

DESIGNING A CDIO FINAL YEAR PROJECT

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Abstract

In September 2006, the Singapore Polytechnic's management decided that the entire institution will adopt CDIO. This applies to more than 30 full-time diploma programs involving 12 000 students in 8 academic schools and 800 faculty members. All will be involved in implementing CDIO in their programs over the next few years. To assist in the implementation, a small cross disciplinary team was set up. This cross disciplinary team is headed by the Educational and Staff Development Department and comprised members from the academic schools. The team's challenge was to propose a model for implementing the different CDIO principles within the existing curriculum framework. They promptly identified three CDIO projects that had to be addressed immediately.

Keywords: Design-build experience, CDIO Syllabus, CDIO Skills

CDIO Workgroups in Singapore Polytechnic

Three workgroups are set up to tackle these issues accordingly. After much deliberation, the core team decided to start addressing the challenge in the following 3 areas: the CDIO Syllabus, the Introduction to Engineering, and the Design-Build Experience. The CDIO Syllabus was identified as the team had to get the course and program documents in place for reference by other colleagues in the institution. Introduction to Engineering and Design-Build experiences were also initiated as they would provide visible quick successes as advised by CDIO.

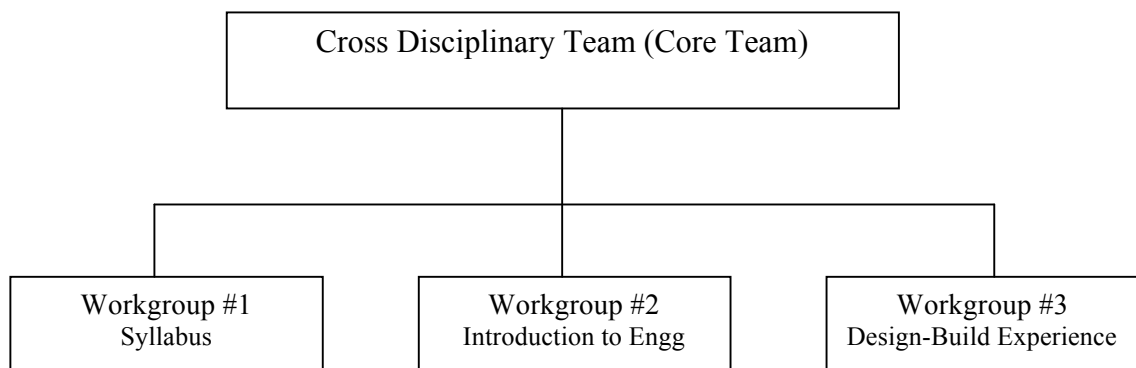


Figure 1. CDIO Workgroups

Three workgroups were formed in October 2006 and the members in these workgroups were assigned two key tasks. The first being to draft out generic principles and work processes that would be adopted institution wide. They will also disseminate these concepts and adopt them in their respective schools so as to serve as case studies.

Syllabus Workgroup

Using the available four part CDIO syllabus available, the Syllabus Workgroup met to customise the syllabus for the institution. Taking into consideration our program outcomes, students' abilities, industry and institution needs, all the 13 CDIO skills were reviewed and revised accordingly at the third (x.x.x) and fourth level (x.x.x.x). Table 1 shows the revised syllabus for Interpersonal skills: Teamwork and communications at the third level (x.x.x)

Table 1: Revised CDIO Syllabus for Singapore Polytechnic

Interpersonal Skills: Teamwork and Communication		
3.1	Teamwork	3.1.1 Forming Effective Teams
		3.1.2 Evaluate strategies to promote team development
		3.1.3 Display teamwork, including leadership, in a range of team role situations
3.2	Communications	3.2.1 Identify appropriate communications strategy and style
		3.2.2 Identify appropriate communication structure
		3.2.3 Demonstrate effective written communication
		3.2.4 Use Electronic/Multimedia Communication
		3.2.5 Use Graphical Communication
		3.2.6 Engage in Oral Presentation and Inter-Personal Communications

The syllabus was written as outcome based learning objectives so that they can be easily integrated into our course and program documents. The group members will now bring this syllabus back to their respective departments and apply it to their programs in the next phase.

Introduction to Engineering

The workgroup sees the benefits of including an "Introduction to Engineering" course in their programs as it will make engineering relevant and exciting for year 1 students, most of who have no idea what engineering is all about. The team agreed that for this course, the activities could be focused on the following themes

- How Stuff Work/ Components of Systems
- How Engineers work
- Impact of Engineering on the environment and society

Students will also be involved in more real world, fun engineering activities that integrated concepts to be taught in the different courses in the program. However, the key challenge is finding the necessary time to teach this course since most of the existing time-tables are packed with other subjects and activities.

The approach taken by this workgroup is to identify key content and program aims which can be transformed into interesting activities around the themes above. However, it may not be possible to achieve most of the objectives set out in “Introduction to Engineering” using the limited time resource in just one existing course. Thus, it may be necessary to combine several courses and then sieve out some time to achieve this objective. This is how the School of Electrical and Electronic Engineering plans to do. They will integrate 4 existing courses; Project 1, Principles of Electrical & Electronic Engineering, Digital Electronics and IDEA, and then insert the key contents of “Introduction to Engineering” within the time frame. The challenge now rests with the implementation team.

Design-Build Experience

In the case of achieving desired design-build experiences, the workgroup recognised that there is a need to better improve the students’ experience and facilitation of existing 3rd Year Students’ Project courses. This workgroup identified numerous opportunities to improve students’ experience and acquisition of CDIO skills. If the project is executed well, we will see students deeply engaged and motivated and developing strong technical and design skills. The remaining paper will discuss a proposed model for implementing design-build experiences as well as the processes and tools to be applied. The proposed model will be of particular interest to institutions in the initial stage of CDIO implementation.

Roadmap to achieve desired design-build experiences

In the Singapore Polytechnic, almost all final year students carry out a project course before their graduation. Students will be assigned a supervisor based on the project chosen and they will work on it throughout the final year of study. We noted that some students produced excellent projects but many failed to achieve much despite the amount of time allocated and abundant resources made available.

To effectively achieve the desired students’ design-build experiences, this workgroup devised the following roadmap which serves as an implementation guide and also provides key consideration issues.

Phase 1 – the preparation stage

To implement design-build activities, a good understanding of CDIO standard 5 is required. There are also many case studies available at the CDIO website. The outcome of this stage of implementation is the identification of gaps in the existing teaching and learning methodology and learning outcomes of our curriculum with respect to opportunities for design-build experiences.

Phase 2 – the planning stage

In this stage, decisions are made on the implementation details. For example, the project team may want to ask themselves which course and year would be the most ideal to integrate the CDIO process, which aspects of the CDIO process need more focus, and what processes and tools do the students need to know to conceive, design and build new products and systems. Workspace requirements and other additional resources (eg teaching staff, Technical Support Officers) also need to be determined at this stage.

Phase 3 – the development stage

In this stage, the necessary teaching resources, like templates for creative thinking or checklists and rubrics for critiques and assessments, are developed or obtained. The required training for staff is identified and conducted. An assessment strategy is planned and the assessment tools developed. Deciding on a buy-in/communication strategy for students is recommended.

Phase 4 – the implementation stage

This final stage involves the roll out of the design-build programme. Evaluation of the roll out is planned and initiated, and if necessary, changes made to the programme.

Design-build experience process

One key deliverable of this workgroup is to devise the design-build process with implementation details of how students conceive, design and build a user-centred, community- or industry-related project. The team suggested the following process for design-build projects.

Select a theme

The team of lecturers in charge of third year projects could identify themes for students' project work. Examples of themes include environment, health, handicap, elderly, communication, education, entertainment/leisure etc.

The topics identified should be central to the curriculum, and have lots of possibilities for students to make connections among concepts. The topics should also get students to ask questions, to want to learn more, to find out about something they don't already know, and believe that it is important to them, the community or industry.

Get a partner

To encourage the production of useful and/or industry or community linked projects, lecturers are encouraged to source for a willing industry or community partner. The lecturers could collaborate with the external partner to develop a project brief for students. Briefings by the external partner on the organisation's or industry's problems or needs could provide students with relevant information to identify the

needs of the organization/industry

Identifying possible projects

Students are encouraged to use tools like activity mapping, ethnography and interviews to identify possible projects. Students should present their project ideas to their classmates and lecturer in a critique session so that feedback and ideas can be offered. A project proposal specifying the details of the project is written only when the project is approved.

Design the project

Students generate solutions and designs for their project using creative thinking tools like SCREAM, morphological matrix, TRIZ or Mood boards. A second critique session is conducted for students to present their technical and design solutions. After receiving feedback and getting approval for their design solution, the blueprint or specifications may be produced together with early prototype such as a 3D model. Thereafter, students may proceed with the implementation and fabrication of their projects.

It is proposed for this project to be implemented over two years' duration where the C-D stages are carried out in Year 2 and I-O in Year 3. The new model as shown in Figure 2 provides students with more time to carry out comprehensive and thorough conceive and design activities instead of focusing on the building of the project from the onset. With this model, it is hoped that the students will see more meaning in the projects they do, learn the process of conceiving and designing good projects, and produce more innovative and better designed products.

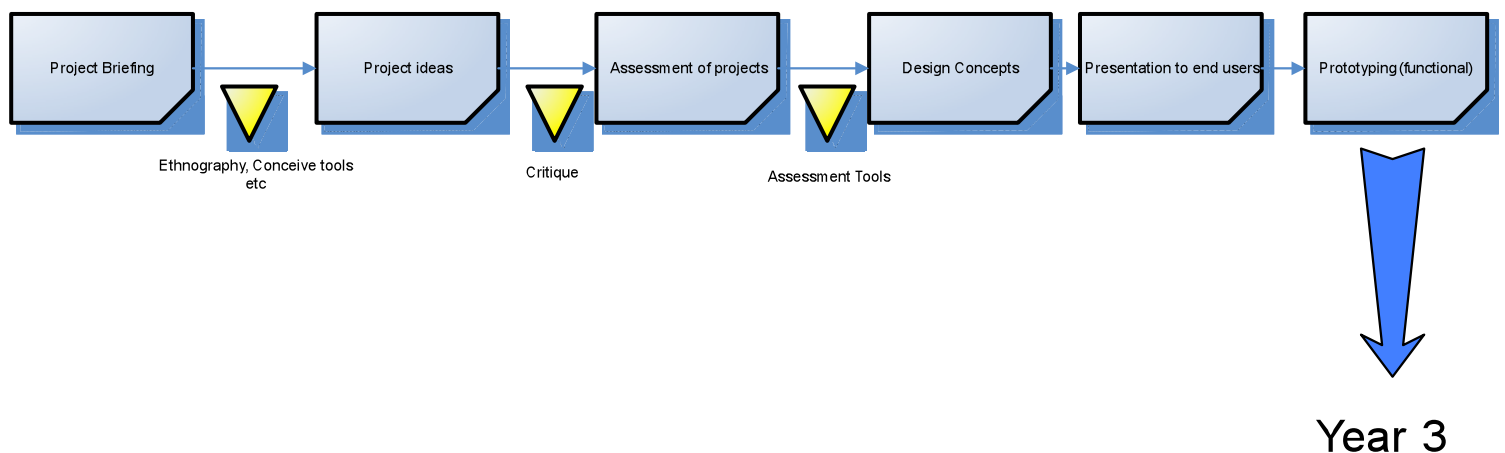


Figure 2. Design-build experience process

As can be seen, the entire process provides many opportunities for students to develop their personal, interpersonal and CDIO skills.

Assessment and feedback

Students need to receive continual feedback so that they are aware of how they fare and are guided towards the target throughout the entire process of their project. Feedback may be broadly categorised as formative and summative.

Assessments with marks awarded are commonly used for summative feedback. They are generally different and more varied for design-build experiences. Instead of marking test and exam papers, supervisors have to assess CDIO attributes displayed such as creative thinking skills and perseverance. This is a new area for staff and we need to develop strategies and assessment schemes to effectively gauge students' performance.

Presently, the assessment scheme for final year project is well designed with different categories of marks awarded by supervisors, the distinction panel, industry panel and also exhibition participation. We might need to fine tune it for assessing CDIO skills. What we also lack presently is a formative feedback mechanism for guiding students throughout the project. The critique sessions may serve as good formative feedback mechanism.

There are various methods and techniques for conducting successful critique sessions. The method employed depends on the project content, group size, progress and students' level. The content of critique may change as the project progresses. Several considerations and extensive preparation have to be made to bring about effective feedback.

Students are generally apprehensive during critique sessions and lecturers need to transform this potential hostile and intimidating environment into an engaging and beneficial experience. Participants of the critique sessions should always bear in mind the objective of a critique session is for students to learn and thus critiques should always be supported by a reason for the opinion so that appropriate actions may be taken to bring about a better project and enhanced design-build experience.

The lecturer giving the critique should try to be constructive, organised, thoughtful and specific so that students may gain learn and benefit from these sessions.

Implications on Administrative Support and Structure

In the past, projects were addressed as complicated challenges that could be solved through breaking them down into smaller and smaller chunks. Thus, most projects are categorised according to the technology it most suitably belongs to. However, as can be observed, recent important modern problems are complex rather than complicated. Complex problems are messier and more ambiguous in nature; they may also be connected to other problems. Thus, the hierarchical and silo structures which were perfectly designed to break problems down into more manageable fragments are not effective in handling high levels of complexity. For this reason, the structure in handling these projects have to also change to face this new and complex world.

Instead of a lecturer guiding a group of students, a group of staff with different strengths will become supervisors for a group of students working in a specific theme. This will enhance the ability to tackle complicated problems that fall into numerous technologies. Also, group teaching will open up opportunities of staff from different disciplines to teach together. Staff from the Language and Design Schools could also form the teaching group to help students with the other aspects of project work.

Teaching in a lecture room is very different from facilitating project work. How do we help students to learn best while operating in the project modes. Do we give them instructions or do we leave them to their own devices? Staff needs to know what they have to do and how to lead the students in carrying out the projects effectively. Figure 3 illustrates the spectrum of possible lecturer's behaviours that vary according to the different CDIO stages and also basing on students' learning characteristics. Thus, the lecturer who is orchestrating the desired deign-build experience has to take on various roles and possess appropriate attitudes such as personal sensitivity and commitment. However, many of these skills require experience and awareness. Thus, time and training must be given for developing these skills.

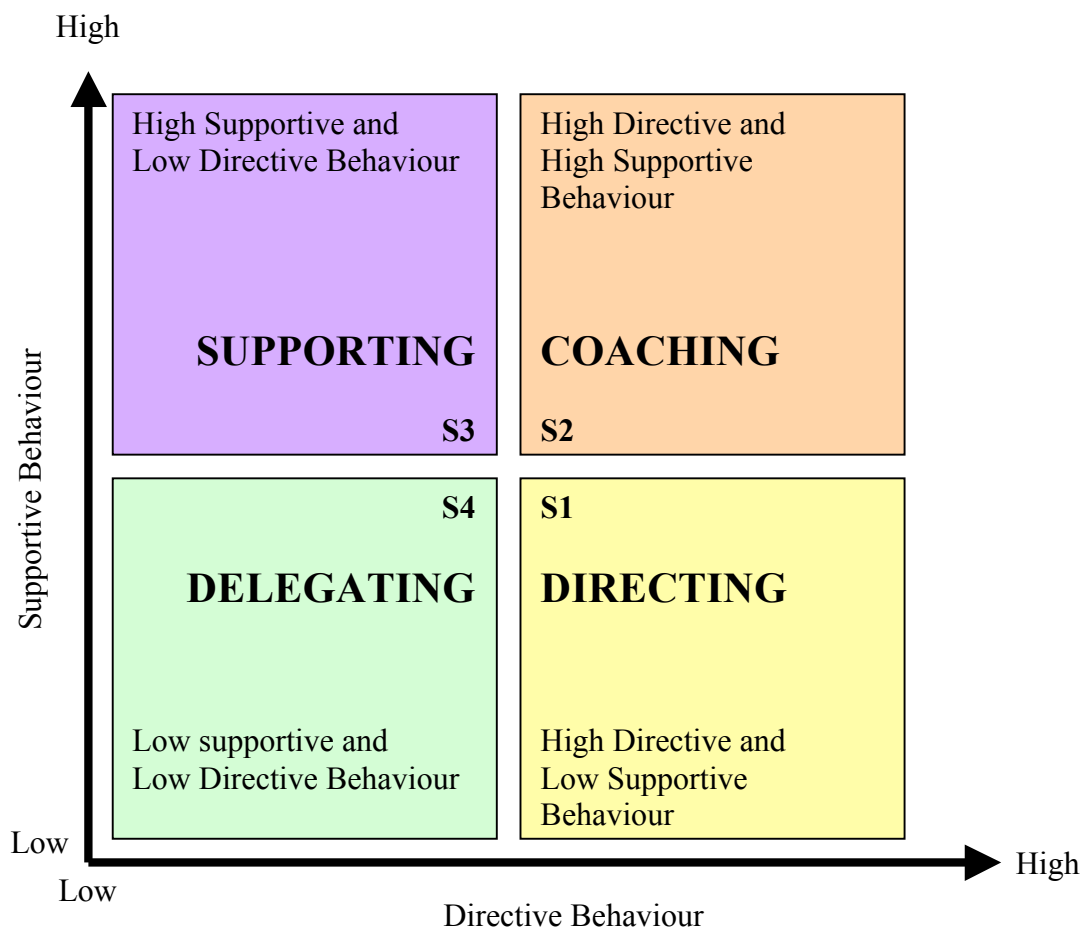


Figure 3. Facilitator behaviour in CDIO

Conclusion

Over the past six months, the core team and the three workgroups have laid down good groundwork for rolling out the various initiatives. We are presently about to start implementing these projects in the schools and they pose another set of challenge. Results will be shared in future meetings and conferences.

References

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Acknowledgements

This paper is based on the work of Singapore Polytechnic's CDIO committee. The members include Dr Linda Lee, Lee Chee Whye, Cheah Sin Moh, Danny Quek, Dennis Sale, Joyce Tan, Cheryl Wee, Christopher Shaw and the authors. The authors would also like to thank Mr Lau Lee Yee and Mr Ng Weng Lam for their support.

Biographical Information

Helene Leong-Wee has been in the education service for the past 20 years. She was a teacher and senior curriculum specialist in the Ministry of Education (Singapore) involved in the development and introduction of the teaching of critical and creative thinking skills in schools in Singapore. She has conducted numerous workshops on promoting critical and creative thinking, and creative problem solving for teachers and students. In her present position as a Section Head, Innovation Processes, in the Educational and Staff Development Department (ESDD) at Singapore Polytechnic, she is involved in promoting innovation through the curriculum. She also facilitates courses for lecturers in the Certificate in Teaching (Higher Education) and the Advanced Certificate in Teaching (Higher Education). Besides staff development, she is also an external assessor for the Ministry of Education (Singapore)'s School Excellence Model and an Academic Quality Councillor in Singapore Polytechnic.

S.H. Pee is a Senior Lecturer in the School of Electrical and Electronic Engineering at Singapore Polytechnic, Singapore. She is presently a Program Manager for modules in the CIE (Creativity, Innovation and Enterprise) strand. She likes to explore innovative ways to promote students' interest and motivation in learning. She has recently written a chapter on "CDIO Project Based Learning" for the book, *Teaching Strategies that Promote Thinking* published by McGraw-Hill. In the chapter she shares how students can develop very creative projects using the CDIO process. Besides teaching, she is also actively involved in the area of fieldbus and is the Manager at the Centre for Fieldbus Technology, Singapore Polytechnic. Suat Hoon is actively engaged in professional societies; she is the President of Fieldbus Foundation End User Society (Singapore) and also the Council Member of Instrumentation & Control Society (Singapore).

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