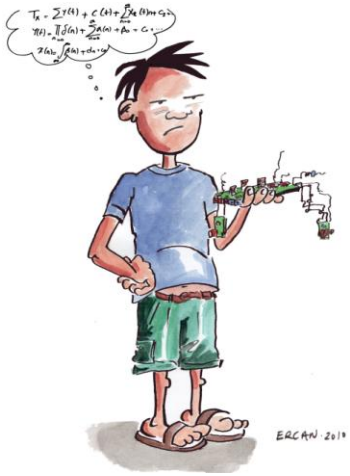
Designing a CDIO Programme: The CDIO Syllabus and Standards

Helene Leong
Director
Educational Development Department
Singapore Polytechnic

SINGAPORE POLYTECHNIC



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

THE ENGINEERING TRANSFORMATION

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

meaningful

Sense of purpose

joy of learning

What should this learning experience be like?

joy of engineering

motivation to learn

What Do We Teach ?

How Do We Teach ?

cdio

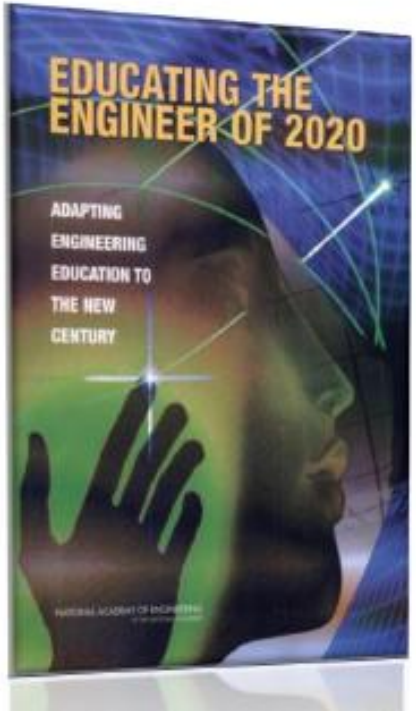
CONCEIVE DESIGN IMPLEMENT OPERATE

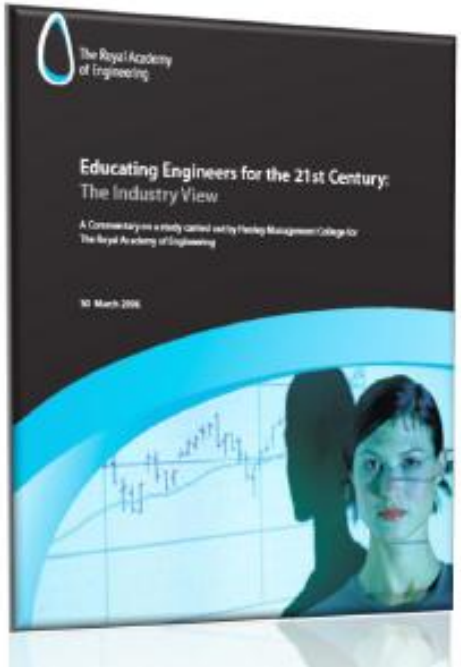
Worldwide Initiative

More than 100 Institutions of Higher Learning

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-**D**esigning-**I**mplementing-**O**perating 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

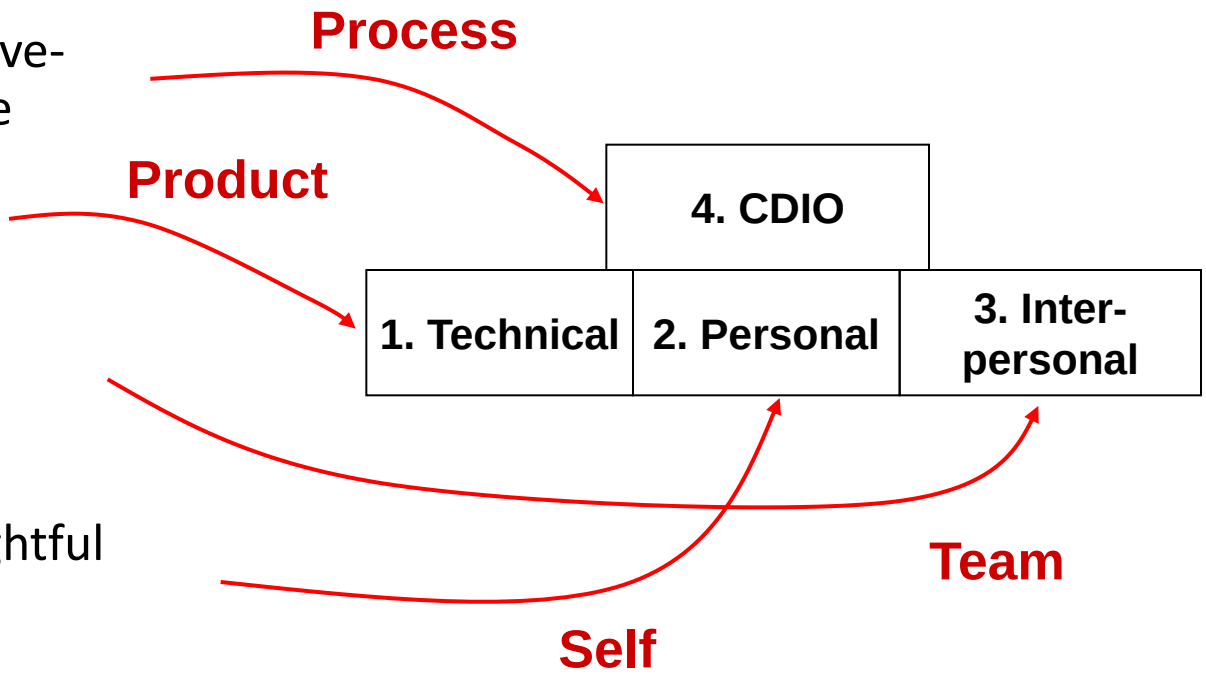
Educate students who:

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

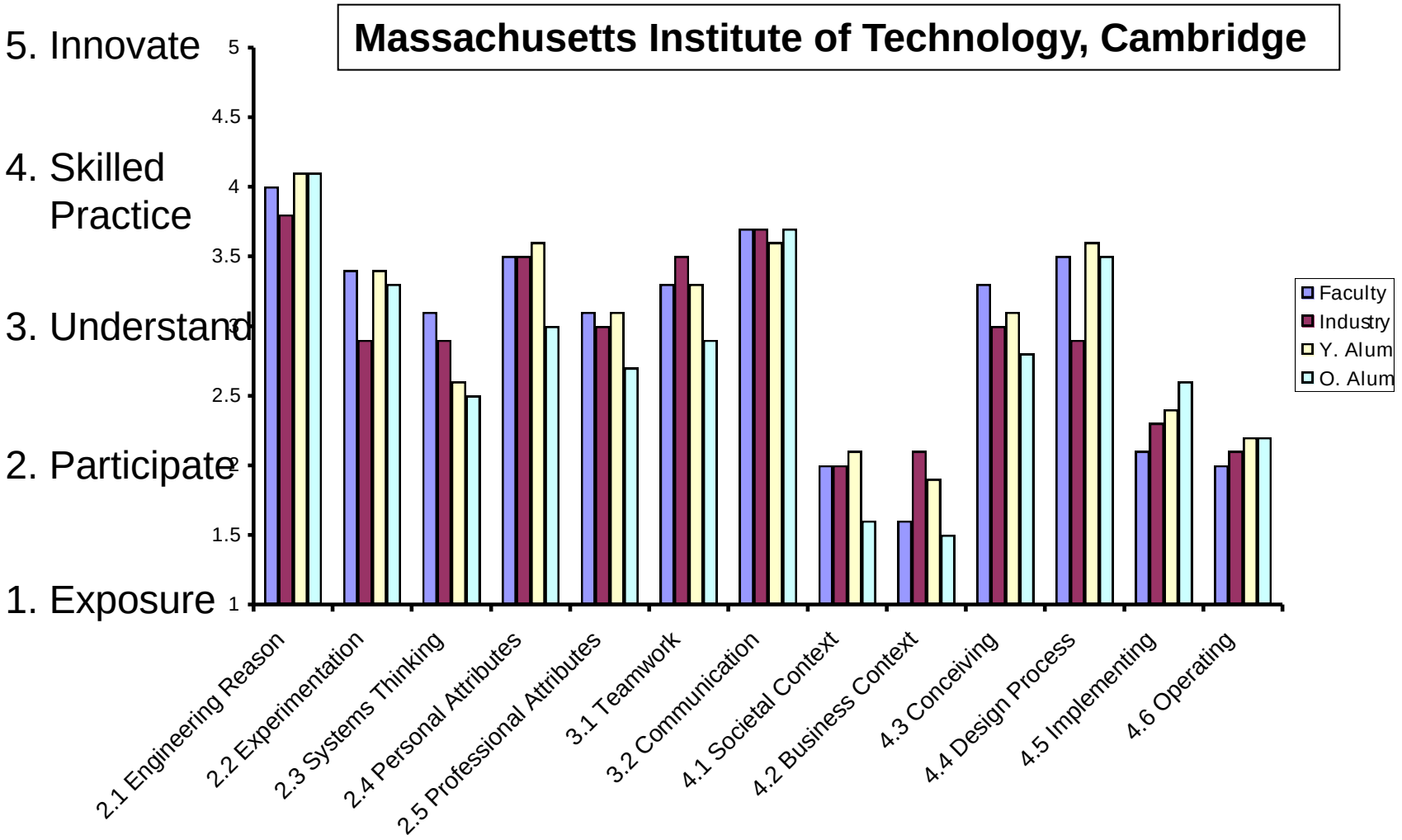
SCIENCES
1.2. CORE ENGINEERING FUNDAMENTAL KNOWLEDGE
1.3. ADVANCED ENGINEERING FUNDAMENTAL KNOWLEDGE

2 PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES
2.1. ENGINEERING REASONING AND PROBLEM SOLVING
2.1.1. Problem Identification and Formulation
2.1.2. Modeling
2.1.3. Estimation and Qualitative Analysis
2.1.4. Analysis With Uncertainty
2.1.5. Solution and Recommendation
2.2. EXPERIMENTATION AND KNOWLEDGE DISCOVERY
2.2.1. Hypothesis Formulation
2.2.2. Survey of Print and Electronic Literature
2.2.3. Experimental Inquiry
2.2.4. Hypothesis Test, and Defense
2.3. SYSTEM THINKING
2.3.1. Thinking Holistically
2.3.2. Emergence and Interactions in Systems
2.3.3. Prioritization and Focus
2.3.4. Tradeoffs, Judgment and Balance in Resolution
2.4. PERSONAL SKILLS AND ATTITUDES
2.4.1. Initiative and Willingness to Take Risks
2.4.2. Perseverance and Flexibility
2.4.3. Creative Thinking
2.4.4. Critical Thinking
2.4.5. Awareness of One's Personal Knowledge, Skills, and Attitudes
2.4.6. Curiosity and Lifelong Learning
2.4.7. Time and Resource Management
2.5. PROFESSIONAL SKILLS AND ATTITUDES
2.5.1. Professional Ethics, Integrity, Responsibility and Accountability
2.5.2. Professional Behavior
2.5.3. Proactively Planning for One's Career
2.5.4. Staying Current on World of Engineer

3 INTERPERSONAL SKILLS: TEAMWORK AND COMMUNICATION
3.1. TEAMWORK
3.1.1. Forming Effective Teams
3.1.2. Team Operation
3.1.3. Team Growth and Evolution
3.1.4. Leadership
3.1.5. Technical Teaming
3.2. COMMUNICATION
3.2.1. Communication Strategy
3.2.2. Communication Structure
3.2.3. Written Communication
3.2.4. Electronic/Multimedia Communication
3.2.5. Graphical Communication
3.2.6. Oral Presentation and Interpersonal Communication
3.3.1. English
3.3.2. Languages within the European Union
3.3.3. Languages outside the European Union

4 CONCEIVING, DESIGNING, IMPLEMENTING AND OPERATING SYSTEMS IN THE ENTERPRISE AND SOCIETAL CONTEXT
4.1. EXTERNAL AND SOCIETAL CONTEXT
4.1.1. Roles and Responsibility of Engineers
4.1.2. The Impact of Engineering on Society
4.1.3. Society's Regulation of Engineering
4.1.4. The Historical and Cultural Context
4.1.5. Contemporary Issues and Values
4.1.6. Developing a Global Perspective
4.2. ENTERPRISE AND BUSINESS CONTEXT
4.2.1. Appreciating Different Enterprise Cultures
4.2.2. Enterprise Strategy, Goals and Planning
4.2.3. Technical Entrepreneurship
4.2.4. Working Successfully in Organizations
4.3. CONCEIVING AND ENGINEERING SYSTEMS
4.3.1. Setting System Goals and Requirements
4.3.2. Defining Function, Concept and Architecture
4.3.3. Modeling of System and Ensuring Goals Can Be Met
4.3.4. Development Project Management
4.4. DESIGNING
4.4.1. The Design Process
4.4.2. The Design Process Phasing and Approaches
4.4.3. Utilization of Knowledge in Design
4.4.4. Disciplinary Design
4.4.5. Multidisciplinary Design
4.4.6. Multi-objective Design
4.5. IMPLEMENTING
4.5.1. Designing the Implementation Process
4.5.2. Hardware Manufacturing Process
4.5.3. Software Implementing Process
4.5.4. Hardware Software Integration
4.5.5. Test, Verification, Validation and Certification
4.5.6. Implementation Management
4.6. OPERATING
4.6.1. Designing and Optimizing Operations
4.6.2. Training and Operations
4.6.3. Supporting the System Lifecycle
4.6.4. System Improvement and Evolution
4.6.5. Disposal and Life-End Issues
4.6.6. Operations Management

VALIDATION WITH KEY STAKEHOLDERS



REMARKABLE AGREEMENT!

CDIO syllabus correlated with ABET

CDIO Syllabus	ABET EC2010 Criterion 3										
	a	b	c	d	e	f	g	h	i	j	k
1.1 Knowledge of Underlying Mathematics, Science	■										
1.2 Core Engineering Fundamental Knowledge	■										
1.3 Adv. Engr. Fund. Knowledge, Methods, Tools	▒										■
2.1 Analytical Reasoning and Problem Solving					■						▒
2.2 Exper., Investigation and Knowledge Discovery		■									
2.3 System Thinking			▒								
2.4 Attitudes, Thought and Learning									■		
2.5 Ethics, Equity and Other Responsibilities						■					▒
3.1 Teamwork				■							
3.2 Communications							■				
3.3 Communication in Foreign Languages											
4.1 External, Societal and Environmental Context			▒					■		■	
4.2 Enterprise and Business Context			▒					■			
4.3 Conceiving, Systems Engr. and Management			■								
4.4 Designing			■								
4.5 Implementing			▒								
4.6 Operating			▒								
	■	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)

Customisation & Validation Of Skills

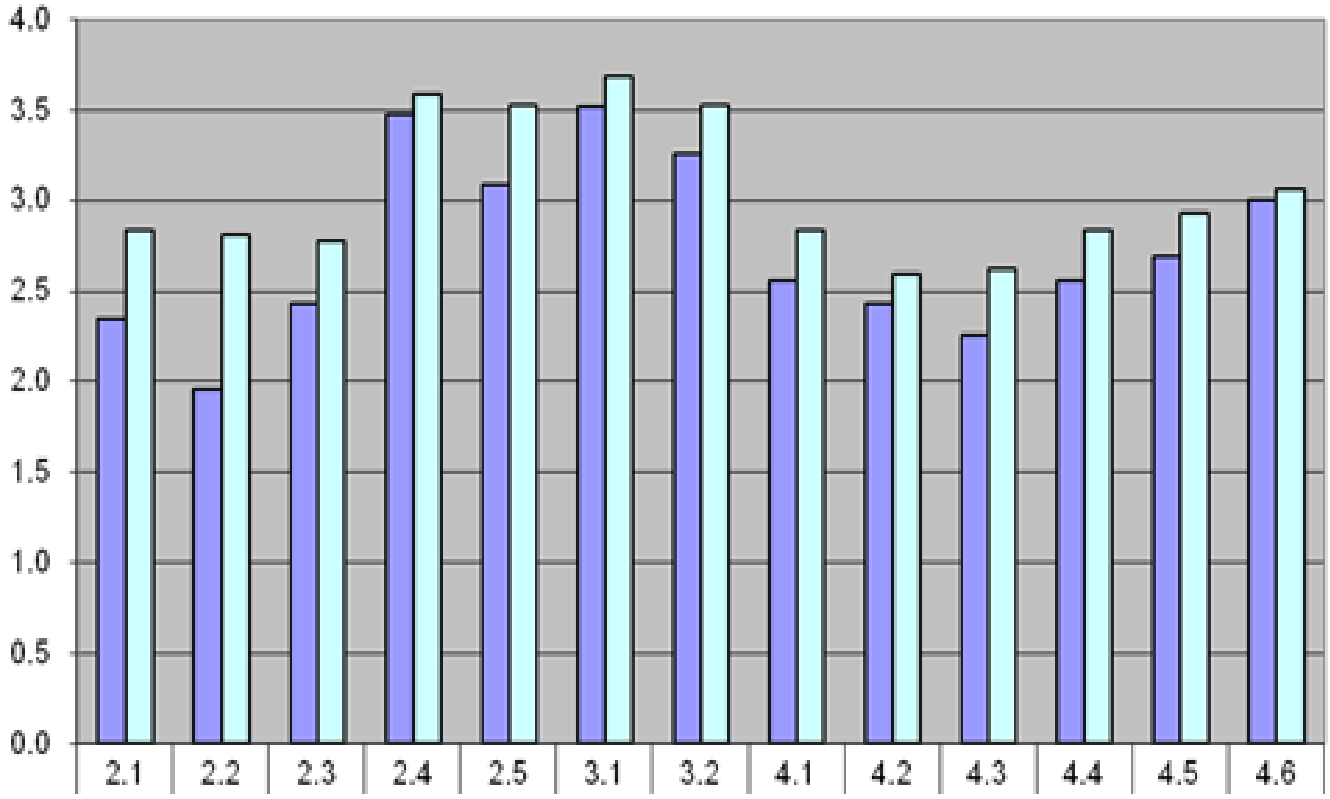
Gap Analysis & Curriculum Mapping

Curriculum Integration & Design Of Activities

Assessment Redesign

Program Evaluation

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

CDIO Syllabus – Customised for SP

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
3. Stay Current on Emerging Research and Practices in your Field

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

Teamwork

SEMESTER 1	SEMESTER 2
Core Module 1A-1	Core Module 1B-1
Core Module 1A-2	Core Module 1B-2
Core Module 1A-3	Core Module 1B-3
Core Module 1A-4	Core Module 1B-4
Core Module 1A-5	Core Module 1B-5
Core Module 1A-6	Core Module 1B-6

SEMESTER 3	SEMESTER 4
Core Module 2A-1	Core Module 2B-1
Core Module 2A-2	Core Module 2B-2
Core Module 2A-3	Core Module 2B-3
Core Module 2A-4	Core Module 2B-4
Core Module 2A-5	Core Module 2B-5
Core Module 2A-6	Core Module 2B-6

SEMESTER 5	SEMESTER 6
Core Module 3A-1	Core Module 3B-1
Core Module 3A-2	Core Module 3B-2
Core Module 3A-3	Core Module 3B-3
Core Module 3A-4	Core Module 3B-4
Core Module 3A-5	Core Module 3B-5
Core Module 3A-6	Core Module 3B-6

Year 1: Exposure to CDIO skills

Year 2: Reinforcement of CDIO skills

Year 3: Practice and Apply of CDIO skills

Customisation & Validation Of Skills

Gap Analysis & Curriculum Mapping

Curriculum Integration & Design of Activities

Assessment Redesign

Program Evaluation

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.

Technical skills

Creativity and Innovation

Flood alert system

Uflip - automatic flip page for elderly or handicap

Automatic Car Parking System

Presentation Skills

Problem Solving Skills

Teamwork

CDIO STANDARDS

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

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

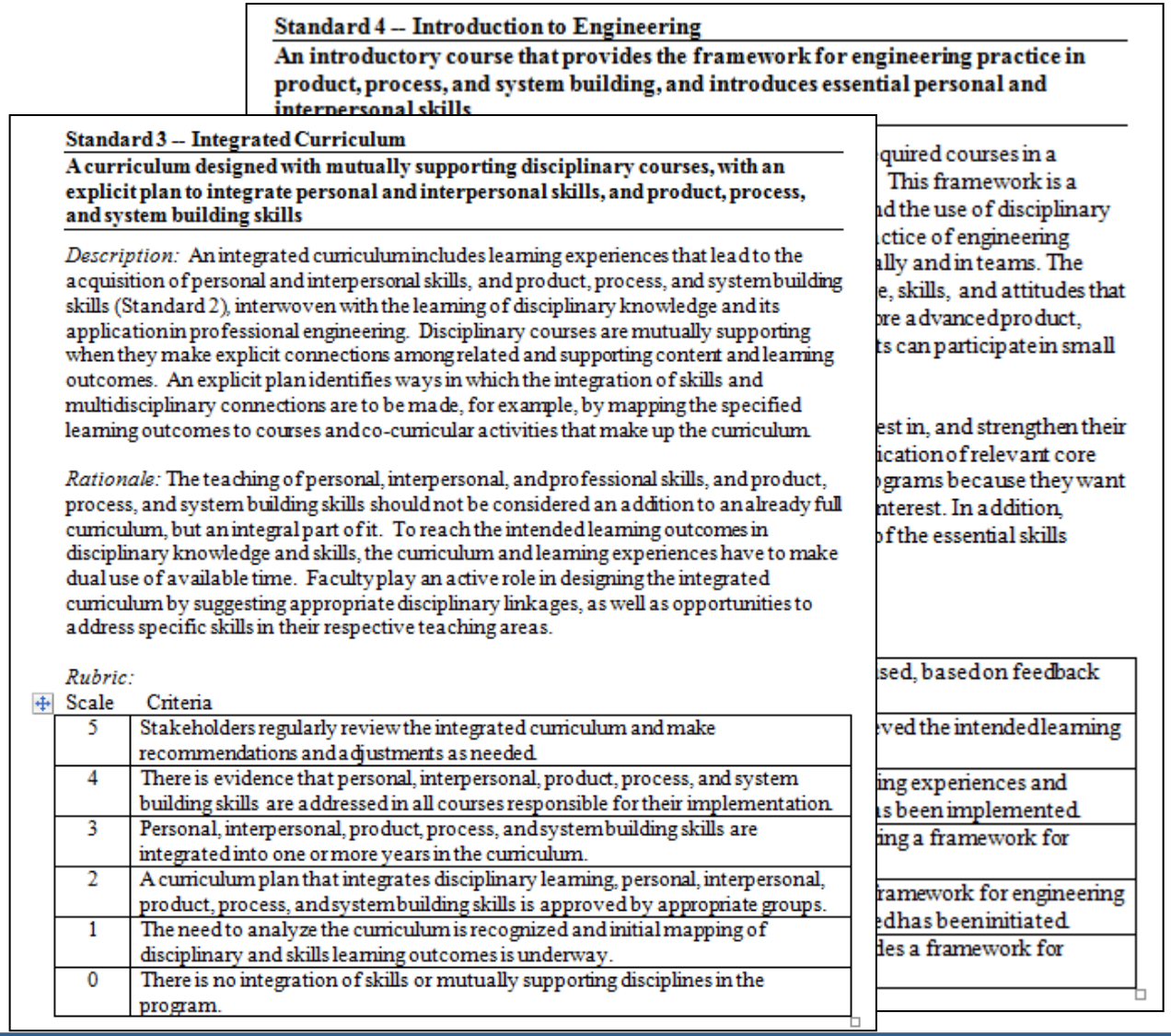
Evolve to a model in which these resources are better employed to **promote student learning**

CDIO Standards

	Standard 1	CDIO as the context
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 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

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), interwoven 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.

Rationale: 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:

Scale	Criteria
5	Stakeholders regularly review the integrated curriculum and make recommendations and adjustments as needed.
4	There is evidence that personal, interpersonal, product, process, and system building skills are addressed in all courses responsible for their implementation.
3	Personal, interpersonal, product, process, and system building skills are integrated into one or more years in the curriculum.
2	A curriculum plan that integrates disciplinary learning, personal, interpersonal, product, process, and system building skills is approved by appropriate groups.
1	The need to analyze the curriculum is recognized and initial mapping of disciplinary and skills learning outcomes is underway.
0	There is no integration of skills or mutually supporting disciplines in the program.

CDIO Self-Evaluation Template

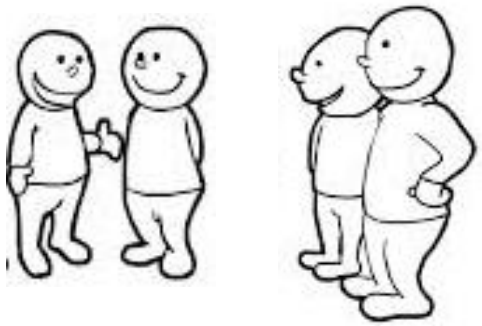
	CDIO STANDARD	EVIDENCE OF COMPLIANCE	RATING	ACTIONS
1	CDIO as Context Adoption of the principle that product and system lifecycle development and deployment – Conceiving, Designing, Implementing and Operating - are the context for engineering education			
2	CDIO Syllabus Outcomes Specific, detailed learning outcomes for personal, interpersonal and product and system building skills, consistent with program goals and validated by program stakeholders			
3	Integrated Curriculum A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal and product and system building skills			

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

Standard 3 (Integrated Curriculum)

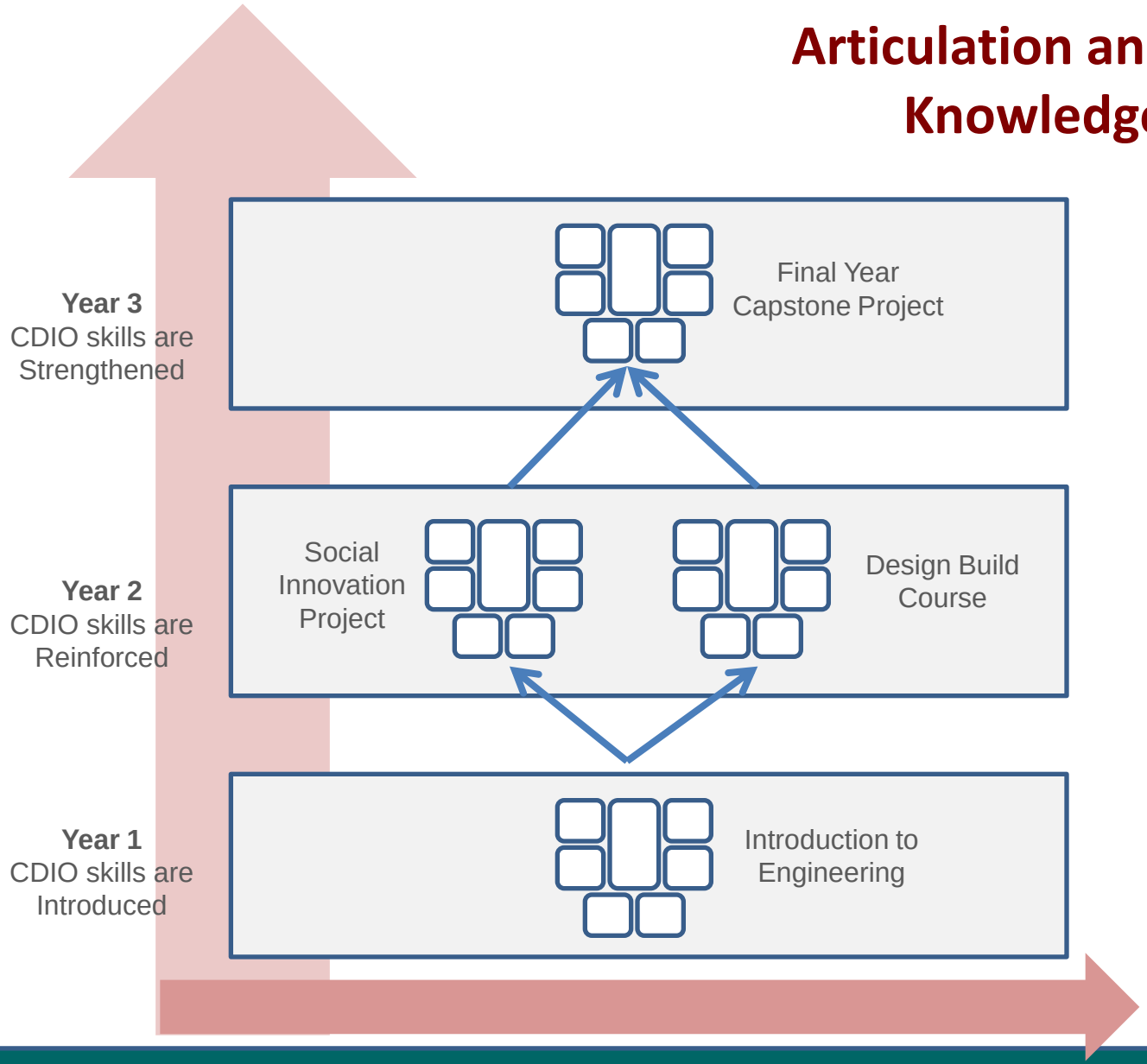
Standard 4 (Introduction to Engineering)



Implementation in SP

SINGAPORE POLYTECHNIC

Horizontal and Vertical Articulation and Integration of Knowledge and Skills



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

merged

Computer-aided Design

- reading and visualization of engineering drawings and applying modelling skill to create part models and drawings

Context

Connector Trimming Machine

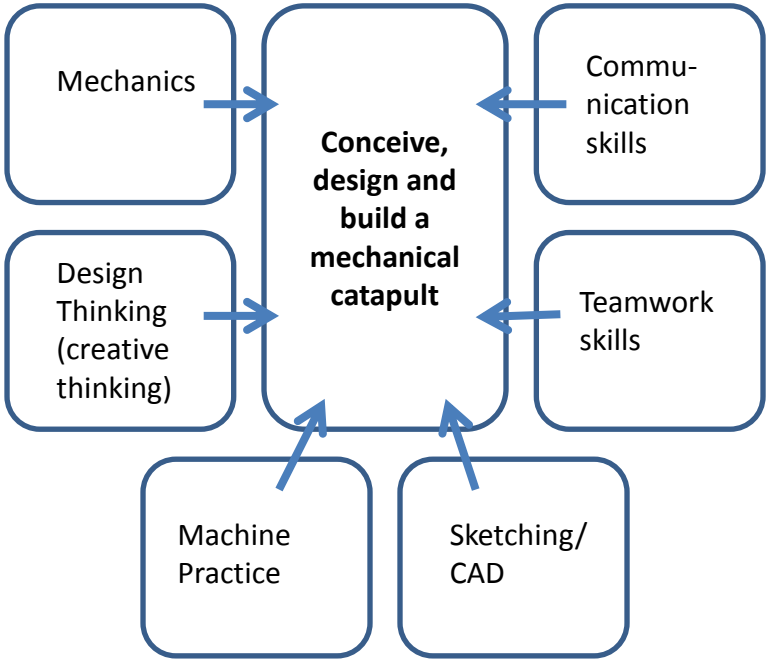
Communication & Teamwork

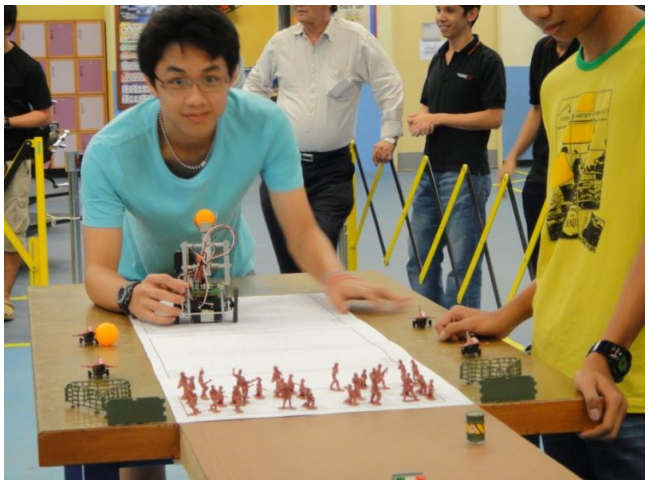
Manage Learning

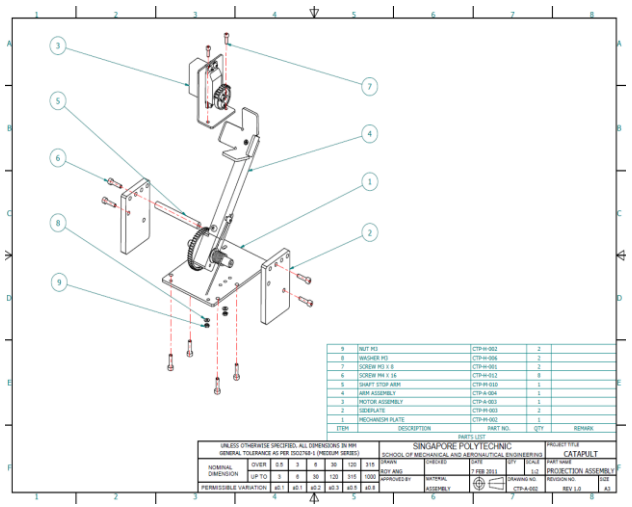
CDIO Skills

Sequencing and Linking Modules

Creating opportunities to integrate Knowledge and Skills across modules







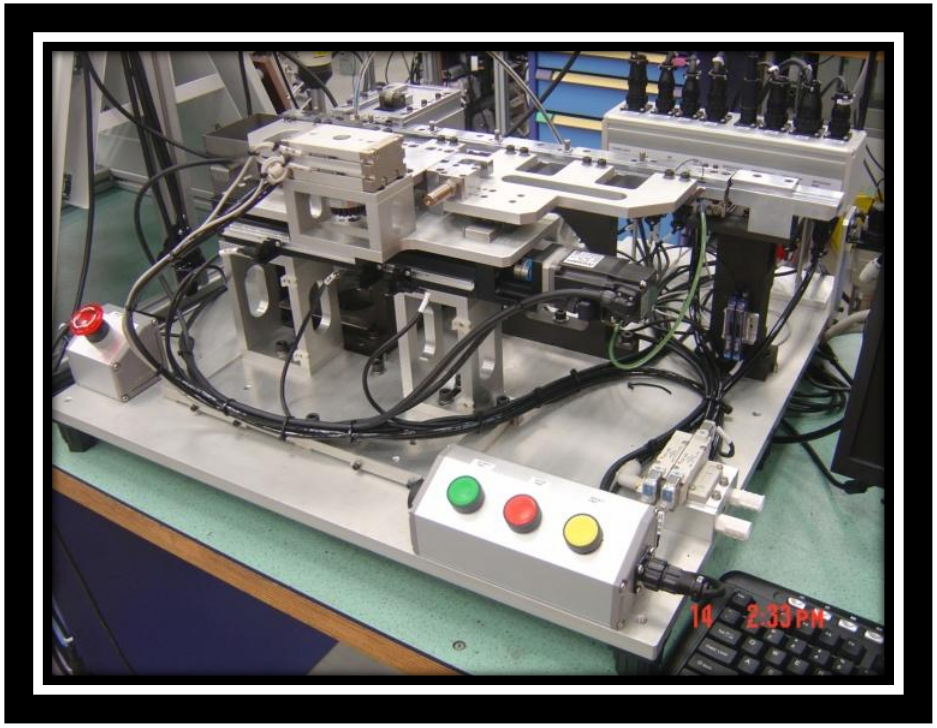
Year 1 Introduction to Engineering

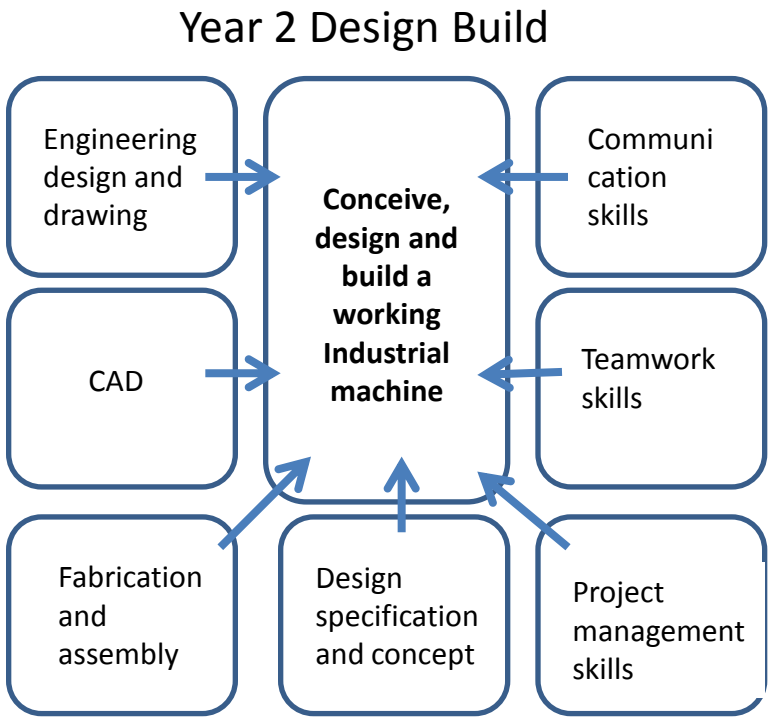
http://www.youtube.com/watch?v=KUGwLHn1vbw&feature=g-upl

Sequencing and Linking Modules

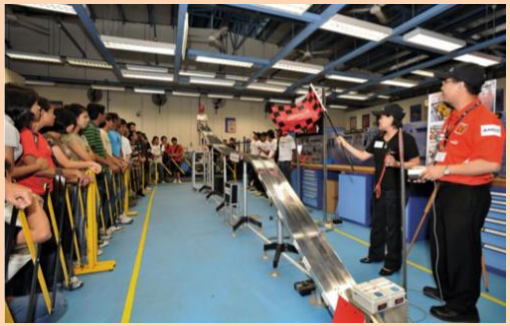
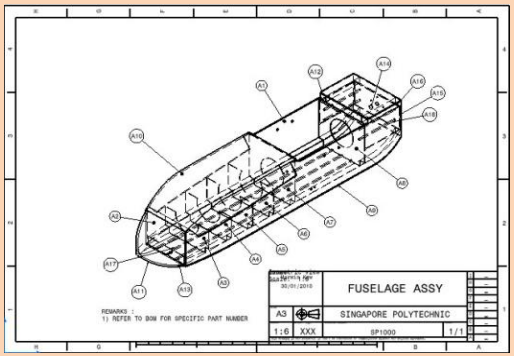
Creating opportunities to integrate Knowledge and Skills across modules

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



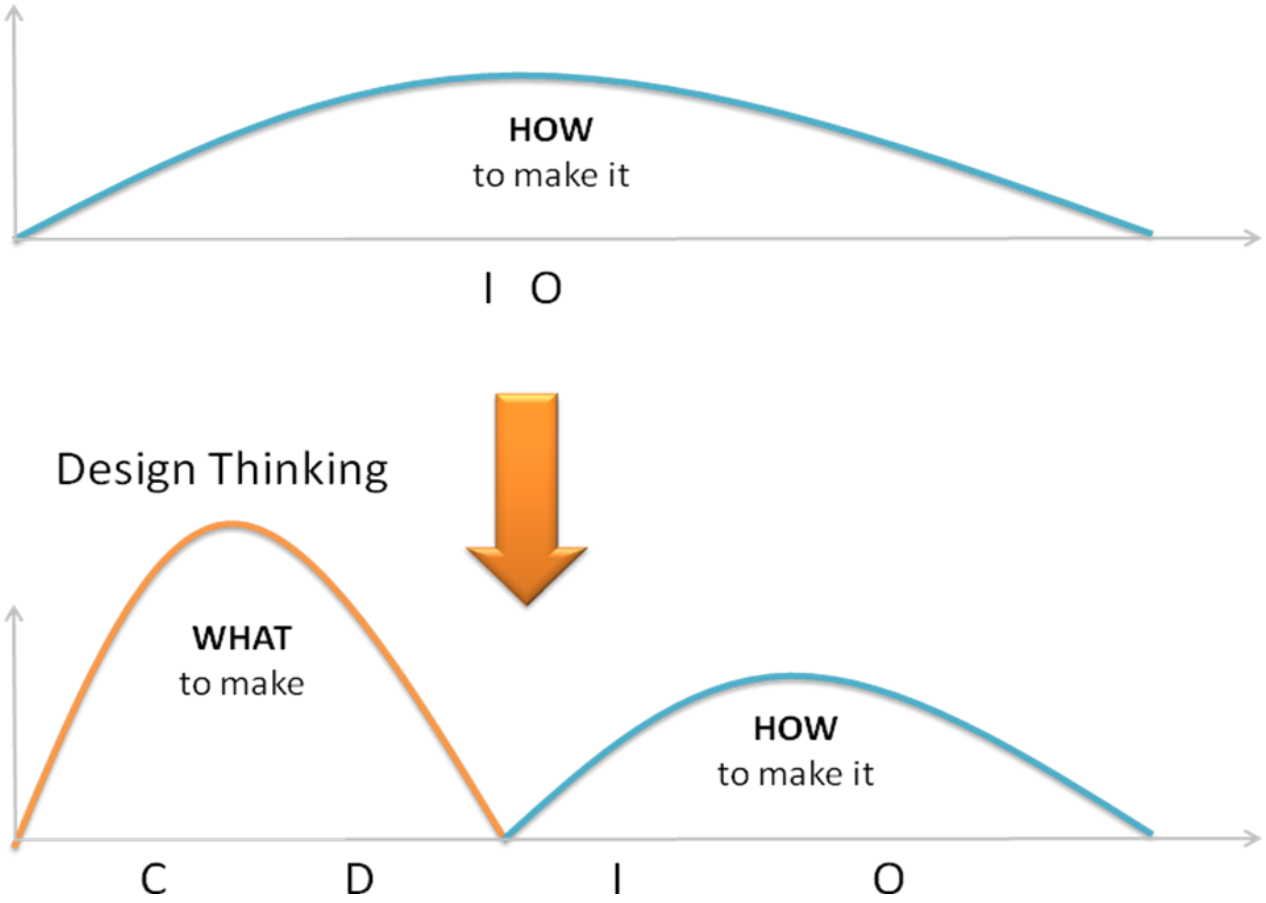


Student Experiences Re-designed

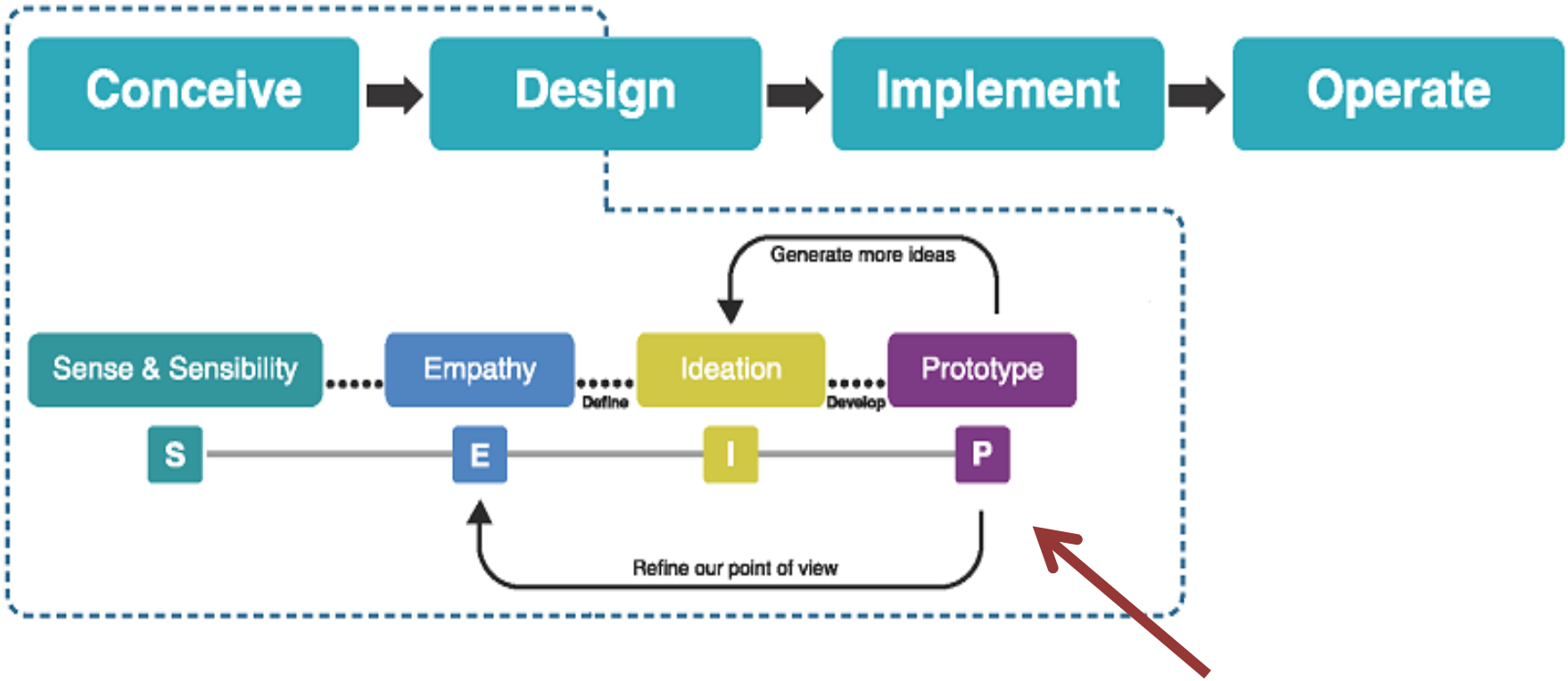
Year 1	Year 2	Year 3
 	 	 
Introduction to Engineering (basic conceive, design and implement)	**Year 2 project** Conceive, Design (Design Thinking)	**Capstone Project** Conceive, Design, Implement and Operate

STRENGTHENING THE CDIO FRAMEWORK

Design Thinking Methodology



Strengthening CDIO with Design Thinking



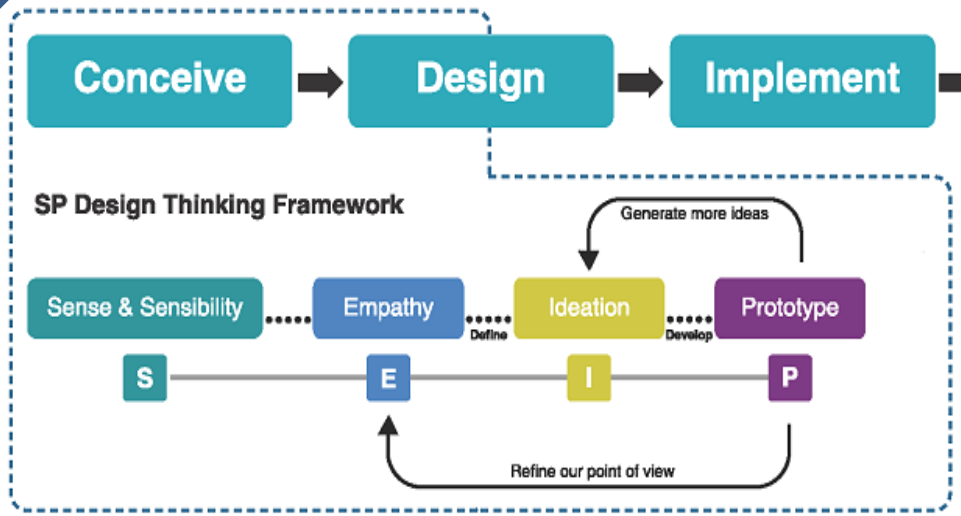
SP Design Thinking Framework

Meaningful Engagement

through Social Innovation

Engineering Innovator With a Social Cause

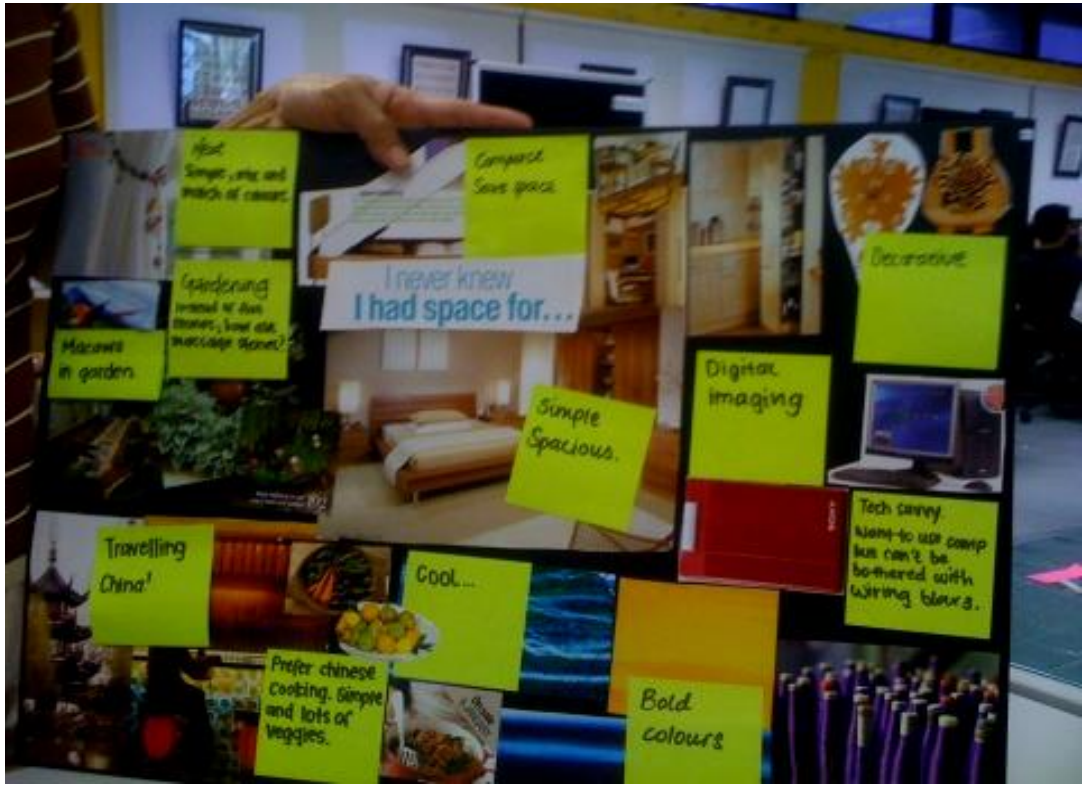
- **To Do** Hands-on Engineering : possesses both theory and practice
- **To Be** Innovative, Steve Jobs is his role model, able to work in multidisciplinary teams
- **To Serve** Socially and Environmentally in a purposefully manner



Social Innovation

Empathy

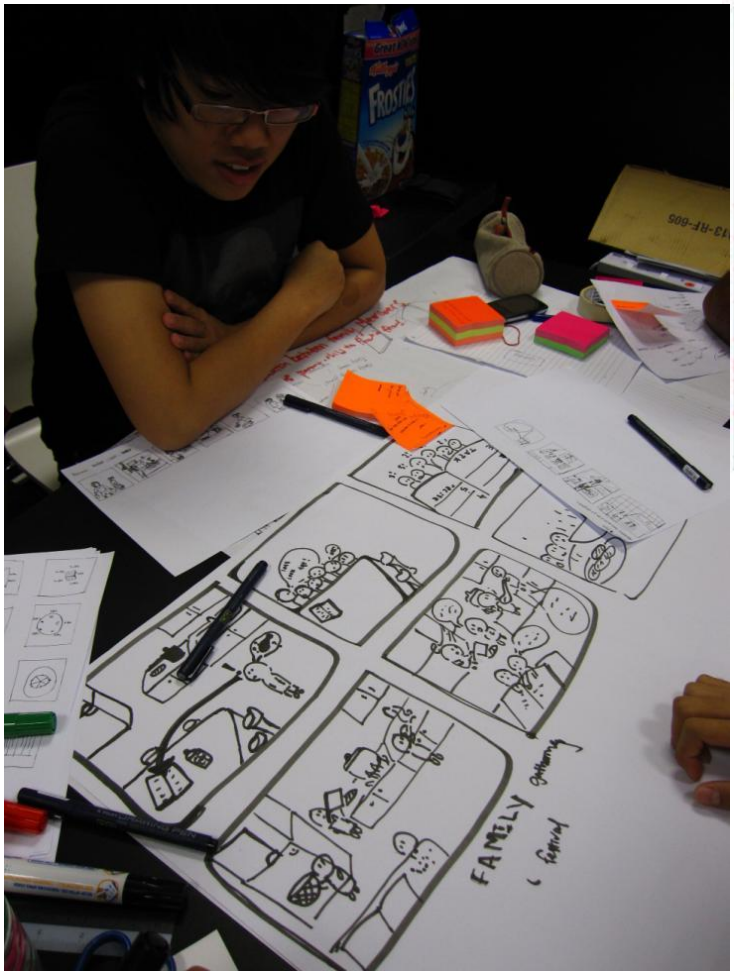
Ethnographic Study of the Lifestyle of Singaporeans aged 50+



- 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

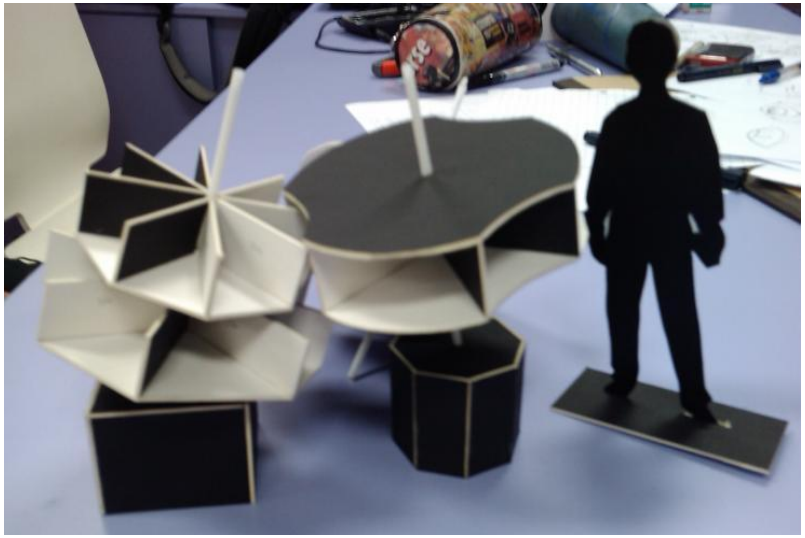
Ideation


FAMILY

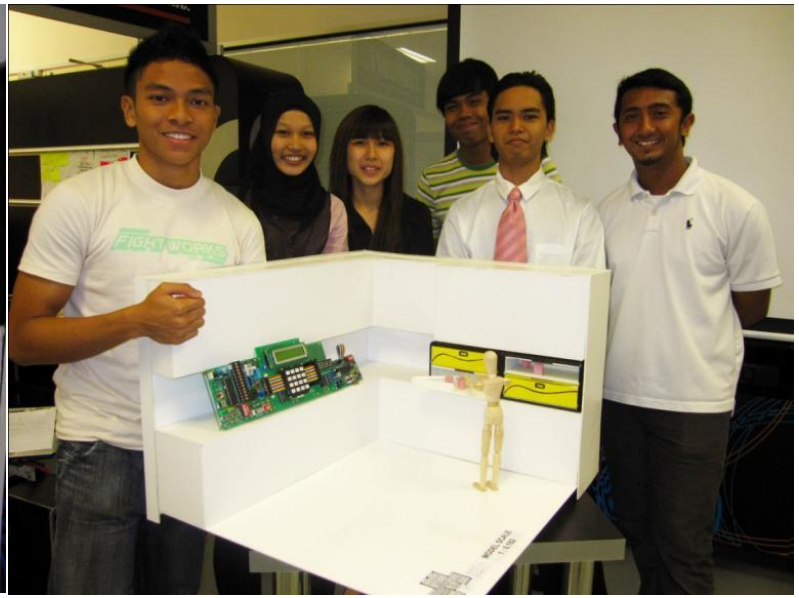

Environment
People
- Ironing Space
- Storage Space
- Home
- Laundry
Space
Poems
Media
Service
- Save


HELLO

Prototyping



Final Concept & Prototype



Horizontal Refrigerator

PURPOSEFUL CHALLENGES, INNOVATIVE THINKING, GROWTH MINDSETS

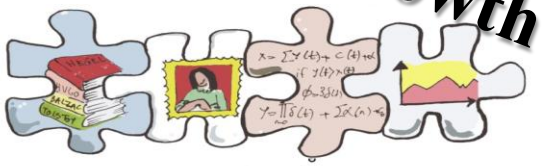
Using **Design Thinking** and **skills** to come up with **innovative solutions** for communities in Asia

INTRINSIC MOTIVATION

Essential Skills for the VUCA World

Creativity, Out-of-Box Thinking

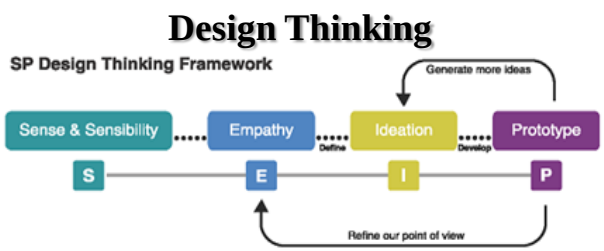
Self-Driven Learner with life purpose, **Growth Mindset** to embrace challenge

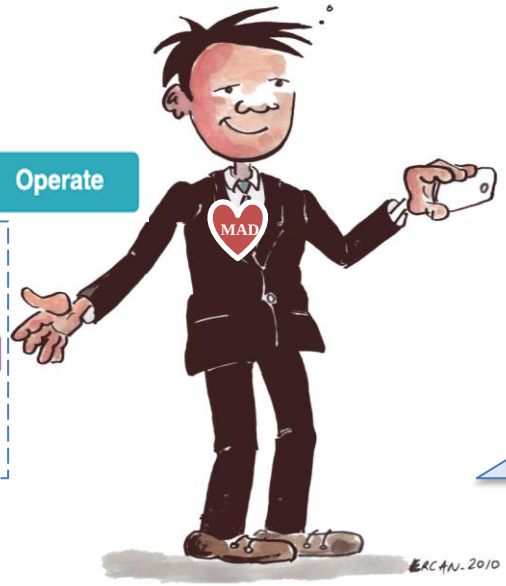


cdio
CONCEIVE DESIGN IMPLEMENT OPERATE

Conceive → Design → Implement → Operate

Design Thinking





Intrinsic Motivation Framework

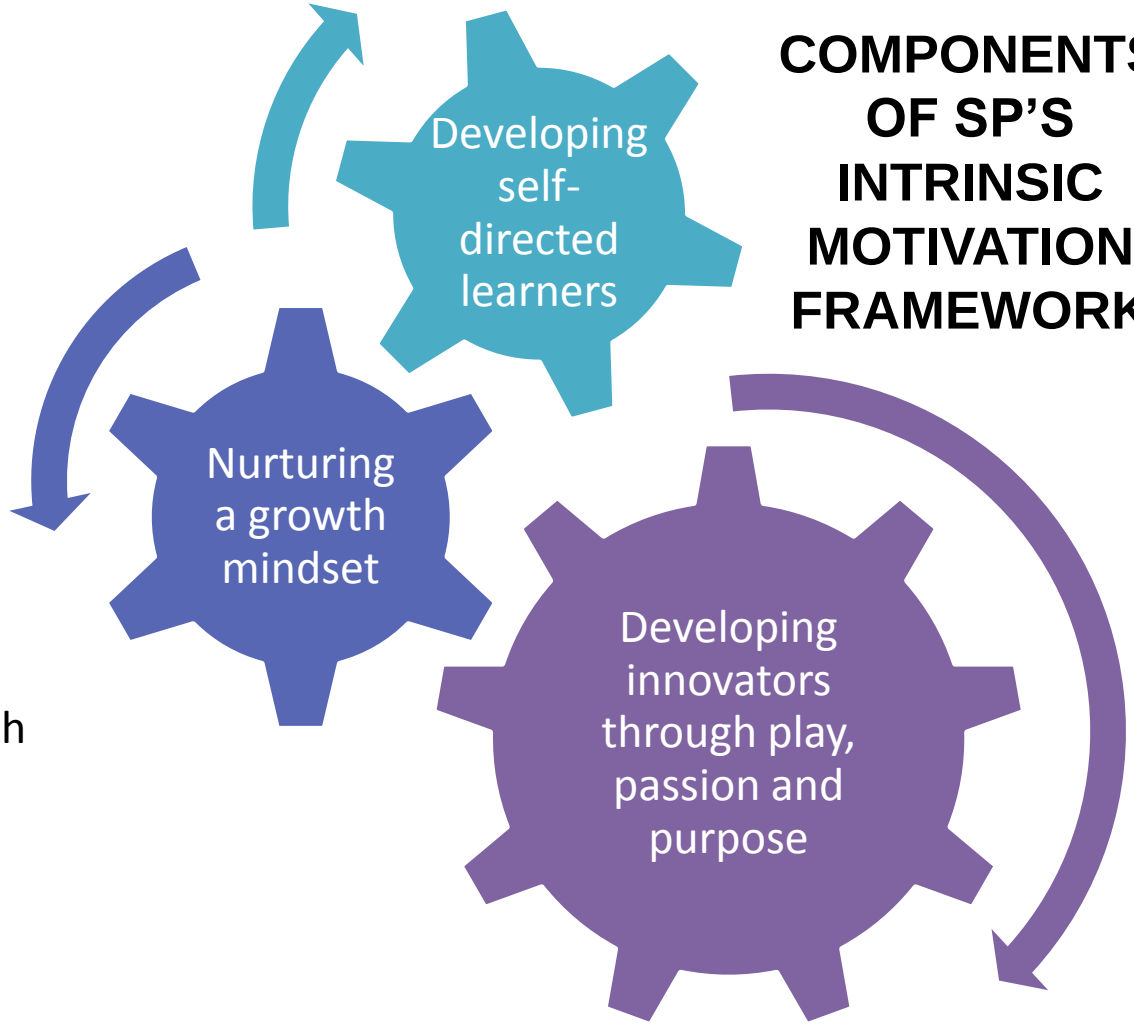
Dare to Think (Innovation)

To develop the CREATIVE CONFIDENCE in our students

Dare to Do ("Can Do" Spirit)

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

COMPONENTS OF SP'S INTRINSIC MOTIVATION FRAMEWORK



The Pedagogy

Diploma in Mechatronics & Robotics (DMRO)

Year 3 (iNVENT)

Empower to Create

Year 2 (iNTEGRATE)

Imbue with Knowledge & Ability to Integrate

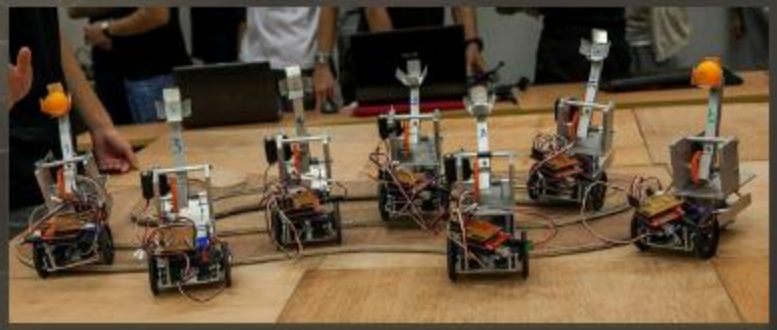
Year 1 (iNSPIRE)

Instill the Desire to Be & to Learn

3

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)

FIRST

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

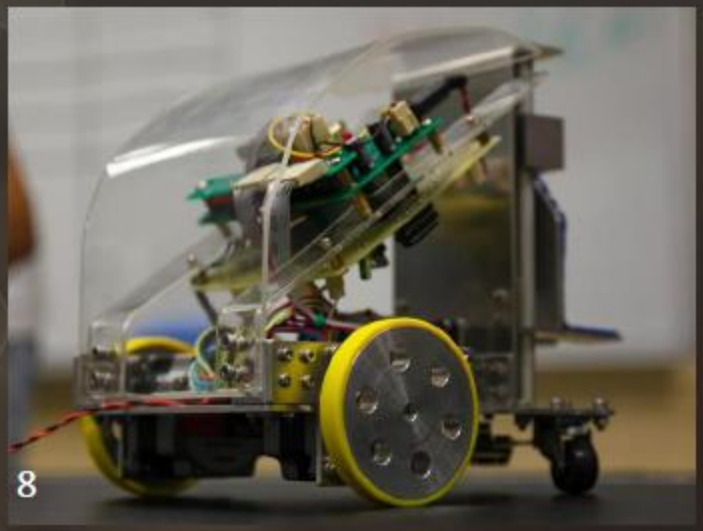
GET OVER IT™

6

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



8

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)

10

Year 3 - iNVENT

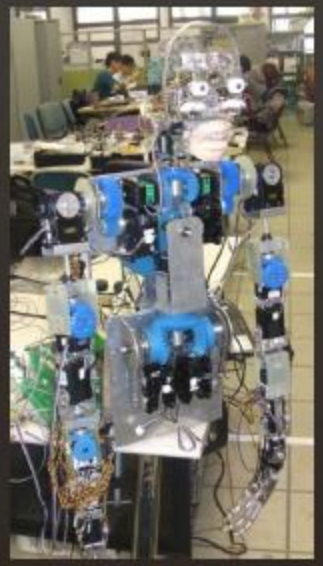
Engaging Projects – apply knowledge of inter-disciplines and develop problem-solving & engineering skills

Hybrid Robot

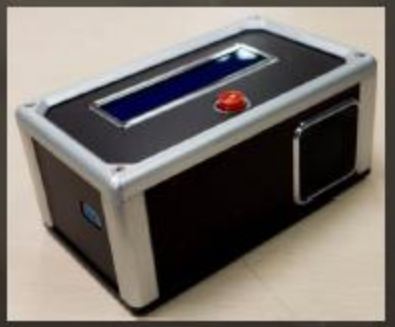
Hybrid Vehicle

Year 3 - iNVENT

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



Exoskeleton



Healthcare Device

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

Before CDIO	With CDIO
Learning outcome is determined by “what we think students are capable of doing”	Learning outcome is determined by what the graduates are expected to do, i.e. job competency

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!