



Syllabus for



P061 – “Modeling Simulation and Optimization in the Engineering Product Development Process”

A module in the Engineering Product Development 20 hp course

Credits	5.0
Examiners	Ola Isaksson, Tobias Larsson, Johan Ölvander
Contact	Ola.isaksson@chalmers.se
Registration	To Ola.isaksson@chalmers.se before February 23 rd 2020
Target group	Professionals and PhD candidates who want to get a deeper understanding of the role of modelling, simulation and optimization within Product Development.
Prerequisites	MSc in Engineering or similar.
Aim	The course aims to provide a basic understanding for how modelling, simulation and optimization can be employed to support the product development process.

Teachers/tutors



Ola Isaksson, Professor in Product Development, Chalmers university of technology. Ola.isaksson@chalmers.se

Ola is a professor and research group lead in Systems Engineering and Engineering Design at the department of Industrial and Materials Science. For most of his carrier he has worked as a company specialist in product development within Volvo Aero and GKN Aerospace. His research interest ranges from automation and multidisciplinary methods in engineering, value driven design, platform based development and sustainable and product-service systems. Since his PhD in Computational Support in Product Development, modeling and simulation support in early phases of PD have remained central.



Tobias Larsson, Professor in Mechanical Engineering, Blekinge institute of technology (BTH) Tobias.larsson@bth.se

Tobias is a director and research leader of the product development research lab; director of the KKS profile “Model Driven Development and Decision Support” and the Dean of the Faculty of Engineering at BTH. His research background is in Simulation Driven Design, and have currently a research focus on Value modelling and simulation, knowledge management, and innovation engineering capability when developing Product-service systems. Tobias explore novel methods for the constantly expanding “engineering desktop” aiming to support the Model Based Engineering/Enterprise. The updated "engineering toolbox 2.0" for the engineer of the future needs to support organisations capability for innovation and product development.



Johan Ölvander, professor in Engineering Design, Linköping university. johan.olvander@liu.se

Johan is research group lead and head of the division of Machine design. Johans research interests are within the field of product design and development, and specifically how simulation and optimization techniques can be employed in order to support the development of complex engineering systems. Important aspects of this work include formulation of the optimization problem in general and multiobjective and multidisciplinary optimization in particular. The research includes development of optimization algorithms such as the Complex method and Multi-Objective Genetic Algorithms. The focus is on real world applications where extensive dynamic simulation models are used to predicted the properties of the systems. Industrial application areas include: industrial robotics, fluid power systems and components, aircraft design, aircraft fuel systems, and automotive applications.

In addition – colleagues at Chalmers, BTH and LiU will be engaged in specific sections.

With support from:



Fee for industrial members

7 500 SEK

Learning outcomes

Upon completion of the course the participants should have:

- Gained increased knowledge of the roles of modelling, simulation and optimization in the product development process.
- Gained an increased understanding of different type of models used in EPD, from modelling of functionality, via physics based modelling, to modelling of customer value of products and services.
- Improved knowledge about uncertainties in modelling and simulation and increase the ability to perform validation and verification of simulation results.
- Obtained the ability to formulate an engineering design problem as an optimization problem and solve it using adequate optimization algorithms.
- Improved ability to communicate orally and in writing the role of modelling, simulation and optimization in the EPD process in a research context.

Course Outline

- The course is organized in 4 events, three physical and one web based.
- **1st session: Course introduction 3/3 2020 (WEB)**
Time: 15.00-16.30
Content: Course introduction (topic, readings and assignments). Introduction of literature and software to be used. Confirmation of all dates.
- **2nd session: Modeling behavior and functionality (March 23-24)**
Venue: CHALMERS, Göteborg
Content: Modeling and simulation to understand product behaviour (functions, value, robustness, manufacturing). Industrial state of art example.
Aim: To give an overview and hands on experience in (a selection) of WHAT can be modelled and simulated in EPD, and what need to be modelled and simulated (trends).
- **3rd session: Model Based Development and simulation based optimization (April 1-2)**
Venue: BTH, Karlskrona
Content: CAE, Digital Twins, model based development, optimization
Aim: To give an overview of- and hands on experience of- HOW modelling and simulation are used in EPD. Concepts of validity, quality and digital verification are



explained together with an introduction to optimization and multidisciplinary engineering.

- **4th session: Multi-disciplinary modelling and optimisation, course project presentation (May 25-26)**

Venue: LiU, Linköping

Content: multi-disciplinary and multi-objective optimization, surrogate based optimisation. Presentation of course assignments.

Aim: To give an overview of system level – and multi-disciplinary optimisation applications. Present / discuss course outcome.

Organisation

The course is organized in the following way:

The first session is an online meeting, where the course is introduced and the short assignment is presented. The following physical sessions at Chalmers, BTH and LiU provide a condensed mix of theory, hands on exercise and industry input through guest lectures. By necessity, the course will provide a “look and feel” introduction to the specific techniques introduced, with the opportunity to engage deeper in some part in the course assignment.

The final physical session (Linköping) also include a presentation and discussion session of all assignments conducted during the course.

The assignment is further expected to be submitted no later than three weeks after the final session.

Literature

Selected recommended literature (papers and/or book chapters) are introduced at the first session.

Examination

The course is examined through active participation at the workshops/sessions, presentation of course assignments at the workshops and with the written report delivered at the end of the course. The three professors Isaksson, Ölvander and Larsson assess each student’s participation and work and Ola Isaksson is the course examiner.

