CDIO IMPLEMENTATION

PERRY ARMSTRONG
SCHOOL OF MECHANICAL & AEROSPACE ENGINEERING
QUEEN’S UNIVERSITY BELFAST
THE CDIO INITIATIVE

IS AN INTERNATIONAL INITIATIVE TO REFORM ENGINEERING EDUCATION, WHICH INVOLVES COLLABORATION BETWEEN LEADING ENGINEERING SCHOOLS AND DEPARTMENTS FROM AROUND THE WORLD.
THE CDIO COLLABORATORS

- Massachusetts Institute of Technology, Cambridge, USA
- Chalmers University of Technology, Göteborg, Sweden
- Linköping University, Linköping, Sweden
- Royal Institute of Technology, Stockholm, Sweden
- Queen's University Belfast, Belfast, Northern Ireland
- Technical University of Denmark, Lyngby, Denmark
- U.S. Naval Academy, Annapolis, Maryland, USA
- Singapore Polytechnic, Singapore
- Queen's University, Kingston, Ontario, Canada
- University of Auckland, Auckland, New Zealand
- University of Pretoria, Pretoria, South Africa
- University of Liverpool, Liverpool, UK
THE CDIO COLLABORATORS

- Hogeschool Gent, Gent, Belgium
- École Polytechnique de Montréal, Montreal, Canada
- Lancaster University, Lancaster, UK
- California State University, Northridge, USA
- University of Bristol, Bristol, UK
- Hochschule Wismar, Germany
- Shantou University, China
- Umeå University, Sweden
- Daniel Webster College, USA
- University of Colorado, USA
- University of Sydney, Australia
- Politecnico di Milano, Milan, Italy
THE CDIO COLLABORATORS

- Turku University of Applied Sciences, Turku, Finland
- Jönköping University, Jönköping, Sweden
- Instituto Politécnico do Porto, Porto, Portugal
- University of Leeds, Leeds, UK
- Metropolia University, Helsinki, Finland
- Tsinghua University, China
- Arizona State University, USA
- University of Calgary, Canada
- Queensland University of Technology, Australia
- Australian Association for Engineering Education
WHY CDIO?

MIT (late 1990s)

ENGINEERING EDUCATION WAS PROVIDING STUDENTS WITH ADEQUATE KNOWLEDGE OF ENGINEERING SCIENCE, BUT WAS FAILING TO PREPARE THEM FOR EMPLOYMENT AS PRACTISING ENGINEERS.
WHY CDIO?

ENGINEERING IS A CREATIVE PROFESSION

ENGINEERS CREATE PRODUCTS, PROCESSES AND SYSTEMS.

IN FACT, ENGINEERS MAY BE INVOLVED IN ALL STAGES OF THE LIFECYCLE OF A PRODUCT, PROCESS OR SYSTEM

CONCEPTION

DESIGN

IMPLEMENTATION

OPERATION

IMPORTANT THAT STUDENTS ACQUIRE THE KNOWLEDGE & SKILLS ASSOCIATED WITH THESE LIFECYCLE STAGES
THE TOTAL REQUIREMENT

THE PRACTISING ENGINEER

Knowledge & Skills Required

- External & Societal Context
- Enterprise & Business Context
- Interpersonal Skills
- Personal & Professional Skills
- Technical Knowledge
- Conception, Design, Implementation & Operation
<table>
<thead>
<tr>
<th>Level</th>
<th>Category</th>
<th>Subcategories</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Technical Knowledge</td>
<td>(associated with the specific Engineering discipline)</td>
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<tr>
<td>2</td>
<td>Personal &amp; Professional Skills</td>
<td>2.1 Engng Reasoning and Problem Solving</td>
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<td></td>
<td></td>
<td>2.2 Experimenting and Knowledge Discovery</td>
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<td></td>
<td>2.3 Systems Thinking</td>
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<td></td>
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<td>2.4 Personal Skills &amp; Attributes</td>
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<tr>
<td></td>
<td></td>
<td>2.5 Professional Skills &amp; Attitudes</td>
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<tr>
<td>3</td>
<td>Interpersonal Skills</td>
<td>3.1 Teamwork and Leadership</td>
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<tr>
<td></td>
<td></td>
<td>3.2 Communication</td>
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<tr>
<td>4</td>
<td>Product, Process &amp; System Skills</td>
<td>4.1 External &amp; Societal Context</td>
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<tr>
<td></td>
<td></td>
<td>4.2 Enterprise &amp; Business Context Context</td>
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<tr>
<td></td>
<td></td>
<td>4.3 Conceiving</td>
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<tr>
<td></td>
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<td>4.4 Designing</td>
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<td></td>
<td>4.5 Implementing</td>
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<td>4.6 Operating</td>
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Two further levels of detail added with input from Industry.
THE CDIO APPROACH (What to Teach)

- **CDIO**: A “Back to the Drawing Board” Approach
- **WHAT TO TEACH?**
  - **THE CDIO SYLLABUS**
    - Input from Industry
    - Stakeholder Surveys inc. Alumni & Employers
    - Accreditation Criteria
  - CUSTOMISED SYLLABUS
    - Proficiency Required
  - PROGRAMME LEARNING OUTCOMES

For a particular degree programme
CDIO: A “Back to the Drawing Board” Approach

HOW TO TEACH?

THE CDIO STANDARDS

Twelve Requirements for an Engineering Degree Programme including the need for:

• An Introductory Course
• Design-Implement Experiences
• An Integrated Curriculum
THE INTRODUCTORY COURSE

MECHANICAL & MANUFACTURING ENGINEERING
YEAR 1: INTRODUCTORY COURSE

Knowledge from Engineering Science, Materials & Design Courses

DESIGN-IMPLEMENT TEAM PROJECT 1
SKILLS: Lectures & Practicals
Assignment (Reflective)

DESIGN-IMPLEMENT TEAM PROJECT 2
SKILLS: Lectures & Practicals
Assignment

DESIGN-IMPLEMENT TEAM PROJECT 3
Assignment
DESIGN-IMPLEMENT EXPERIENCES

MECHANICAL & MANUFACTURING ENGINEERING
YEAR 2: STRENGTH OF MATERIALS COURSE
DESIGN-IMPLEMENT EXPERIENCES

MECHANICAL & MANUFACTURING ENGINEERING
YEAR 3: FORMULA STUDENT COMPETITION
Design-Implement Experiences

Mechanical & Manufacturing Engineering
Year 4: Final Year Team Project

Proposal for an Innovative New Product

Innovation & Entrepreneurship Course
Business & Marketing Course
Series of Seminars
Local Companies

Conceptual Design
Detailed Design
Production of Prototype

Market Analysis
Business Plan
Manufacturing Plan

YEAR LONG PROJECT
DESIGN-IMPLEMENT EXPERIENCES

MECHANICAL & MANUFACTURING ENGINEERING
YEAR 4: FINAL YEAR TEAM PROJECT
CURRICULUM INTEGRATION

CDIO

Sequence of Disciplinary Courses
Design-Implement Experiences

PBL

Sequence of Projects or Problems
Disciplinary Knowledge
THE INTEGRATION OF SKILLS

CDIO APPROACH
Plan a Logical Sequence of Learning Experiences for each Skill

Skill A  Skill B

1  1
2  2
3  3
4  4
5  5
6

Sequence of Disciplinary Courses

Design-Implement Experiences
THE INTEGRATION OF SKILLS

CDIO APPROACH
Plan a Logical Sequence of Learning Experiences for each Skill

<table>
<thead>
<tr>
<th>Skill A</th>
<th>Skill B</th>
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<tbody>
<tr>
<td>1</td>
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Sequence of Disciplinary Courses

Design-Implement Experiences

CDIO APPROACH
The Integration of Skills
Plan a Logical Sequence of Learning Experiences for each Skill

Skill A
1. Course 1
2. Course 2
3. Course 3
4. Course 4
5. Course 5
6. Course 6

Skill B
1. Course 1
2. Course 2
3. Course 3
4. Course 4
5. Course 5
6. Course 6

Sequence of Disciplinary Courses

Design-Implement Experiences
THE INTEGRATION OF SKILLS

CDIO APPROACH
Plan a Logical Sequence of Learning Experiences for each Skill

Skill A  Skill B

1  2  3  4  5

Sequence of Disciplinary Courses

Design-Implement Experiences

1  2  3  4  5  6
CDIO: A “Back to the Drawing Board” Approach

WHAT TO TEACH?

THE CDIO SYLLABUS

Programme Learning Outcomes

Graduates much better prepared to become practising engineers

HOW TO TEACH?

THE CDIO STANDARDS

Introductory Course Design-Implement Experiences Integrated Curriculum etc.

More effective learning Students more motivated Graduates more self-confident
MORE ON CDIO

www.cdio.org

Rethinking Engineering Education
Edward Crawley et. al., Springer, 2007