



Centre of Excellence
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HÖGSKOLEVERKET
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SHAPING THE FUTURE OF MECHANICAL ENGINEERING EDUCATION

Mikael Enelund,

The Mechanical Engineering Program



BACKGROUND

- Education development is a continuous project
- Programs need to be continuously developed
- Long-term successful education development needs to be able to continue the positive trend
- Engineering educations will meet huge challenges in the next 5-10 years
- Globalization has given new opportunities for engineering work. Not fully reflected in today's educations
- The rapid development of computers and internet has given new opportunities for engineering work as well as for teaching and learning. Not fully reflected in today's educations.
- The reformulation of the Mechanical engineering program is running as a long-term project entitled: *Shaping the future of Mechanical engineering at Chalmers*

Outline

- Background
- Outline
- Mission of engineering education
- Opportunities/Challenges
- Mechanical engineering program of today
- Future plans
- Long term developments
- Short term developments
- Conclusion

THE MISSION OF AN ENGINEERING EDUCATION

To educate engineers that are well-prepared to create and develop products and systems that improve safety and quality of life for a growing population.

This shall be achieved using a minimum of resources to ensure we do not limit the possibilities for coming generations to continue to develop their quality of life and safety.

OPPORTUNITIES/CHALLENGES

- New technologies, systems and solutions for energy supply and transportation are needed, the growing global population requires more efficient use of materials, land and other resources. Engineers need to take active and leading roles in solving these challenges
- More engineers are needed while at the same time the demographic situation is such that the number of 20-year-olds will decrease. Further, it seems that the interest in engineering education and an engineering career is decreasing.
- Engineering education needs to create exciting and attractive opportunities for a diverse pool of talented young people from all areas of our society.

OPPORTUNITIES/CHALLENGES CONT'D

- Rapid development of computers and the internet
 - Solving most problems faced in modern engineering includes high precision digital models and simulations.
 - Ability to use these tools effectively is a key component in the globalisation of engineering.
 - Digital models can easily be transferred and global companies employ engineers in low cost areas for design, development and research.
- Engineers educated at Chalmers must be competitive and provide additional value compared to engineers at low-wage markets.

OPPORTUNITIES/CHALLENGES CONT'D

- Young persons learn much differently than they used to a few decades ago. “the Nintendo Syndrome”
 - *Do not read manuals but go and try. If “killed” try something else until you get to the next level. If no success go to the internet to get a hint.*
 - *This comes through in studying: it is becoming increasingly hard to make students read books. At the same time providing them with ways to try before reading proves educationally rewarding.*
- Students have laptops and smartphones
- We need to develop the teaching and infrastructure to benefit from this.

THE M PROGRAM'S IDEA

The M program aims at developing the knowledge, skill and competence of the students required to participate and lead the development and design of industrial products, processes and systems for a sustainable development of the society. The program also prepares for positions in other areas of society where skills in analysis and processing of complex open-ended problems are of great importance.

The vision of the M program is to offer a relevant, stimulating and advanced level engineering education with a holistic view which emphasizes on engineering fundamentals and practice

PROGRAM CHARACTERISTICS

- The program description is used as the general tool for development, implementation, quality work and management
- The “main thread” of the program is a holistic view of product and system lifecycle development and deployment.
- The base is the fundamentals of mathematics and mechanical engineering with emphasis on common principles. Matlab is the general simulation tool
- Joint assignments and projects between courses so that education and learning of a topic is not to be isolated in a specific course.
- Computational oriented and integrated mathematics education with focus on modelling, simulation and analyses

PROGRAM CHARACTERISTICS

- The introductory course of the program provides a framework for the practice of engineering in product and system building
- 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 syllabus and pedagogy of the program are continuously improved in cooperation with teachers, students, administrators & industry
- Engaged and skilled teachers
- Active student participation
- Strong program advisory board
- Elaborate and purposeful quality system

THE CDIO JOURNEY

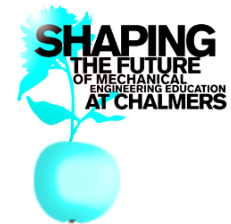
| Pre CDIO | CDIO planning | CDIO basic design & piloting | CDIO implementation | CDIO + |
|--|--|---|--|---|
| -2000 | 2000-2001 | 2001-2004 | 2004-2008 | 2009- |
| <p>M2000 reform</p> <ul style="list-style-type: none">• Project courses• More design• Early eng experiences• Master-like profiles <p>• No design-build-test</p> | <ul style="list-style-type: none">• Set project goals• Concretize CDIO concept• Bench-marking• Design-build-test pilots | <ul style="list-style-type: none">• Prototyping lab• Multiple design-build-test projects• Integrated learning• 3+2 education structure adopted | <ul style="list-style-type: none">• Mathematics• Sustainability• Bachelor project• English on master level• Quality system <p>• Recognition from HSV</p> | <p>Virtual learning environments</p> <p>Set new goals</p> <p>Shaping the future of mechanical engineering</p> |

SHAPING THE FUTURE OF MECHANICAL ENGINEERING EDUCATION AT CHALMERS

- Reformulation of the education as a long term project
- Students, professors, industry and administration are involved
- Begun with a self-organized international workshop Oct 2009
 - Prominent researchers and industrialists attended the workshop and shared their experiences in developing the role of the engineer and their visions of the future engineering education.



SHAPING THE FUTURE OF MECHANICAL ENGINEERING EDUCATION AT CHALMERS



- Graduates of 2020:
 - ✓ broad grounding in fundamentals,
 - ✓ innovative and creative,
 - ✓ global and sustainability focused,
 - ✓ teamwork, communication and leadership skills honed
 - ✓ broadly educated, not simply to solve problems others have set for them, but to identify problems and issues, and
 - ✓ specialist skills within a specific area
- Visiting committee (academia and industry). First visit June 2011

REFORMED EDUCATION

Continue the CDIO-journey and extend/develop the concept

- Focus is on the professional role as an engineer
- Transfer from enforcing students to solve oversimplified problems with in before hand known analytical solutions to solve general open problems by use of computers
- Math is much more than calculations. Let the computer do the calculations and spend the time on formulating real problems and analyzing solutions. Engineers do a lot of calculations but not the kind that is taught!
- Use computers and up-to-date software
- Full view of problem solving
- Seamless transfer between theory and practice
- Cooperation with industry

REFORMED EDUCATION CONT'D

- Virtual/interactive learning environments for learning, training and assessment. Virtual prototype laboratory
- New role for the teacher, dialogue instead of monologue
- More training of creative abilities, innovation and entrepreneurship
- The process of integration of sustainability issues in the curriculum needs to be continued and extended
- Teach how to learn how to apply engineering fundamentals to any new emerging technology
- New technologies and materials need to be included in a more flexible curriculum and used in DBT-projects.
- Globalization issues need to be integrated.
- Make the education exciting and attractive for young people!

DEVELOPMENTS CDIO+

- ✓ Virtual learning environment in Mathematical statistics. Fracture mechanics team project
- ✓ Course in computer aided design (CAD) with focus on training. Final exam in computer lab
- ✓ Intellectual properties regarded as a generic skill and taught in an integrated fashion
- ✓ Re-design of material science and manufacturing technology courses to have a more distinct product focus
- ✓ Sustainability more distinctly integrated and a separate course with focus on materials and lifecycle analysis is launched
- ✓ Industrial software for simulations in basic courses: Mechanics, Strength of materials and Fluid Mechanics
- ✓ Virtual learning environment for 1st year math courses (fall 2011)

CONCLUDING REMARKS

- Considerable challenges and opportunities for engineering education next decades
- The M-program has a clear purpose, goals and a strategy to meet the challenges
- Multi-year focus
- The M-program is continuously improved in cooperation with teachers, students, administrators as well as the advisory board where representatives from industry take part.
- Focus on the profession, “civilingenjör” is a professional degree
- Focus on realistic examples in courses and integrated curriculum
- The CDIO model has provided the program with a number of strategies and tools that will be essential for this development
- DO THINGS, MOST IMPORTANT IN ALL PEDAGOGICAL WORK!