Designing a CDIO Programme: The CDIO Syllabus and Standards

Helene Leong
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First year engineering student

- Not sure of the purpose of studying engineering
- Find engineering dry & complex
- Does not aspire to stay in engineering after graduation

Engineering Innovator With a Cause

- Can Do Hands-on Engineering: possesses both theory and practice
- Can Be Innovative, able to work in multidisciplinary teams
- Can Serve Socially and Environmentally in a purposefully manner
What should this learning experience be like?

- Sense of purpose
- Joy of learning
- Joy of engineering
- Motivation to learn

What Do We Teach?
How Do We Teach?
Worldwide Initiative

More than 100 Institutions of Higher Learning

CDIO | A Worldwide Innovative Educational Framework
Why CDIO Initiative?

- Feedback from industries, graduates and practising engineers that certain important professional skills are not developed in the existing curriculum.
Why CDIO Initiative?

- Meeting standards and criteria set by accreditation bodies such as ABET- Accreditation Board for Engineering & Technology

- Falling Engineering Enrolment as well as students finding that engineering is too dry and theoretical in the first year of study
Goals of CDIO

To educate students who are able to

• master a deeper working knowledge of the technical fundamentals

• lead in the creation and operation of new products, processes and systems

• understand the importance and strategic impact of research and technological development on society

And to attract and retain students in Engineering
THE C-D-I-O PROCESS

Lifecycle of a product, process, project, system, software, material

Conceive: customer needs, technology, enterprise strategy, regulations, and conceptual, technical and business plans.

Design: plans, drawings, and algorithms that describe what will be implemented

Implement: transformation of the design into the product, process, or system, including manufacturing, coding, testing and validation

Operate: the implemented product or process delivering the intended value, including maintaining, evolving and retiring the system
C-D-I-O Process: the Context for Engineering Education

Conceiving-Designing-Implementing-Operating should be the context, but not the content, of engineering education

- Closely aligned to engineering practice
- Communicates the rationale and relevance of what students are learning
- Interconnects concepts and knowledge that builds on each other
- Increase retention of new knowledge and skills
CDIO @ SINGAPORE POLYTECHNIC

- CDIO collaborator since 2004 – piloted in the School of Electrical and Electronic Engineering

- Adopted by 6 academic schools, Implemented in 15 programs
  - in 2007
    - Architecture and the Built Environment
    - Chemical and Life Sciences
    - Electrical and Electronic Engineering
    - Mechanical and Aeronautical Engineering
  - in 2009
    - Digital Media and Info-Comm Technology
  - in 2012
    - Singapore Maritime Academy

- Designated as a CDIO Regional Centre for Asia
Asia Region

Singapore Polytechnic
Nanyang Polytechnic
Kanazawa Institute of Technology
Kanazawa Technical College
Vietnam National University - Ho Chi Minh City
Duy Tan University
School of Engineering at Taylor's University College

Shantou University
Beijing Jiaotong University
Beijing Institute of Petrochemical Technology
Chengdu University of Information Technology
Dalian Neusoft Institute of Information
Suzhou Industrial Park Institute of Vocational Technology
Tsinghua University
Yanshan University
THE CDIO SYLLABUS
CDIO OVERVIEW

The activities within the CDIO Initiative are based on two key documents

**What : CDIO Syllabus**
- Disciplinary Knowledge
- Personal Skills
- Interpersonal Skills
- CDIO Skills

**How : 12 Standards**
- Curriculum
- T&L methods
- Assessment
- Faculty Competence
- Workspace
THE CDIO SYLLABUS

What is the full set of knowledge, skills and attitudes that a student should possess as they graduate from university?

At what proficiency?
CDIO SYLLABUS: TRANSLATING NEEDS TO GOALS

Educate students who:
Understand how to conceive-design-implement-operate
Complex value-added engineering systems
In a modern team-based engineering environment
And are mature and thoughtful individuals

The CDIO Syllabus - a comprehensive statement of detailed goals for an engineering education
CDIO Syllabus

1. Disciplinary Knowledge & Reasoning (Learning to Know)
   - Knowledge of underlying mathematics and sciences
   - Core engineering fundamental knowledge
   - Advanced engineering fundamental knowledge, methods and tools

2. Personal and Professional Skills & Attributes (Learning to Be)
   - Analytical reasoning and problem solving
   - Experimentation, investigation and knowledge discovery
   - System thinking
   - Attitudes, thoughts and learning
   - Ethics, equity and other responsibilities

3. Interpersonal Skills: Teamwork & Communication (Learning to Live Together)
   - Teamwork
   - Communications
   - Communication in a foreign language

4. Conceiving, Designing, Implementing & Operating Systems in the Enterprise & Environmental Context (Learning to Do)
   - External, societal and environmental context
   - Enterprise and business context
   - Conceiving, systems engineering and management
   - Designing
   - Implementing
   - Operating
CDIO SYLLABUS

- Syllabus at 3rd level of detail
- One or two more levels are detailed
- Rational
- Comprehensive
- Peer reviewed
- Basis for design and assessment

CDIO | A Worldwide Innovative Educational Framework
VALIDATION WITH KEY STAKEHOLDERS

Massachusetts Institute of Technology, Cambridge

5. Innovate
4. Skilled Practice
3. Understand
2. Participate
1. Exposure

1. Exposure
2. Participate
3. Understand
4. Skilled Practice
5. Innovate

- 2.1 Engineering Reason
- 2.2 Experimentation
- 2.3 Systems Thinking
- 2.4 Personal Attributes
- 2.5 Professional Attributes
- 3.1 Teamwork
- 3.2 Communication
- 4.1 Societal Context
- 4.2 Business Context
- 4.3 Conceiving
- 4.4 Design Process
- 4.5 Implementing
- 4.6 Operating

Faculty
Industry
Y. Alum
O. Alum

REMARKABLE AGREEMENT!
### CDIO syllabus correlated with ABET

<table>
<thead>
<tr>
<th>CDIO Syllabus</th>
<th>ABET EC2010 Criterion 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Knowledge of Underlying Mathematics, Science</td>
<td></td>
</tr>
<tr>
<td>1.2 Core Engineering Fundamental Knowledge</td>
<td></td>
</tr>
<tr>
<td>1.3 Adv. Engr. Fund. Knowledge, Methods, Tools</td>
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</tr>
<tr>
<td>2.1 Analytical Reasoning and Problem Solving</td>
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<tr>
<td>2.2 Exper., Investigation and Knowledge Discovery</td>
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<tr>
<td>2.3 System Thinking</td>
<td></td>
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<tr>
<td>2.4 Attitudes, Thought and Learning</td>
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<tr>
<td>2.5 Ethics, Equity and Other Responsibilities</td>
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</tr>
<tr>
<td>3.1 Teamwork</td>
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<tr>
<td>3.2 Communications</td>
<td></td>
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<tr>
<td>3.3 Communication in Foreign Languages</td>
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<tr>
<td>4.1 External, Societal and Environmental Context</td>
<td></td>
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<tr>
<td>4.2 Enterprise and Business Context</td>
<td></td>
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<tr>
<td>4.3 Conceiving, Systems Engr. and Management</td>
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<tr>
<td>4.4 Designing</td>
<td></td>
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<td>4.5 Implementing</td>
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<td>4.6 Operating</td>
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</table>

- **Strong Correlation**
- **Good Correlation**
Comparison with Engineering Professional Career Tracks

1. Generic set of skills needed by all engineers:
   • Analytical Reasoning and Problem Solving (2.1),
   • System Thinking (2.3),
   • Attitudes, Thought and Learning (2.4),
   • Ethics, Equity and Responsibility (2.5),
   • Teamwork (3.1),
   • Communications (3.2),
   • Communications in Foreign Languages (3.3) and
   • Externaland Societal Context (4.1).

2. Skills for Engineering Professional tracks
   • The Researcher - Experimentation, Investigation and Knowledge Discovery(2.2)
   • The System Designer/Engineer - Conceiving, System Engineering and Management (4.3)
   • The Device Designer/Developer - Designing (4.4), Implementing (4.5)
   • The Product Support Engineer/Operator - Operating (4.6)
   • The Entrepreneurial Engineer/Manager - Enterprise and Business Context (4.2)
Survey of industry, faculty and alumni on relevance of CDIO skills
ACTIVITY: EXPECTED PROFICIENCY

- Form groups of 6
- As a group, rate the proficiency of each CDIO learning outcome at the x.x level on a scale of 1 to 4 where:

**Scale:**
1 To have experienced or been exposed to
2 To be able to participate in and contribute to
3 To be able to understand and explain
4 To be skilled in the practice or implementation
MIT-CDIO syllabus

System Thinking
1. Thinking Holistically
2. Emergence and Interactions in Systems
3. Prioritization and Focus
4. Trade-offs, Judgement and Balance in Resolution

Professional Skills and Attitudes
1. Professional Ethics, Integrity, Responsibility & Accountability
2. Professional Behaviour
3. Proactively Planning for One’s Career
4. Staying Current on World of Engineer

SP-CDIO syllabus

System Thinking
1. Understand the Basis and Methods for System Thinking
2. Analyse the Workings of Systems
3. Use a Range of Relevant System Thinking Tools

Professional Skills and Attitudes
1. Evaluate the Impact of Values and Ethics
2. Demonstrate Professional Behaviour at Work and in Society
SP customised CDIO Syllabus

CDIO syllabus

Communication
1. Communications Strategy
2. Communications Structure
3. Written Communication
4. *Electronic/Multimedia Communication*
5. *Graphical Communications*
6. Oral Presentation
7. *Inquiry, listening, dialog*
8. *Negotiation, compromise and conflict resolution*
9. Advocacy

SP-CDIO syllabus

Communication
1. Design appropriate communications strategies
2. Demonstrate effective written communication
3. Demonstrate effective oral communication
3.1 COMMUNICATIONS

3.1.1 Design appropriate communications strategies
Analyze the communication situation (e.g., in terms of purpose, audience and context (PAC))
Identify communications objectives
Read critically and select relevant content
Identify and choose appropriate communication structure and style
Select appropriate multimedia and graphical communication (e.g. email, voicemail, video conferencing, tables and charts, sketching and drawing)

3.1.2 Demonstrate effective written communication
Write with logical organization and clear language flow
Use concise and precise language
Use correct grammar, spelling and punctuation
Apply appropriate written styles with appropriate formatting conventions to suit PAC

3.1.3 Demonstrate effective oral communication
Design and deliver presentations applying communication design principles
Speak clearly and coherently
Use appropriate nonverbal communications (e.g., posture, gestures, eye contact)
Demonstrate active and empathetic listening in a range of communication situations
Ask and answer questions effectively
CDIO IS A REFERENCE MODEL, NOT A PRESCRIPTION

Everything has to be *translated-transformed* to fit the context and conditions of each university / program.

You are probably doing some CDIO elements already.

Take what you want to use, transform it as you wish, give it a new name, assume ownership.

CDIO provides a toolbox for working through the process.
Program Structure for Integration of CDIO Skills across 3 years of Study

<table>
<thead>
<tr>
<th>SEMESTER 1</th>
<th>SEMESTER 2</th>
<th>SEMESTER 3</th>
<th>SEMESTER 4</th>
<th>SEMESTER 5</th>
<th>SEMESTER 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Module 1A-1</td>
<td>Core Module 1B-1</td>
<td>Core Module 2A-1</td>
<td>Core Module 2B-1</td>
<td>Core Module 3A-1</td>
<td>Core Module 3B-1</td>
</tr>
<tr>
<td>Core Module 1A-2</td>
<td>Core Module 1B-2</td>
<td>Core Module 2A-2</td>
<td>Core Module 2B-2</td>
<td>Core Module 3A-2</td>
<td>Core Module 3B-2</td>
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<tr>
<td>Core Module 1A-3</td>
<td>Core Module 1B-3</td>
<td>Core Module 2A-3</td>
<td>Core Module 2B-3</td>
<td>Core Module 3A-3</td>
<td>Core Module 3B-3</td>
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<tr>
<td>Core Module 1A-4</td>
<td>Core Module 1B-4</td>
<td>Core Module 2A-4</td>
<td>Core Module 2B-4</td>
<td>Core Module 3A-4</td>
<td>Core Module 3B-4</td>
</tr>
<tr>
<td>Core Module 1A-5</td>
<td>Core Module 1B-5</td>
<td>Core Module 2A-5</td>
<td>Core Module 2B-5</td>
<td>Core Module 3A-5</td>
<td>Core Module 3B-5</td>
</tr>
<tr>
<td>Core Module 1A-6</td>
<td>Core Module 1B-6</td>
<td>Core Module 2A-6</td>
<td>Core Module 2B-6</td>
<td>Core Module 3A-6</td>
<td>Core Module 3B-6</td>
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</table>

**Year 1:** Exposure to CDIO skills  
**Year 2:** Reinforcement of CDIO skills  
**Year 3:** Practice and Apply of CDIO skills
AFTER
2 Obtain the Rate Law for specific chemical reactions
2.1 Describe the steps involved for determining the rate law parameters.
2.2 Use Arrhenius Law to determine the effect of temperature on the rate of chemical reactions.
2.3 Infer and interpret experimental data on the effect of temperature on the rate of chemical reactions.
2.4 Compare and contrast the integral and differential methods of analysis in rate law determination.
2.5 Use integral and differentiated methods of analysis to determine the rate law for a liquid reaction.
2.6 Calculate and interpret the results for the integral and differential methods of analysis using graphical solution and linear regression.

2.7 Identify the components of an effective team
2.8 Identify team roles and their impact on team performance
2.9 Apply team ground-rules and display teamwork (including leadership) in a range of team role situations when conducting experiments
2.10 Identify contradictory perspectives relating to modifications of a chemical reactor.
2.11 Design appropriate communication strategies and deliver effective oral communication to a given audience.

BEFORE
2 Understand the fundamentals of chemical kinetics
2.1 Distinguish between elementary and non-elementary reactions.
2.2 Explain the rate law and rate constant for elementary reactions.
2.3 Describe the temperature dependence of the rate constant using Arrhenius Equation.
2.4 Explain the molecularity and order of reaction.
2.5 Discuss the factors affecting the rate of reaction.
2.6 Determine the frequency factor and activation energy of a reaction.
3 Understand the methods for determining the rate law for liquid reactions
3.1 Describe the steps involved for determining the rate law parameters.
3.2 Compare and contrast the integral and differential methods of analysis in rate law determination.
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CDIO STANDARDS
The activities within the CDIO Initiative are based on two key documents:

**What: CDIO Syllabus**
- Disciplinary Knowledge
- Personal Skills
- Interpersonal Skills
- CDIO Skills

**How: 12 Standards**
- Curriculum
- T&L methods
- Assessment
- Faculty Competence
- Workspace
CDIO Standards

- define the distinguishing features of a CDIO program
- serve as guidelines for program reform
- create benchmarks and goals that can be applied worldwide
- provide a framework for continuous improvement
HOW CAN WE DO BETTER?

Retask current assets and resources in:

- Curriculum
- Teaching and learning methods
- Design-implement experiences and engineering workspaces
- Learning assessment methods
- Faculty competence
- Program evaluation

Evolve to a model in which these resources are better employed to promote student learning
## CDIO Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Standard 1</td>
<td>CDIO as the context</td>
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<tr>
<td>Standard 2</td>
<td>CDIO Syllabus Outcomes</td>
</tr>
<tr>
<td>Standard 3</td>
<td>Integrated Curriculum</td>
</tr>
<tr>
<td>Standard 4</td>
<td>Introduction to Engineering</td>
</tr>
<tr>
<td>Standard 5</td>
<td>Design-Build Experiences</td>
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<tr>
<td>Standard 6</td>
<td>CDIO Workspaces</td>
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<tr>
<td>Standard 7</td>
<td>Integrated Learning Experiences</td>
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<tr>
<td>Standard 8</td>
<td>Active Learning</td>
</tr>
<tr>
<td>Standard 9</td>
<td>Enhancement of Staff CDIO Skills</td>
</tr>
<tr>
<td>Standard 10</td>
<td>Enhancement of Staff Teaching Skills</td>
</tr>
<tr>
<td>Standard 11</td>
<td>CDIO Skills Assessment</td>
</tr>
<tr>
<td>Standard 12</td>
<td>CDIO Program Evaluation</td>
</tr>
</tbody>
</table>

### Curriculum

- Standard 2: CDIO Syllabus Outcomes
- Standard 3: Integrated Curriculum
- Standard 4: Introduction to Engineering
- Standard 5: Design-Build Experiences

### Workspace/Labs

- Standard 6: CDIO Workspaces

### Teaching and Learning Methods

- Standard 7: Integrated Learning Experiences
- Standard 8: Active Learning

### Enhancement of Faculty Competence

- Standard 9: Enhancement of Staff CDIO Skills
- Standard 10: Enhancement of Staff Teaching Skills

### Assessment Methods

- Standard 11: CDIO Skills Assessment
- Standard 12: CDIO Program Evaluation
Please refer to handout on CDIO standards

- Description
- Rationale
- Rubrics

**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

**Description:** An integrated curriculum includes learning experiences that lead to the acquisition of personal and interpersonal skills, and product, process, and system building skills (Standard 2), intertwined with the learning of disciplinary knowledge and its application in professional engineering. Disciplinary courses are mutually supporting when they make explicit connections among related and supporting content and learning outcomes. An explicit plan identifies ways in which the integration of skills and multidisciplinary connections are to be made, for example, by mapping the specified learning outcomes to courses and co-curricular activities that make up the curriculum.

**Rationales:** The teaching of personal, interpersonal, and professional skills, and product, process, and system building skills should not be considered an addition to an already full curriculum, but an integral part of it. To reach the intended learning outcomes in disciplinary knowledge and skills, the curriculum and learning experiences have to make dual use of available time. Faculty play an active role in designing the integrated curriculum by suggesting appropriate disciplinary linkages, as well as opportunities to address specific skills in their respective teaching areas.

**Rubric:**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Criteria</th>
</tr>
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<tbody>
<tr>
<td>5</td>
<td>Stakeholders regularly review the integrated curriculum and make recommendations and adjustments as needed.</td>
</tr>
<tr>
<td>4</td>
<td>There is evidence that personal, interpersonal, product, process, and system building skills are addressed in all courses responsible for their implementation.</td>
</tr>
<tr>
<td>3</td>
<td>Personal, interpersonal, product, process, and system building skills are integrated into one or more years in the curriculum.</td>
</tr>
<tr>
<td>2</td>
<td>A curriculum plan that integrates disciplinary learning, personal, interpersonal, product, process, and system building skills is approved by appropriate groups.</td>
</tr>
<tr>
<td>1</td>
<td>The need to analyze the curriculum is recognized and initial mapping of disciplinary and skills learning outcomes is underway.</td>
</tr>
<tr>
<td>0</td>
<td>There is no integration of skills or mutually supporting disciplines in the program.</td>
</tr>
<tr>
<td>CDIO STANDARD</td>
<td>EVIDENCE OF COMPLIANCE</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>1 CDIO as Context</td>
<td>Adoption of the principle that product and system lifecycle development and deployment – Conceiving, Designing, Implementing and Operating - are the context for engineering education</td>
</tr>
<tr>
<td>2 CDIO Syllabus Outcomes</td>
<td>Specific, detailed learning outcomes for personal, interpersonal and product and system building skills, consistent with program goals and validated by program stakeholders</td>
</tr>
<tr>
<td>3 Integrated Curriculum</td>
<td>A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal and product and system building skills</td>
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</tbody>
</table>
Exercise: Learn and teach CDIO standards to your colleagues – 30 mins

• Why?
  – Deeper understanding of the standards

• What?
  – Learn two standards
  – Very preliminary self-evaluation on these two

• You need
  – Write up on Standards 3 and 4 and their rubrics
  – Self evaluation teamplate
  – Some paper and pens

• How?
  – Form groups of 4
  – 2 members to read and understand standard 3 (Integrated Curriculum) and the other 2 to read and understand standard 4 (Introduction to Engineering) 15 mins
  – Self evaluate your own programme for the standard 3 and 4 using the rubrics
  – Share with group members
Implementation in SP
CDIO | A Worldwide Innovative Educational Framework

Horizontal and Vertical Articulation and Integration of Knowledge and Skills

Year 3
CDIO skills are Strengthened

Year 2
CDIO skills are Reinforced

Year 1
CDIO skills are Introduced

Final Year Capstone Project
Social Innovation Project
Design Build Course
Introduction to Engineering

Represents a cluster of integrated knowledge and skills
Year 2 Curriculum
Standard 5: Design and Build

Engineering Design
• students learn scheduling, machine component design and selection, fabrication and assembly activities provide real experiences of engineering work

Computer-aided Design
• reading and visualization of engineering drawings and applying modelling skill to create part models and drawings

Context
Connector Trimming Machine

Communication & Teamwork
Manage Learning

CDIO Skills
Sequencing and Linking Modules
Creating opportunities to integrate Knowledge and Skills across modules

Year 1 Introduction to Engineering

http://www.youtube.com/watch?v=KUGwLHn1vbw&feature=g-upl
Sequencing and Linking Modules

Creating opportunities to integrate Knowledge and Skills across modules

Students are introduced a machine with a missing element. They are to design using CAD, fabricate and integrate it into the machine.

Year 2 Design Build

- Conceive, design and build a working Industrial machine
- Engineering design and drawing
- CAD
- Fabrication and assembly
- Design specification and concept
- Communication skills
- Teamwork skills
- Project management skills
## Student Experiences Re-designed

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Introduction to Engineering" /></td>
<td><img src="image2" alt="Year 2 project" /></td>
<td><img src="image3" alt="Capstone Project" /></td>
</tr>
<tr>
<td><strong>Introduction to Engineering</strong> (basic conceive, design and implement)</td>
<td><strong>Year 2 project</strong> Conceive, Design (Design Thinking)</td>
<td><strong>Capstone Project</strong> Conceive, Design, Implement and Operate</td>
</tr>
</tbody>
</table>

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**CDIO | A Worldwide Innovative Educational Framework**
STRENGTHENING THE CDIO FRAMEWORK
Design Thinking Methodology

Design Thinking

WHAT to make

HOW to make it

CDIO | A Worldwide Innovative Educational Framework
Strengthening CDIO with Design Thinking

Conceive → Design → Implement → Operate

Sense & Sensibility → Empathy → Ideation → Prototype

S → E → I → P

Generate more ideas

Refine our point of view

SP Design Thinking Framework
Meaningful Engagement
through Social Innovation

- **To Do** Hands-on Engineering: possesses both theory and practice
- **To Be** Innovative, Steve Jobs is his role model, able to work in multidisciplinary teams
- **To Serve** Socially and Environmentally in a purposefully manner

**Engineering Innovator With a Social Cause**
Empathy

Ethnographic Study of the Lifestyle of Singaporeans aged 50+

- How do they live their lives?
- What are their daily activities?
- What problems/obstacles do they face?

- Interviews and user observations
- Video or photo research
- Photo-montage or moodboard
Ideation
Prototyping
Final Concept & Prototype

Horizontal Refrigerator
PURPOSEFUL CHALLENGES, INNOVATIVE THINKING, GROWTH MINDSETS

THE LEARNING EXPRESS

China
Thailand
Vietnam
Malaysia
Singapore
Indonesia

Using **Design Thinking** and **skills** to come up with **innovative solutions** for communities in Asia
INTRINSIC MOTIVATION
Essential Skills for the VUCA World

Creativity, Out-of-Box Thinking

Self-Driven Learner Growth Mindset

Intrinsic Motivation Framework

To develop the CREATIVE CONFIDENCE in our students

To Find his True Talent

Purposeful Play  Passion  Purpose

Dare to Think (Innovation)

Dare to Do (“Can Do” Spirit)

Conceive  Design  Implement  Operate

Design Thinking

Intrinsic Motivation

Framework

Dare to Do

Passion

Purpose
The Self-Driven Learner with a Growth Mindset with the Creative Confidence to Dare to Think and Dare to Do.
# The Pedagogy

<table>
<thead>
<tr>
<th>Diploma in Mechatronics &amp; Robotics (DMRO)</th>
<th>Year 3 (<em>iNVENT</em>)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Empower to Create</td>
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<tr>
<td></td>
<td>Year 2 (<em>iNTEGRATE</em>)</td>
</tr>
<tr>
<td></td>
<td>Imbue with Knowledge &amp; Ability to Integrate</td>
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<tr>
<td></td>
<td>Year 1 (<em>iNSPIRE</em>)</td>
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<tr>
<td></td>
<td>Instill the Desire to Be &amp; to Learn</td>
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</tbody>
</table>
Year 1 - iNSPIRE

Teaching – Intro to Engineering Module

Catapult Challenge – an inter-class skirmish (I2E)
Year 1 - iNSPIRE
Competition – FIRST Tech Challenge
(by Singapore Science Centre)

Engagement – not in curriculum yet spending time & effort and enjoying it!

GET OVER IT!
Year 2 - iNTEGRATE

1. Teaching – Mechanical Design, Micro-controllers & Programming
2. Anchor Project – build an AGV

Amazing Maze Challenge – for the fastest AGV in the teams
Year 3 - iNVENT

Engaging Projects – in an Engaging Robotics Learning Space

Facility Space
(freely available tools, components & desktop machine)

Play Space (Board Games, Music Making)

Knowledge Space
(Satellite Library Pod)

Sharing Space
(Projectors & Screens for cross pollination of ideas)

Co-Creation Space
(Clustered Project Cells for cross critique & enhance group dynamics & motivation)
Year 3 - \textit{iNVENT}

Engaging Projects – apply knowledge of inter-disciplines and develop problem-solving & engineering skills

Hybrid Robot

Hybrid Vehicle
Year 3 - iNVENT

Engaging Projects – apply knowledge of inter-disciplines and develop problem-solving & engineering skills
CONCLUSION
The CDIO Initiative

• **Industry benefits**
  – CDIO produces engineers who have the knowledge, talents and experience it specifically needs.

• **Educators interested**
  – CDIO syllabus forms a basis for curricular planning and outcome based assessment

• **Students enthusiastic**
  – Graduate with a unique array of personal, interpersonal and system-building experiences
## Curriculum Changes

<table>
<thead>
<tr>
<th>Before CDIO</th>
<th>With CDIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning outcome is determined by “what we think students are capable of doing”</td>
<td>Learning outcome is determined by what the graduates are expected to do, i.e. job competency</td>
</tr>
</tbody>
</table>
CONCLUDING REMARKS

• The CDIO approach provides a reference model for engineering education where professional practice and innovation is focused

• The CDIO approach is codified in the CDIO syllabus and standards. CDIO elements can be used as an integrated set or piecewise, are subject to adaptation to local context etc

• CDIO is an open endeavor – you are all welcome to participate and contribute – over 100 universities worldwide are now members of the CDIO Initiative

• To learn more, visit www.cdio.org or read Rethinking Engineering Education: The CDIO Approach by Crawley, Malmqvist, Östlund, & Brodeur, 2007
THANK YOU!