COMPARATIVE STUDY ON CDIO IMPLEMENTATION IN SELECTED ASEAN COUNTRIES

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ABSTRACT

This paper shares the experience of how Singapore Polytechnic (SP) – via its International subsidiary (Singapore Polytechnic International, or SPI in short) – collaborated with educational institutions in the ASEAN countries in implementing CDIO to revamp their university education. The objective is to share with the engineering institutions the CDIO Teaching and learning Framework with the aim of educating the students to become effective modern engineers. The paper is mainly divided into 3 parts.

The first part briefly explains the CDIO implementation in SP, and the role of Singapore Polytechnic International (SPI) in sharing educational best practices in ASEAN. Focus is on the flagship program entitled “Conceive, Design, Implement and Operate (CDIO) Framework for Re-Thinking Engineering Education”, and the motivation for sharing the experiences gained through the implementation in Singapore Polytechnic. The key objective of the program is to train a group of master trainers who will in turn cascade the CDIO training in their respective universities.

The second part of the paper focus on the experience of 5 institutions in 4 countries in implementing CDIO in their respective campuses, namely Chulalongkorn University and Rajamangala University of Technology Thanyaburi in Thailand, University of Science, VNU-HCM in Vietnam, Universiti Teknologi MARA in Malaysia and Singapore Polytechnic in Singapore. The needs to adopt CDIO, approaches taken, progress-to-date, as well as issues and challenges faced are briefly discussed by the various universities.

Finally, part three summarizes some of the challenges faced and key learning points from the implementation experience and explores some ideas how the various universities may be able to collaborate together in the future.

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KEYWORDS

Curriculum revamp, faculty development, CDIO implementation, CDIO skill set, CDIO Standards

INTRODUCTION

Singapore Polytechnic joined the CDIO Initiative in 2004, the first institution in Asia to be a collaborator. In September 2006, SP's management agreed to support the implementation of the CDIO initiative. Currently, CDIO is being implemented in 15 programs in 5 academic schools in the institution.

Critical to the success of the implementation of the CDIO initiative in Singapore Polytechnic were the support from management, and the close collaboration of drivers, early adopters and education specialists to customize the CDIO syllabus and to interpret the CDIO standards for the local context. The management also provided the necessary resources for redevelopment of workspaces and for teaching staff to enhance their teaching skills and understanding of CDIO.

In June 2011, Singapore Polytechnic was designated as the CDIO Regional Centre for Asia. As a regional centre, Singapore Polytechnic provides a model for transforming engineering education that other institutions of higher learning (IHLs) in Asia can adapt and to provide the expertise to assist faculty to implement the CDIO framework. All the programs implemented in these universities were supported and funded by Temasek Foundation in partnership with Singapore Polytechnic.

Role of Singapore Polytechnic International (SPI)

SPI was formed to realise Singapore Polytechnic's vision to produce better equipped students in an ever-changing global environment. As Singapore Polytechnic is well-known for its pedagogical experiences, SPI, a wholly owned subsidiary of SP, has the advantage of leveraging on the institution's strong brand name and accumulated wealth of experience in providing innovative and quality programmes and services in the areas of consultancy services and training programmes to educators, planners, leaders and governmental agencies from all over the world.

The following are some of the programs offered by SPI:

- Conceive, Design, Implement, Operate (CDIO) Framework for Rethinking Education
- Design Thinking in Education
- Modular Competency-based Curriculum Design and Development
- Quality Assurance Framework for Managing A Modern Technical Institution
- Singapore's Technical and Vocational Education and Training (TVET) Development

The CDIO Programme

Each programme runs for a period of 2-year with the aim of equipping the participants from the various institutions around ASEAN the understanding of the innovative teaching and learning framework so as to provide students with an education stressing engineering fundamentals set in the context of Conceiving-Designing-Implementing-Operating (CDIO) real-

world systems and products. The participants are programme managers, faculty programme developers and teaching faculty from the respective institutions and were trained to be Specialists in implementing CDIO. Some of these Specialists were selected to undergo further training to become Specialist Master Trainers to cascade the knowledge of CDIO to additional participants from the same or other IHLs.

The programme comprises of 3 stages and 5 training components described below:

1. Stage 1- Building of knowledge in CDIO Framework

    - Component 1: Introduction to CDIO Teaching and Learning Framework.
      This one or two day workshop provides an overview of the CDIO Teaching and Learning Framework from the perspective of world-wide changes in engineering education and the importance of meeting industry needs. Two key CDIO documents, CDIO syllabus and the CDIO standards, were discussed at length.

      This usually involves about 100 participants from up to eight institutions depending on the needs of the country.

2. Stage 2 – Redesigning of existing curriculum

      This stage consists of 12 days to complete the 3 components. Usually about 30 participants who attended Component 1 will continue with the training.

    - Component 2: Designing an Integrated Curriculum (Standards 2, 3, 7 and 11).
      This workshop provides participants with a structured approach to design curricula to provide a holistic and integrated learning experience and which involves the redesigning of existing curriculum to incorporate identified skill sets.

    - Component 3: Conceiving and Designing Innovative Products and Systems (Standards 4, 5 and 6).
      This workshop focuses on the approaches faculty can adopt to create more opportunities in the curriculum to introduce students to conceiving and designing innovative products and systems and discover how engineers solve real-world problems creatively

    - Component 4: Designing Active and Experiential Learning Experiences to enhance students learning (Standard 8).
      In this workshop, participants learn to design lessons to move students from being passive learners to engaging students in active and experiential learning activities.

3. Stage 3 – Programme evaluation to evaluate the impact of CDIO implementation (Standard 12).

    - Component 5: Evaluating Programmes for Continuous Improvement
      Participants undergo a 3-day workshop to learn how to identify research questions central to understanding the impact of key aspects of the CDIO implementation. They were also required to produce an evaluation plan to evaluate the effectiveness of CDIO implementation.

EXPERIENCE OF INSTITUTIONS IN IMPLEMENTING CDIO

The experiences of 5 institutions in 4 countries in implementing CDIO in their respective campuses, namely Singapore Polytechnic in Singapore, Chulalongkorn University and Rajamangala University of Technology Thanyaburi in Thailand, University of Science, VNU-HCM in Vietnam and Universiti Teknologi MARA in Malaysia, are presented below.

Singapore Polytechnic (SP), Singapore

SP's CDIO journey began in 2004 with its adoption by the School of Electrical and Electronic Engineering as a pilot run (Pee & Leong, 2006). Today, 4 other schools, namely Mechanical and Aeronautical Engineering, Chemical & Life Sciences, Architecture and Built Environment, and Digital Media and Info-communication Technology had adopted CDIO. To date, more than 15 diplomas had used CDIO to redesign their curriculum. Due to space constraint, the coverage of our effort is necessarily brief. Interested readers are referred to the various papers present at past conferences (available at the Knowledge Library of CDIO web site at www.cdio.org) for more details.

Rationale for adopting CDIO Framework

In 2007, SP embarked on an initiative to better prepare its graduates for the 21st century, to excel not just in their respective technical domain, but also to possess the relevant life skills. We also wanted our students to possess the right values and ethics. We also recognized the changes in today's students brought about by increasing affluence of society, access to technology (most notably the Internet via mobile devices) along with their dispositions (short attention span, preference for instant gratitude, wanting to see relevance of what they are learning, etc) which necessitates a change in our teaching approaches. Learning from the experience of its pilot run in 2004, it became obvious to Singapore Polytechnic's Management that CDIO Framework is most suitable for our needs.

Approaches taken to implement CDIO

A working committee comprising representatives from the various academic schools was formed. These are the would-be adopters of CDIO, and were tasked by senior management with implementing CDIO in their respective schools. The committee met regularly to unpack the original CDIO syllabus and created a SP-CDIO syllabus appropriate for diploma-level education (Sale & Cheah, 2008). The respective schools then worked on its own implementation plan to roll out CDIO for its own diplomas. It is important to note here that the committee did not dictate how CDIO is to be implemented in each school. This effort was left to the respective Course Management Team overseeing the diploma, each working within its own constraints while meeting the needs and expectations of the industry the diploma is serving. This allowed various best practices to emerge. A case study of this approach was presented by Cheah, Phua & Ng (2013) for the Diploma in Chemical Engineering.

Progress and types of changes made

Each diploma made its own progress and implemented its own revamped curriculum based on the road map charted by the respective Course Management Team. Changes made that were common across all diplomas include a more integrated curriculum whereby CDIO skills are infused alongside technical know-how. An example on how CDIO skills is infused alongside technical skill is shown under ANNEX. Students must be taught technical skill to

design and produce the product and CDIO skills such as teamwork and communication to work together in a group and finally to present their completed work.

Students were exposed to simple design and build project in the first year and were taught relevant technical knowledge and CDIO skills to equip them for the capstone project. The success of these efforts can be seen in the improved quality of our students' final year (capstone) projects over the years. An observational study of infusing design thinking into the CDIO framework for capstone project is given by (Soh, 2011). Soh gives an account on how students' progress to capstone project having learnt the relevant skills. Another major change affecting all diplomas is SP's adoption of the use of design thinking in 2010 to supplement the "conceive" element of CDIO. Each diploma adapted elements of design thinking as appropriate, an example of this is given by Ng & Cheah (2012) for the Diploma in Chemical Engineering. Singapore Polytechnic also launched a new initiative called Learning Express to bring together students from various diplomas to work together to help selected communities-in-need around the ASEAN region (Soh & Kristian, 2014). Diplomas may also pursue its own action plan to integrate specific elements of the CDIO syllabus into its curriculum, for example sustainable development (Cheah, 2014) and Integrated Approach to Engineering and Design (Lee, Lo & Lim, 2009).

Issues and challenges faced during implementation

The biggest challenge faced at the earlier phase of CDIO adoption undoubtedly was that of mindset change, and the required buy-in. Many staff thought of this as another management fad that will fizzle off after a while. Many staff was also concerned with inability to cover the content if they also need to teach CDIO skills, citing increased workload and packed curriculum in their defense. Some expressed lack of confidence in teaching CDIO skills or otherwise questioned if this was within the job scope of an engineering staff. These issues and challenges are fair and typical among all the diplomas implementing CDIO in Singapore Polytechnic, and how they were addressed is presented by a paper from Cheah, Phua & Ng (2013).

Future Plans for moving ahead

Moving ahead, SP is consolidating its CDIO effort to align with several new initiatives recently introduced in the institution, such as fostering intrinsic motivation among the students, strengthening its relationship with the industries, Academic Mentor scheme, use of flipped classroom and training of new staff in CDIO. SP had also updated its vision and mission statements, and the working committee will start to look at updating the SP-CDIO syllabus to capture these additional requirements. At the diploma level, the respective Course Management Team will once again prepare its own road map for sustaining its curriculum revamping effort. The Diploma in Chemical Engineering for example had integrated the 12 CDIO Standards into SP's Quality Management System (Cheah, Koh & Ng, 2013).

Moving beyond Singapore's shore, SP will continue its efforts in assisting other institutions in the ASEAN region - namely Indonesia and the Philippines - in carrying out re-engineering of their curriculum using CDIO. We will also continue to invite the universities that we had worked with to join us on our Learning Express initiative. We will also explore other collaborations with these universities for example via the CDIO Regional Meetings.

Chulalongkorn University, Thailand

Chulalongkorn University adopted CDIO in Mechanical Engineering, Chemical Engineering and Environmental Engineering.

Rationale for adopting CDIO Framework

Since 2011, a small group of faculty staff who were interested in engineering education formed the "Engineering Education Initiative, EEi". Early attempts relied on the ABET framework but practical information on how to rethink the education process was still lacking. When Singapore Polytechnic shared the CDIO framework, EEi found the practical experiences, knowledge depository as well as accessibility of personal contact invaluable to the sustained Education Reform at the faculty level.

Approaches taken to implement CDIO

The implementation started with 4 programs to work on the early success activities. Small set of actions were carefully nurtured to make a convincing argument to the program coordinators as well as senior management about the effectiveness of CDIO approach. An attempt was made to distribute these efforts into different areas namely, disciplinary knowledge, personal skill, interpersonal skills and CDIO skills.

Progress and types of changes made

The senior management was convinced with the early successes in adopting the CDIO and consensus were given at the Faculty Board of Management to adopt the CDIO framework to the entire school, 14 undergraduate programs in total.

One of the key successes came from an elective course, Mechatronics in Mechanical Engineering program. A bold move was envisioned to attempt a full CDIO implementation in one course. The success was made possible as assistance was obtained from an alumnus who had graduated from d.School at Stanford. As a result, key practices, network of people in social enterprise areas as well as enthusiastic efforts were made available for the course to be successful in full CDIO implementation. The resulting practices and innovative products are now used as a showcase to expand the adoption of the CDIO framework to other programs.

Issues and challenges faced during Implementation

The usual conviction on "covering the content" is still abounding. But continued efforts to selected groups of faculty start to gain momentum. One of the challenges is the training of students and faculty alike for the personal skills and interpersonal skills. The awareness of these two areas of skills was more apparent in a number of programs with training package made accessible to all.

In addition, to make the effort sustainable, progress has been made to initiate new initiatives in three fronts: hardware/software/people ware. The people ware is basically the introduction of CDIO to a wider audience. The hardware involved a creation of "Learning corridor" that includes active learning classroom, design workspace and playground space for innovation creation. The software involved adopting the home-grown Learning Management System (LMS) called CourseVille to support active learning and individualized feedback.

Future Plans for moving ahead

Since this effort requires long-term commitment and implementation, on-going effort to cofound with RUMTT to form a “CDIO Thailand Consortium” to push this movement forward sustainably is in progress. With friendship, support and network from Singapore Polytechnic, we are convinced that the Reform in Engineering Education in Thailand has never been more realistic.

Rajamangala University of Technology Thanyaburi (RMUTT), Thailand

RMUTT has adopted CDIO in Industrial Engineering, Textile Chemical Engineering, Computer Engineering, Chemical Engineering and Civil Engineering.

Rationale for adopting CDIO Framework

RMUTT has a vision to be a leading science and technology university producing “hands-on" professional graduates at national level and pacing towards international level. “Hands-on” graduates at RMUTT mean persons who can think, design, build, solve problems, communicate and respond to industrial needs. They must possess disciplinary knowledge with integrated learning experiences of basic and advanced practices of their professional skills as well as personal and interpersonal skills. By adopting CDIO Framework, RMUTT can assure the achievement of their goal.

Approaches taken to implement CDIO

The CDIO implementation at RMUTT is a “bottom-up” approach at the beginning with 10 pioneers. The level of implementation depends on each department’s readiness. Industrial Engineering program is fully CDIO-implemented. Other programs adopted CDIO in parts mainly Standard 7 and Standard 8. After 1 year of implementation, the CDIO Framework is fully supported by the university new management team. CDIO Syllabus has been mapped and found to be conforming to Thai Qualification Framework (TQF).

Progress and types of changes made

A questionnaire survey on Thai industries’ requirement on new engineering graduates was conducted. The result showed similarities with other findings around the world. Thai industries need the graduates with strong disciplinary background knowledge, system thinking, communication, teamwork skills and ethical and life-long learning attitudes.

The program structures were revised to integrate those required skills and attitudes into the curriculum. Design & Build, Machine Design & Simulation and Engineering Workshop are new courses to give students design & build experience. There were more than 30 courses using Experiential and Active learning pedagogy. Series of training workshops were conducted to enhance faculty members with CDIO and teaching skills. The workshops were also offered to non-engineering disciplines including Mass Communication Technology, Business Information Technology and Technical Education. The workspace and laboratories were renovated and upgraded with supported budget from the management at nearly 7 million Thai Baht. The 14 million Thai Baht was approved for the new design and build workspace.

After 1 year of CDIO implementation, RMUTT has also been appointed as CDIO collaborator at the last CDIO Regional meeting held at Kanazawa Institute of Technology, Kanazawa,

Japan on 26 March 2014. RMUTT has also obtained permission to translate CDIO Standard into Thai language.

Issues and challenges faced during implementation

The major challenge is “buy-in” from faculty members. A number of faculty members see CDIO as a burden to their current workload. However, after CDIO-TQF mapping was done and explanation on CDIO framework was given, they were more comfortable and more confident in adopting CDIO. Sharing many examples of teaching-learning improvement and changes from CDIO team members made people understand more.

The other challenge is the high investment to improve the workspace and upgrade laboratories. But with full support from university executives, the workspace improvement was highlighted in the budget allocation for the next fiscal year.

Future Plans for moving ahead

CDIO-based education is approved by the executive of RMUTT to be one of framework for producing desired “hands-on” graduates. RMUTT will set up a CDIO committee, with higher numbers of members, and a permanent office to support 4 levels of CDIO implementation namely; Institution level, Faculty level, Department level and Individual support.

A series of in-house training workshops will be conducted to share CDIO-based education to other non-engineering faculty members. Sharing success stories and knowledge management forum will be used to encourage those who implement CDIO and also for other staff to understand. RMUTT executives supported for budget to improve workspace, laboratories, tools and equipment to provide appropriate workspace for students.

RMUTT partnered with Faculty of Engineering, Chulalongkorn University, to plan to expand CDIO network to RMUTs and other Thai universities. As a collaborator, RMUTT planned to attend CDIO meetings and conferences both regional and international to learn more and to contribute to CDIO initiatives.

University of Science, VNU-HCM, Vietnam

VNU-HCM, Faculty of Information Technology has been adopting the CDIO framework for all of its programs including Computer Science, Software Engineering, Information System, Networking and Telecommunication.

Rationale for adopting CDIO Framework

The Faculty of Information Technology has been assessed externally by the AUN-QA in 2009. Even though the result was good and comparable to other well-known universities in the region, there were still many aspects which needed to be improved. In 2010, VNU-HCM was introduced to CDIO Framework and they realized that this approach would help them to solve all the problems quoted from the last assessment. VNU-HCM is one of the first 2 schools in the Vietnam National University – Ho Chi Minh City, the Faculty of Information Technology to be supported by the Government to adopt the CDIO framework to improve our teaching and learning activities in an 8-year pilot project.

Approaches taken to implement CDIO

The school got financial support from VNU-HCM for the 8-year CDIO adoption project. At first, we tried to gain the support from the Board of Rectors at the university and from all lecturers at the school. We started to update the school learning outcomes, the curriculum, the syllabi for all the courses and rolled out the teaching activities based on CDIO for first-year students and followed them until their last year. In the meantime, all of our lecturers have been trained by professor and experts in improving their teaching methods and CDIO skills.

Progress and Changes Made to Date

In the first year, VNU-HCM updated the learning outcomes of the school and the curriculum based on the CDIO syllabus and feedback from stakeholders. All lecturers have been trained the teaching methods and CDIO skills from well-known professors, such as Prof. Peter Gray, Johan Malmqvist, and Christina Edström. One of the greatest supports VNU-HCM obtained was from Singapore Polytechnic and Temasek Foundation in training activities for their lecturers in the last 2 years of their implementation. With the updated learning outcomes, curriculum and syllabi, the teaching activities were rolled out to the first year students in 2011. To-date, VNU-HCM has applied CDIO-based teaching activities to all the courses across 4-year training at the school.

Issues and challenges faced during implementation

Initially, the school faced skeptical reactions from the top management and lecturers. Many professors believed that they were already doing well and do not see the need to adopt the new framework. After the CDIO core team produced results that they realized that the framework can be adopted to improve the teaching and learning activities at the school.

Although the issue of “buy-in” was settled, another obstacle that hindered the adoption of CDIO framework was the workload for lecturers. Lecturers had to spend a lot of time participating in different training activities at the school and update all of their syllabi to align with CDIO requirements. Also, design and development of class activities required a substantial amount of time and effort.

Last but not least, financial problem posed the biggest challenge to the success of the adoption. At first, the school got some funding to support extra-activities that lecturers have to prepare for their classes. However, this support only lasted for a few years. Especially, to improve the workspace for students or to buy different items for real-world projects also requires frequent financial support.

Future Plan for Moving Ahead

At the moment, all the courses at school have implemented and adopted with the CDIO framework in their activities. The school plans to run a study to compare the results of students who have learnt 4 years with and without CDIO adoption. In addition, based on the feedback from stakeholders, there would be changes and updates to adapt activities to the current environment and status of the school.

The school also needs to find out ways for sustainable development and implementation of CDIO in the next few years since budget and financial support are limited. This is especially so for staff trainings are considered seriously. Until now, the school had been working closely

with Singapore Polytechnic and Temasek Foundation to build up a group of Master Trainers who will be in charge of training new faculty members in the school and others in the university.

The plan ahead is for lecturers to work together to design and build joint-projects between courses. This will reduce the workload for both lecturers and students without compromising the quality and requirements for the quality of teaching and learning activities.

Universiti Teknologi MARA (UiTM), Malaysia

UiTM adopted CDIO for Faculty of Mechanical Engineering (Bachelor of Engineering Hons), Faculty of Chemical Engineering (Diploma in Chemical Engineering), Faculty of Civil Engineering (Diploma in Civil Engineering) and Faculty of Electrical Engineering (Diploma in Electrical).

Rationale for adopting CDIO Framework

There was an urgency to support Malaysia and UiTM agenda in supporting Outcome-Based Education (OBE), and Student-Centred Learning (SCL). CDIO tool/framework to guide in integrating knowledge, technical skills, soft skills, product, system, and process in a curriculum was appropriate for the university. The adoption of CDIO allowed more meaningful teaching-learning environment and excitement with appropriate technology for students' motivation in ensuring students involvement with unique learning style was made possible. Other areas which can enhance the curriculum are initiatives in improving student's communication for marketable graduates, increasing employability rate and the opportunity for practices of hands-on activity and an integrated design project which can strengthen students experience in invention and engineering innovation.

Approaches taken to implement CDIO

The university rebranded the faculties' Integrated Design Project with a focus on teaching and learning innovation and supports. An initial platform or forum for the engineering programs was created in Universiti Teknologi MARA to involve and share new ways of teaching-learning to all staff. Another strategy is by keeping staff on board to focus on a specific motive so as to further enhance the teaching-learning approach. This will ensure quality stream mapping of individual courses to be significantly interconnected to each other. Motivating students learning by introducing, and getting students involved in teamwork learning and assessing appropriately the students' knowledge and skills. Another approach is to incorporate skills in curriculum and systematically monitor and evaluate the implementation to ensure improvement.

The university appointed the UiTM CDIO coordinator, head of master trainer and a group of master trainers to further conduct and monitor CDIO program.

Progress made to date, types of changes made

In UiTM, programs curriculum were reviewed to incorporate CDIO skillets in the selected course syllabus. The curriculum was designed to ensure students experience in the conceive-design-implement-operate cycle, where the students were directly engaged during their learning time. Effort was also made to realign and map the skills which also includes societal context, enterprise and business. The learning outcome covered technical disciplinary

knowledge, personal and interpersonal skills, product, system, process building skills which is required by engineer.

UiTM reviewed and reformed the curriculum of the selected programs so that proper integrated curriculums with jointly supporting disciplinary knowledge and an explicitly plan to integrate all skills and project or team-based activity (standard 3) can be accomplished. Other implementations include 'Introduction to Engineering' course and Design-Implement Project experiences in the program (Diploma and Bachelor Program). Students were engaged in the practice of engineering through problem solving from simple design exercises to complex engineering projects (design-builds projects).

The university gradually invested in CDIO spaces and improved the available environment (laboratory, studio, design centre) to enhance hands-on learning, personal and social learning and places where students can interact with each other and engage with engineering practices.

Issues and challenges faced during implementation

One of the greatest challenges is to provide content/activities for the active and experiential learning, instructional strategies to support the learning activities and assessment of students' learning. Designing programs to cater to the different level of students' background and in engaging students in the various programs (number of students per batch can be up to 500 students for Universiti Teknologi MARA) must be considered.

Another challenge posed is to design the learning activities and assessment mechanism to link to the learning outcomes and the program learning outcomes.

Future Plan for Moving Ahead

One of the greatest challenges is to sustain the implementation of CDIO Framework for the first cycle of the 4 piloted programs. Students and CDIO initiatives achievement were assessed periodically (every academic semester). UiTM strategically plan, execute and monitor actions in ensuring staff competency and to provide training for staff to boost staff competency.

UiTM plan to continuously improve and ensure sufficient engineering workspaces, facilities, equipment, and modern tools (including software and hardware) for students to experience and practice real-world practices. There are also plans to enhance learning assessment mechanism to provide fair assessment to align with the teaching-learning activities experienced by students and to organize activities and showcase CDIO products at national level.

SUMMARY OF EXPERIENCES AND CHALLENGES

One common experience shared by all institutions after CDIO implementation is that students were more motivated and engaged very actively in the design and build project.

The challenge faced by most institutions is to first understand the CDIO framework and how to implement the framework. Other challenges are buy-in from faculty members and availability of workspaces to carry out the activities.

KEY LEARNING POINTS & MOVING AHEAD

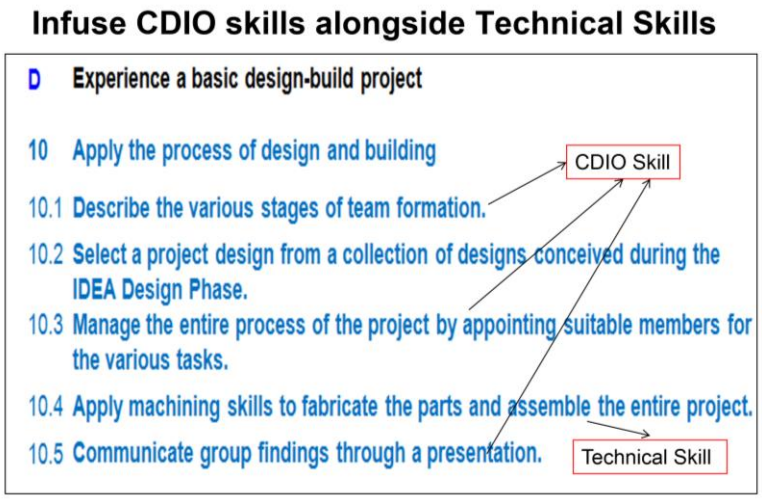
This section presents some learning points from the perspective of SP, who led the CDIO revamping effort in the abovementioned IHLs. It had been an enriching and rewarding experience for the authors from SP and SPI, who served in various capacities as manager and planner in the initial discussion stage, and as facilitator during the conduct of the workshops for various components on the programme.

SP was able to provide an extensive (though not exhaustive) range of examples which brought clarity to the challenge in integrating CDIO skills into the curriculum. The challenge is for these universities to have continuous cascading to ensure expanding of capabilities and buy-in from the rest of the staff members.

An important learning point for us is that, due to the long duration of the programme, we need to quickly establish good rapport with the participants. The programme is different from others that we ourselves attended as participants where the interactions with the facilitator more or less ended once the 2 or 3-day workshop ended. We were pleased that all the participants in our workshops were very enthusiastic about the programme and the interactive nature of the workshops allows everyone to get along very well within a short time. The fact that the facilitators themselves are engineers-turned-academic meant that they are able to relate to the participants using the language and jargon understood by both parties.

Moving ahead, SP will continue to engage IHLs in other countries around the region in adopting CDIO as the basis for revamping their curriculum. These include IHLs in the Philippines and Indonesia as mentioned previously, as well as others still undergoing negotiation. SP will also work with the institutions mentioned in this paper to assist them in monitoring the progress made in the cascading effort, as well as program evaluation say after 3 years of implementation. SP will also engage these IHLs in conducting joint educational research in topics such as role of cultural background in ethical behaviour among students, or its influence on student motivation and other skillsets. SP is planning to scale-up its Learning Express program so that more students will take part in the program. To this end, SP will continue to collaborate with these IHLs in expanding the range of possible projects for the students.

ANNEX



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BIOGRAPHICAL INFORMATION

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Dinh Ba Tien is currently the Head of Software Engineering Department, Faculty of Information Technology, University of Science, Vietnam National University – Ho Chi Minh city.

He graduated from the University of Huddersfield, United Kingdom in 2007. He is one of the key members of the CDIO team of the school who participates in an 8-year CDIO adoption project with the goal of improving the teaching and learning quality at the school.

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