E.F., Malmqvist, J., Östlund, S., & Brodeur, D.R., Edström, K. (2011). *Rethinking Engineering Education: The CDIO Approach*. Switzerland: Springer International Publishing.

Derks, L., & Hollander, J. (2015). *Essenties van NLP*. Utrecht: Servire.

Hallenga-Brink, S.C. (2014). CDIO Application Faculty of Technology, Innovation and Society. *Internal CDIO document*. The Hague University of Applied Sciences.

Hallenga-Brink, S.C., & Dekelver, J. (2016). CDIO as Blueprint for Community Service Engineering Education. *Proceedings of the 12th International CDIO Conference*, Turku.

Hallenga-Brink, S., & Vervoort, I. (2015). Higher Education Institutions as international hubs in community service engineering innovation networks a European Lifelong Learning Program project. In *2015 Conference on Raising Awareness for the Societal and Environmental Role of Engineering and (Re)Training Engineers for Participatory Design (Engineering4Society)* (pp. 34–40).

Kamp, A., & Klaassen, R. (2013). Making curricular change: Case report of a radical reconstruction process. *Proceedings of the 9th International CDIO Conference,* Boston.

Koenders, E., & Nientied, P. (2011). *De Menskant van veranderen: Spiral Dynamics in de praktijk. (The human side of change: Spiral Dynamics in practice).* Amsterdam: Uitgeverij Business Contact.

Mars, A. (2006). Hoe krijg je ze mee? (How do you get them to join in?). Assen: Van Gorcum.
Meijers, F. et al. (2008). Praten of (b)laten? Over de behoefte aan dialoog in het onderwijs. Den Haag: The Hague University of Applied Sciences, Lectoraat Pedagogiek van de Beroepsvorming.

Merriënboer, J.G., Clark, R.E., & de Croock, B.M. (2002). Blueprints for complex learning: The 4C/ID model. *Educational Technology Research and Development*, vol.50 (2), pp. 39-61.

Mishra, P. & Kereluik, K. (2011). What 21st Century Learning? A review and a synthesis. In M. Koehler & P. Mishra (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2011* (pp. 3301-3312). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).

THUAS (2014). Wereldburgers in een lerende samenleving: De Haagse Hogeschool op weg naar 2020. *Visiedocument (vision document)*. The Hague University of Applied Sciences.

Verbiest, E., & Vandenberghe, R. (2002). Professionele leergemeenschappen. Een nieuwe kijk op permanente onderwijsvernieuwing en ontwikkeling van leerkrachten. (Professional learning communities. A new view on continuing educational innovation and professional development). Personeel en Organisatie, (1), 57 – 86.

BIOGRAPHICAL INFORMATION

Suzanne Hallenga-Brink, M.Sc. M.Sc. is an industrial design engineer and educational scientis and works as the program leader of the international undergraduate program of Industrial Design Engineering | Open Innovator. She is also the process director of the implementation of CDIO at the twelve programs of the Faculty of Technology, Innovation and Society. In her research she focuses on the learning process of 21st century competences in teaching staff development, innovative educational methods and talent development.

Oda Kok, BAS, MMI is an engineer in Engineering Physics and master in Management & Innovation and works as a program manager of three programs: Engineering Physics, Mathematics & Applications and the international program of Process & Food Technology. She was part of the research group of Lector Frans Meijers on Pedagogy of vocational and professional development. The theme of her Masters research was Collective Learning amongst Program Leaders.

Corresponding author

Suzanne Hallenga-Brink
Faculty of Innovation, Technology,
Innovation and Society
The Hague University of Applied Sciences
Johanna Westerdijkplein 75, 2521EN
The Hague, the Netherlands
+31 70 445 7717
s.c.hallenga-brink@hhs.nl