TEN YEARS OF CDIO – EXPERIENCES FROM A LONG-TERM EDUCATION DEVELOPMENT PROCESS

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Background

- Education development sometimes takes place as a “project” where the development is slowed when the project is “done”
- Long-term successful education development needs to be able to continue the positive trend
- Few such cases are presented in the literature, but we argue that Chalmers’ M programme’s ten-year CDIO effort is one
- In this paper, we bring forward experiences and knowledge from this case. These, in turn, could constitute a base for proposing improvements in education development practice
- The authors have been deeply involved throughout the process – deep knowledge of events but risk for bias

Aims

- Provide a detailed account for a long-term education development process.
- Evaluate the result: in what way is the programme different and better today?
- Examine how the M programme's development has affected reform of other programmes at Chalmers.
- Identify critical success factors for achieving a sustained programme development process over a long time period.

Outline

- Background
- Aims
- Outline
- M programme of today
- The CDIO journey & future plans
- Evaluation
- Critical success factors for sustainable education development
- Conclusion

Programme basics

- 5-yrs two cycle programme (3-yrs BSc and eight 2-yrs MSc)
- 500 students on BSc-level + 550 on MSc-level incl 150 international students
- 140 courses from 9 departments

- Largest and most popular ME programme in Sweden

How do we come up with a solution to this? ► Some problems are solved at the drawing table, while others are solved as they arise. Or as someone smart once said: "A drawing is a paper tiger, when you have a prototype in front of you, you're many steps closer to solving your problem".

THE PROTOTYPE LAB

Geometry, strength of materials principles and computational simulations – they're all just as essential. But the knowledge based on practical applications is also essential when you leave the university to enter the "real world".

GET READY FOR SOME ACTION!
On the shop floor, you must be able to talk the same language as your co-workers and there are times when you have to pitch in yourself to help out your team. An engineer who is technical in the everyday meaning of the term can save a lot of time and money.

▲ Iron beams, steel sections and copper pipes – you will be impressed by what this "cold saw" can handle.

WOOD AND METAL UNDER THE SAME ROOF
The Prototype Lab is a living environment. The machinery whine, hiss and hammer while teams of loud voices decide on the next step of a process. During one and the same session, you slice that key wooden detail thin as a leaf, while your teammate polishes the gorgeous chrome details of your prototype model completely glossy. And even if you can't expect a decent grade, you can try to weld it all together by means of a MIG welder... all the equipment you need is available in the 400 m² lab.

SEVERAL ALTERNATIVES IF YOU WANT TO END UP HERE
Students from Mechanical Engineering, Automation & Mechatronics, Industrial Design Engineering and the corresponding Master's programmes get some of their education in the Prototype Lab. The courses given here are named things like "Integrated Construction and Manufacturing" and they all have in common that you learn how to transform your bright product concept into something you can see, test and feel.

CHALMERS www.chalmers.se/am

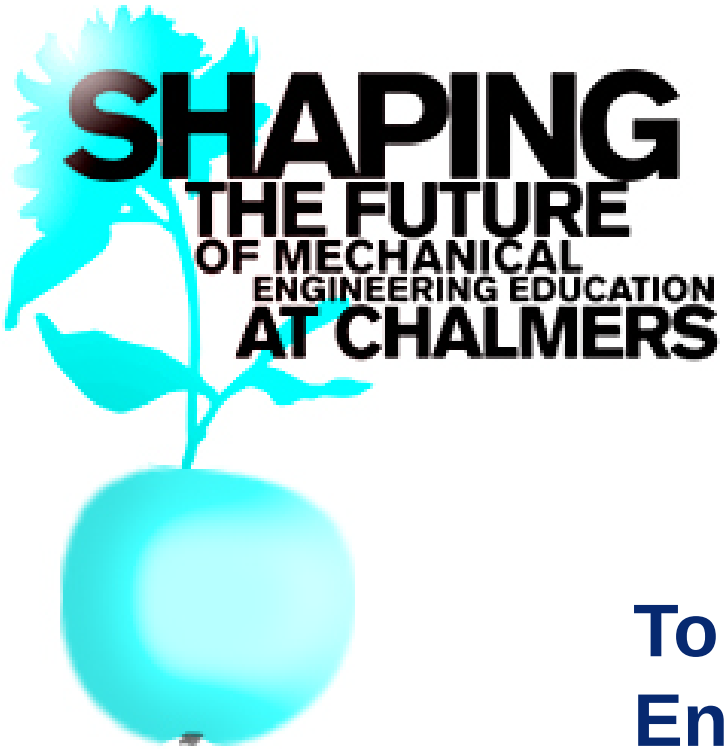
Programme characteristics

- The “main thread” of the programme is a holistic view of product and system lifecycle development and deployment.
- The computational oriented and integrated mathematics education with focus on modeling, simulation and analyses
- The introductory course of the programme provides a framework for the practice of engineering in product and system building
- DBT-courses with realistic and relevant assignments
- The programme has its own prototype laboratory and workshop
- Development of the students´ teamwork and communication skills is integrated in the courses with progression
- Aspects of sustainable development are emphasized, and the focus is on product development, materials and energy supply.
- The programme description is used as the general tool for development, implementation, quality work and management

The CDIO journey

Pre CDIO	CDIO planning	CDIO basic design & piloting	CDIO implementation	CDIO +
-2000	2000-2001	2001-2004	2004-2008	2009-
M2000 reform • Project courses • More design • Early eng experiences • Master-like profiles • No design-build-test	• Set project goals • Concretize CDIO concept • Bench-marking • Design-build-test pilots	• Prototyping lab • Multiple design-build-test projects • Integrated learning • 3+2 education structure adapted	• Mathematics • Sustainability • Bachelor project • English on master level • Recognition from HSV	• Virtual learning environment for math stat • Set new goals

Future plans



To be outlined by Mikael Enelund at 13.50 in Förmaket

Evaluation

Evaluation data

- ➡ The original goals & their fulfilment
- ➡ CDIO self-evaluation
  - Alumni survey
- ➡ Faculty interviews
  - Student interviews
  - Cost follow-up

- National agency of higher education (HSV) evaluations

➡ To be reviewed in presentation

The original & emerging goals & their fulfilment (examples)

Initial & fulfilled on time	• Sequence of design-build-test projects • Early engineering experiences
Fulfilled, but delayed	• The prototyping lab • Mathematics reform
Not fulfilled	• Studio for distributed student design teamwork • PRS system for active learning
Emergent & fulfilled	• Integrated learning of teamwork & communication • Sustainability • Systematic programme design • Programmatic assessment

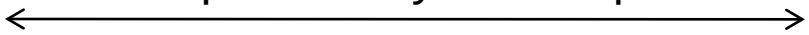
CDIO self-evaluation evolution

Standard		2000	2003	2005	2008	2010
1	CDIO as context	2	2	4	4	4
2	CDIO syllabus outcomes	1	1	2	4	4
3	Integrated curriculum	2	2	3	4	4
4	Integration to engineering	3	4	4	4	4
5	Design-build experiences	1	3	4	4	4
6	CDIO workspaces	1	3	4	4	4
7	Integrated learning experiences	2	2	3	4	4
8	Active learning	1	1	3	3	4
9	Enhancement of faculty CDIO skills	1	1	2	2	2
10	Enhancement of faculty teaching skills	1	2	2	3	3
11	CDIO skills assessment	2	2	3	3	3
12	CDIO programme evaluation	1	2	3	4	4
Average		1.5	2.1	3.1	3.6	3.7

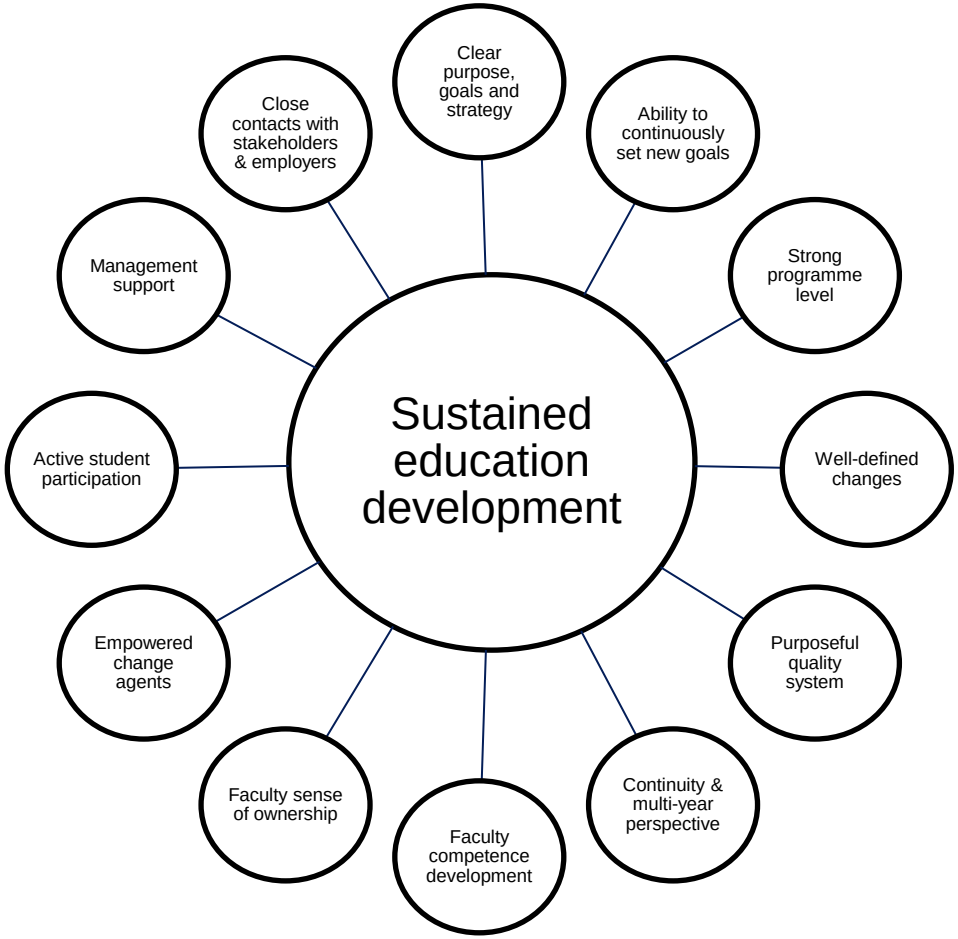
0	1	2	3	4

Faculty interviews

Catalysts	Barriers
An engineering education concept with the profession as the core focus	The structured CDIO education concept implies a stronger programme level and a top-down perspective
The structured education concept	Interpretation and translation issues
The strategies for integrating generic competences into the education	Programmes and faculty members that are strongly oriented towards preparing for a research career or an analytical profession may feel that CDIO lacks appreciation of analysis
The toolbox, CDIO contains many parts that can be used independently	CDIO involves significant changes for both teachers and students.



Critical success factors for sustainable education development



Conclusions

- During the ten year period, the M programme has introduced a large number of educational innovations
- Internal and external evaluations verify that the programme has developed positively during the period and holds a high quality.
- The CDIO model has provided the programme with a number of strategies and tools that have been essential for this development
- Other programmes who have adapted a CDIO approach identify as main catalysts:
  - the programme-level thinking of CDIO
  - its focus on the professional role of engineers, and
  - its applicability as a strategy for integrated learning of generic competences
- Barrier barriers to CDIO implementation include
  - its perceived top-down focus
  - difficulties in interpreting the CDIO concept in certain fields
  - lacking faculty competence in and experience of practical engineering work