



Ready to Engineer

Conceive **D**esign **I**mplement **O**perate

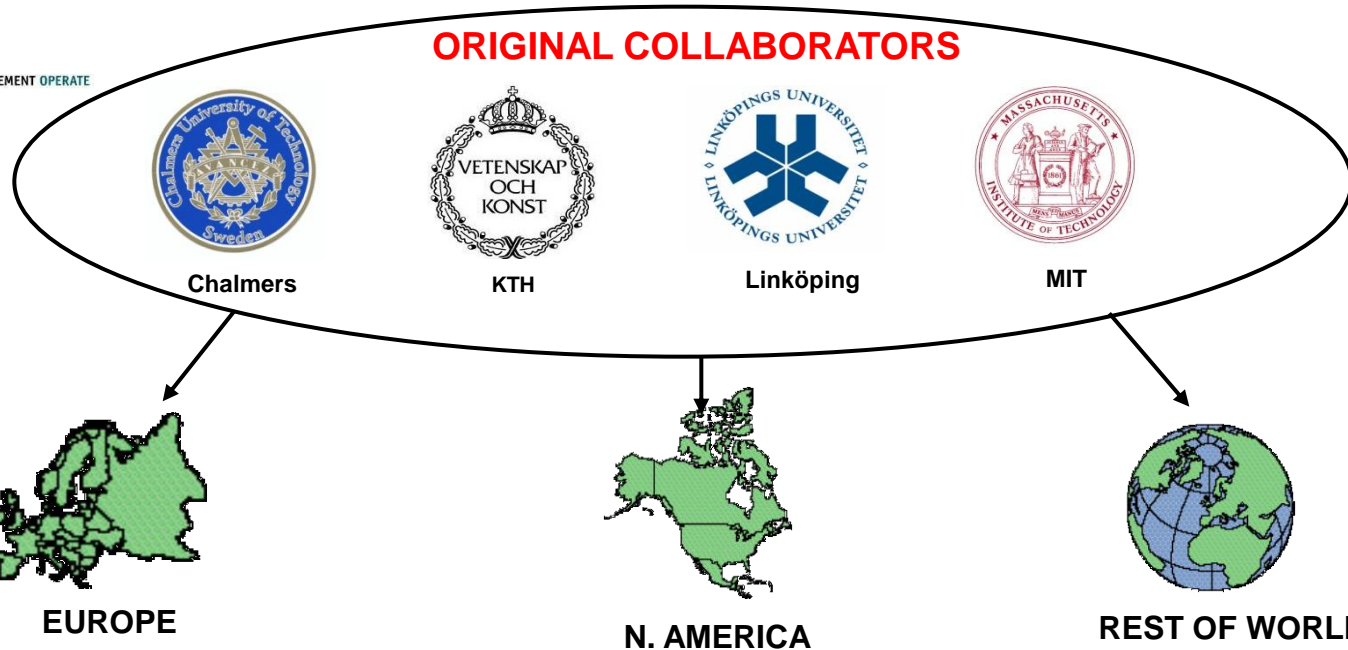
THE CDIO INITIATIVE



- **The CDIO Initiative is an international initiative for the reform of engineering education**
- **It develops an approach to engineering education that uses the product/system/process lifecycle as the context of the education**
- **Founded in 2001 by MIT, Chalmers, KTH and Linköping University. Currently over 50 universities collaborate in the initiative**

CDIO DISSEMINATION

ORIGINAL COLLABORATORS



COLLABORATORS

- | | | | | |
|---|--|---|--|--|
| 
Denmark Tech. U. | 
Queen's U., Belfast | 
US Naval Academy | 
U. Auckland | 
U. Pretoria |
| 
U. Liverpool | 
École Poly., Montréal | 
Queen's U. Ontario | 
Singapore Poly. | 
Hogeschool Gent |
- HOCHSCHULE WISMAR UNIVERSITY OF APPLIED SCIENCES
UNIVERSITY OF TECHNOLOGY AND BUSINESS DESIGN
-

- **What is the full set of knowledge, skills and attitudes that a student should possess as they graduate from university? At what level of proficiency?**
 - *In addition to the traditional engineering disciplinary knowledge*
- **How can we do better at assuring that students learn these skills?**
 - *Within the available student and faculty time, funding and other resources*

WHAT DO ENGINEERS DO?



**”Scientists investigate that which already is.
Engineers create that which has never been.
- Theodore von Karmann**

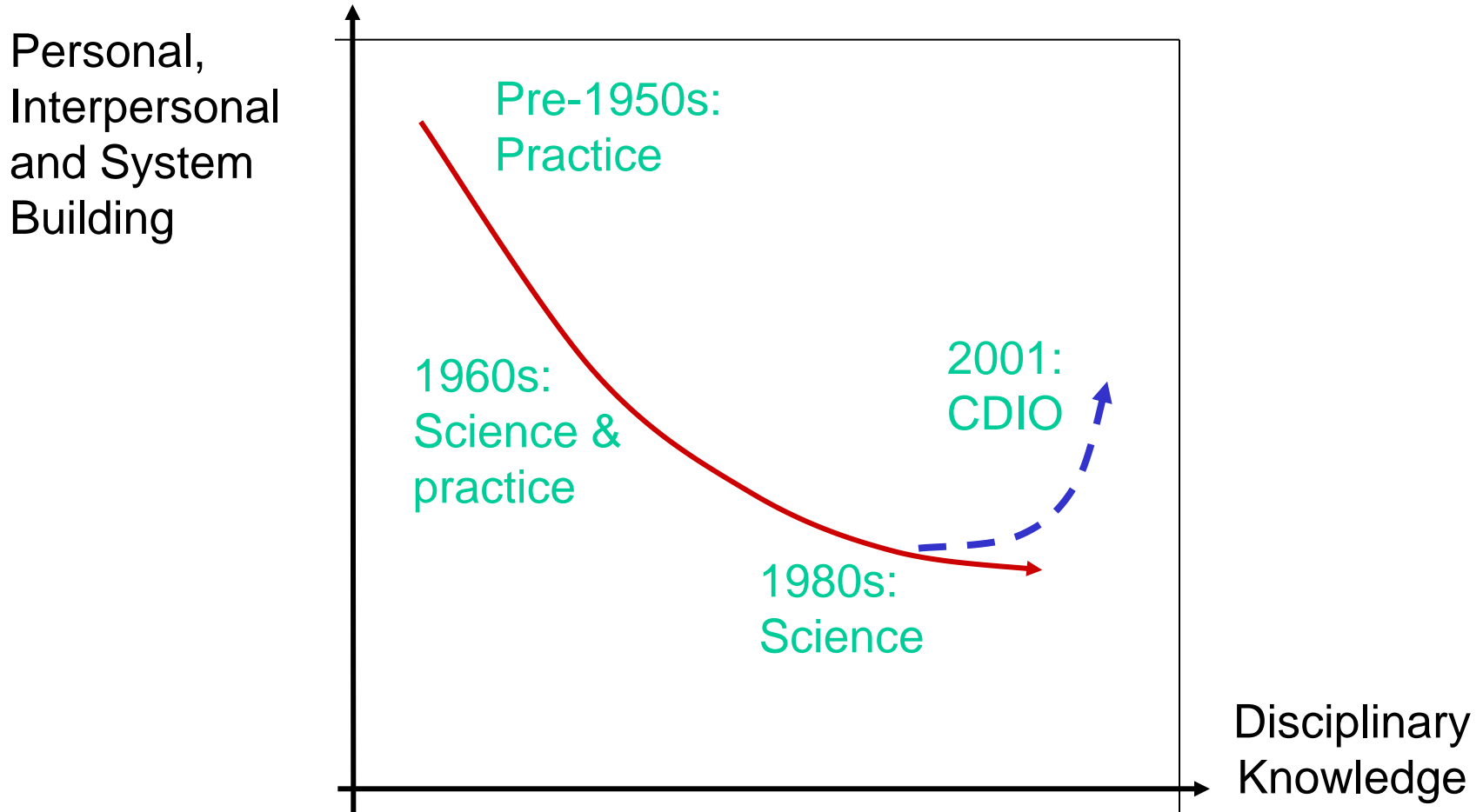
**”What you need to invent, is an
imagination and a pile of junk”
- Thomas Edison**

**”What is chiefly needed is skill
rather than machinery”
- Wilbur Wright**

**”Engineers Conceive, Design, Implement and Operate
complex products and systems in a team-based
environment”**

We have adopted CDIO as the engineering context of our education

EVOLUTION OF ENGINEERING EDUCATION



Engineers need *both* dimensions, and we need to develop education that delivers both

- To educate students to master a ***deeper working knowledge*** of the technical fundamentals
- To educate engineers to ***lead in the creation and operation*** of new products and systems
- To educate future researchers to understand the importance and ***strategic value of their work***

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

- At what level of proficiency?***
- In addition to the traditional engineering disciplinary knowledge***

Desired Attributes of an Engineering Graduate

- **Understanding of fundamentals**
- **Understanding of design and manufacturing process**
- **Possess a multi-disciplinary system perspective**
- **Good communication skills**
- **High ethical standards, etc**

Underlying Need

Educate students who:

- **Understand how to conceive-design-implement-operate**
- **Complex value-added engineering systems**
- **In a modern team-based engineering environment**

WHAT IS THE SET OF KNOWLEDGE, SKILLS AND ATTITUDES?



- **Technical Knowledge & Reasoning**
 - Knowledge of underlying sciences
 - Core engineering fundamental knowledge
 - Advanced engineering fundamental knowledge
- **Personal and Professional Skills & Attributes**
 - Engineering reasoning and problem solving
 - Experimentation and knowledge discovery
 - System thinking
 - Personal skills and attributes
 - Professional skills and attributes
- **Interpersonal Skills: Teamwork & Communication**
 - Multi-disciplinary teamwork
 - Communications
 - Communication in a foreign language
- **Conceiving, Designing, Implementing & Operating Systems in the Enterprise & Societal Context**
 - External and societal context
 - Enterprise and business context
 - Conceiving and engineering systems
 - Designing
 - Implementing
 - Operating

CDIO Syllabus contains
2-3 more layers of detail

Dublin Descriptors

- **General and not connected to any profession**
- **5 program-level goals**
- **Difficult to connect to course goals**
- **Minimum proficiency level requirements**

CDIO Syllabus Goals

- **Connected to professional context, subject area and local profile**
- **> 17 program-level goals**
- **Includes more detailed and specific course goals**
- **Proficiency levels may be set to exceed minimum requirements**

DUBLIN DESCRIPTORS X CDIO



Second Cycle
Dublin Descriptors

	<u>CDIO Syllabus</u>																
	1.1 Knowledge of underlying sciences	1.2 Core engineering fundamental knowledge	1.3 Advanced engineering fundamental knowled.	2.1 Engineering reasoning and problem solving	2.2 Experimentation and knowledge discovery	2.3 Systems thinking	2.4 Personal skills and attitudes	2.5 Professional skills and attitudes	3.1 Teamwork	3.2 Communication	3.3 Communication in foreign languages	4.1 External and societal context	4.2 Enterprise and business context	4.3 Conceiving and engineering systems	4.4 Designing	4.5 Implementing	4.6 Operating
Dublin Descriptor #1	X	X	X														
Dublin Descriptor #2				X	X	X											
Dublin Descriptor #3						X		X				X					
Dublin Descriptor #4									X								
Dublin Descriptor #5							X										

ADDITIONAL REQUIREMENTS ACHIEVED



↙ **DUBLIN DESCRIPTORS ADDRESSED**

EUR-ACE / ASSIN X CDIO



Relation between CDIO Syllabus - EUR-ACE / ASIIN Standards			EUR-ACE ASIIN					
			1	2	3	4	5	6
CDIO Syllabus								
1	Technical knowledge and reasoning	1.1 Knowledge of underlying sciences	1					
		1.2 Core engineering fundamental knowledge	1					
		1.3 Advanced engineering fundamental knowledge	1					
2	Personal and professional skills and attributes	2.1 Engineering reasoning and problem solving		1	1			
		2.2 Experimentation and knowledge discovery		1	1	1		
		2.3 System thinking		1	1	1	1	
		2.4 Personal skills and attitudes		1	1	1	1	1
		2.5 Professional skills and attitudes				1	1	1
3	Interpersonal skills: Teamwork and communication	3.1 Teamwork					1	
		3.2 Communications					1	
		3.3 Communications in foreign languages					1	
4	Conceiving, Designing, Implementing and Operating systems in the enterprise and societal context	4.1 External and societal context			1	1	1	
		4.2 Enterprise and business context			1	1	1	
		4.3 Conceiving and engineering systems			1			
		4.4 Designing			1			
		4.5 Implementing			1	1		
		4.6 Operating			1	1		

How can we do better at assuring that students learn these skills?

- Within the available student and faculty time, funding and other resources***

ACTIVE LEARNING

Engages students directly in thinking and problem solving activities

Emphasis on engaging students in manipulating, applying, analyzing, and evaluating ideas

Examples:

- Pair-and-Share
- Group discussions
- Debates
- Concept questions

EXPERIENTIAL LEARNING

Active learning in which students take on roles that simulate professional engineering practice

Examples:

- Design-implement experiences
- Problem-based learning
- Simulations
- Case studies

CONNECTING IT ALL IN AN INTEGRATED CURRICULUM



Development routes (schematic)				
Year 1	Introductory course	Physics	Mathematics I	
	Mechanics I	Mathematics II	Numerical Methods	
Year 2	Mechanics II	Solid Mechanics	Product development	
	Thermodynamics	Mathematics III	Fluid mechanics	Sound and Vibrations
Year 3	Control Theory	Electrical Eng.	Statistics	Signal analysis
	Oral presentation	Report writing	Project management	Teamwork

Implementing the change

- How can we work systematically to improve our educational programs?**

THE CHALLENGE - TRANSFORM THE CULTURE



CURRENT

- Engineering Science
- R&D Context
- Reductionist
- Individual

DESIRED

- Engineering
- Product Context
- Integrative
- Team

*... but still based on a rigorous treatment of
engineering fundamentals*

IMPLEMENTING CHANGE AT UNIVERSITIES



Observation #1: Universities are, by design, resistant to change as organizations

Observation #2: Notwithstanding Observation #1, universities *can* be changed by appropriate application of best practice in leading organizational change

EXAMPLES: EARLY SUCCESSES



- **Start, or modify, a first-year engineering course that includes a simple design-implement experience.**
- **Modify an upper-level course to include a simple, low-cost design-implement experience.**
- **Modify an appropriate meeting room or flexible classroom space to create a design-implement workspace that supports hands-on and social learning.**

TO LEARN MORE ABOUT CDIO



- Visit www.cdio.org
- Read the book:
Rethinking Engineering Education: The CDIO Approach, Crawley et al., Springer-Verlag, ISBN 0387382879

A screenshot of a web browser displaying the CDIO Home Page. The browser's address bar shows "CDIO Home Page". The page features the CDIO logo at the top left, with the tagline "CONCEIVE DESIGN IMPLEMENT OPERATE™" below it. A teal banner on the right says "WELCOME TO THE CDIO INITIATIVE™". A central teal sidebar contains a menu with items like "WHO WE ARE", "CDIO CENTRAL STATION", "CDIO eJOURNAL", "MEETINGS/MEETING PRESENTATIONS", "PAPERS", "INSTRUCTOR RESOURCE MODULE DEVELOPMENT", "CDIO STANDARDS", "CDIO SYLLABUS", and "WALLENBERG PROJECT". To the right of the sidebar, there is a paragraph titled "The CDIO INITIATIVE™" and another paragraph below it. At the bottom, there is a list of member institutions and a "SEARCH INSIDE!" button with a magnifying glass icon.

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WHO WE ARE
-About CDIO
-Collaborating schools
-CDIO people
-Frequently asked questions
-A word to students
-Contacts

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MEETINGS/MEETING PRESENTATIONS

PAPERS

INSTRUCTOR RESOURCE MODULE DEVELOPMENT

CDIO STANDARDS

CDIO SYLLABUS

WALLENBERG PROJECT

The CDIO INITIATIVE™ is an innovative educational framework for producing the next generation of engineers. It provides students with an education stressing engineering fundamentals set in the context of Conceiving — Designing — Implementing — Operating real-world systems and products.

The CDIO Initiative was developed with input from academics, industry, engineers and students. It's universally adaptable for all engineering schools. **CDIO Initiative** collaborators throughout the world are adopting CDIO as the framework of their curricular planning and outcome-based assessment.

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SEARCH INSIDE!

