Teaching Optimization

Product Realization, Linköping University

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Product Realization

- Four groups
  - Design
  - Integrated Product and Production Development
  - Industrial Production
  - Design Automation Laboratory

- Educating engineers during years 1-5 in the programs
  - Mechanical Engineering
  - Design and Product Development

Design Automation Laboratory

Recieve design suggestions automatically and minimize repetive work

Methods

- Flexible CAD-models
- Modeling, Simulation and Optimization
- Machine Learning

Philosophy

- Combine optimization skills with engineering skills
- Tutorials to learn the basics / methods
- Projects to demonstrate that they can apply the methods
- We are trying to teach methods and tools that we think will be important in the future
  - Parametric CAD (TMKT57) started 2008
  - Multidisciplinary optimization (TMKT79) started 2014
- We constantly attempt to introduce knowledge and methods from our research in our courses to keep the course content relevant

Course Package

Year 4, VT1	Year 4, VT2	Year 5, HT1	Year 5, HT2
TMKT48 Design Optimization	TMKT57 Product Modelling	TMKT79 Collaborative Multidisciplinary Optimization	TMKU01 Design Automation for Customized Products
Basic Optimization	Flexible CAD-models	Practical MDO	Customer needs Digital twin

TMKT48 Design Optimization

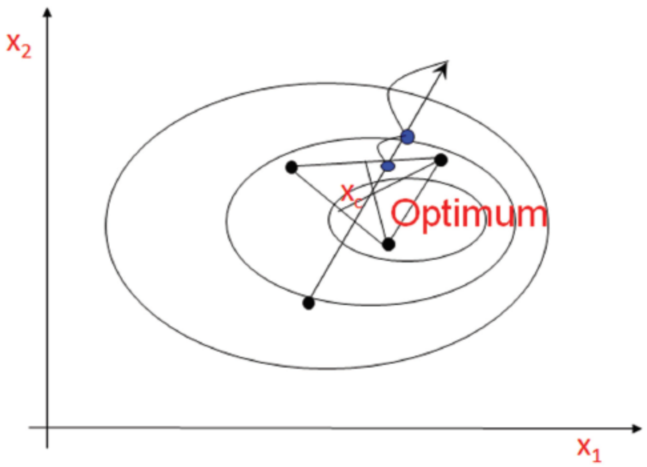
- Introduce
  - Modeling
  - Simulation
  - Optimization
- MATLAB
- Simulink

OPTIMIZATION ALGORITHMS

How they work
Advantages
Disadvantages

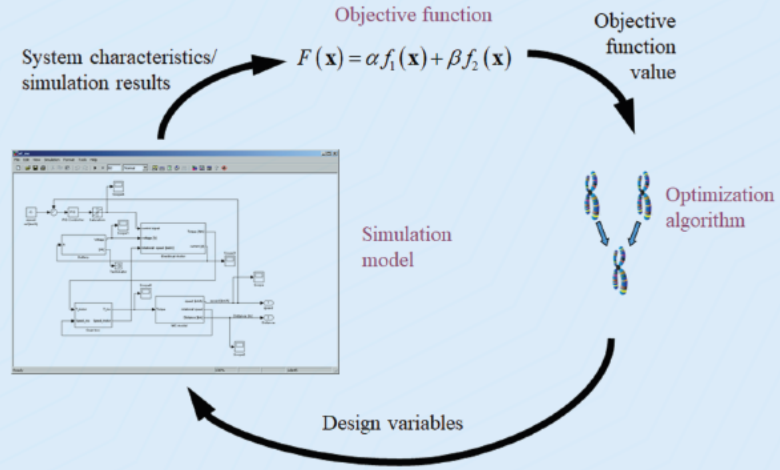
Algorithms such as:

- Complex
- Genetic Algorithms
- Gradient-Based
- Particle Swarms



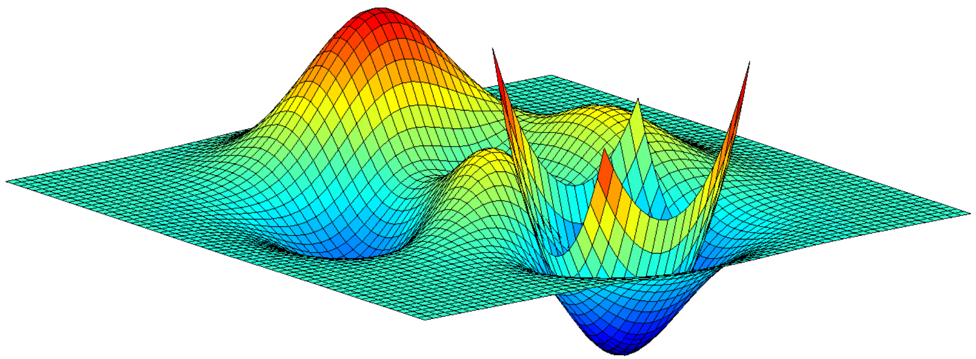
SIMULATION BASED OPTIMIZATION

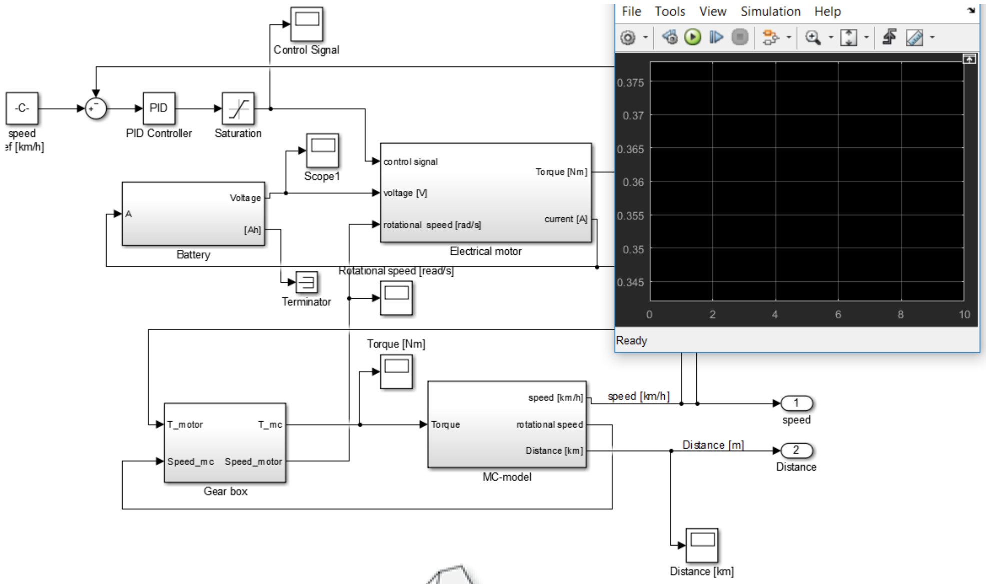
Include simulation models in the optimization

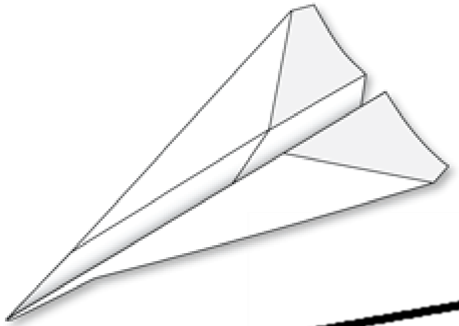


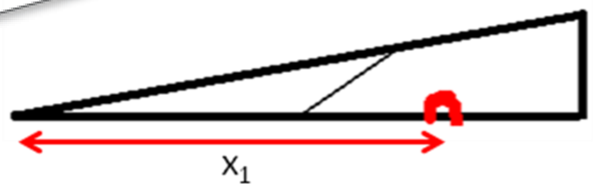
TMKT48 Design Optimization

- Optimization Algorithms
- Multi Objective Optimization
- Surrogate/Meta models
- Sensitivity Analysis
- Probabilistic Optimization
- Select Design



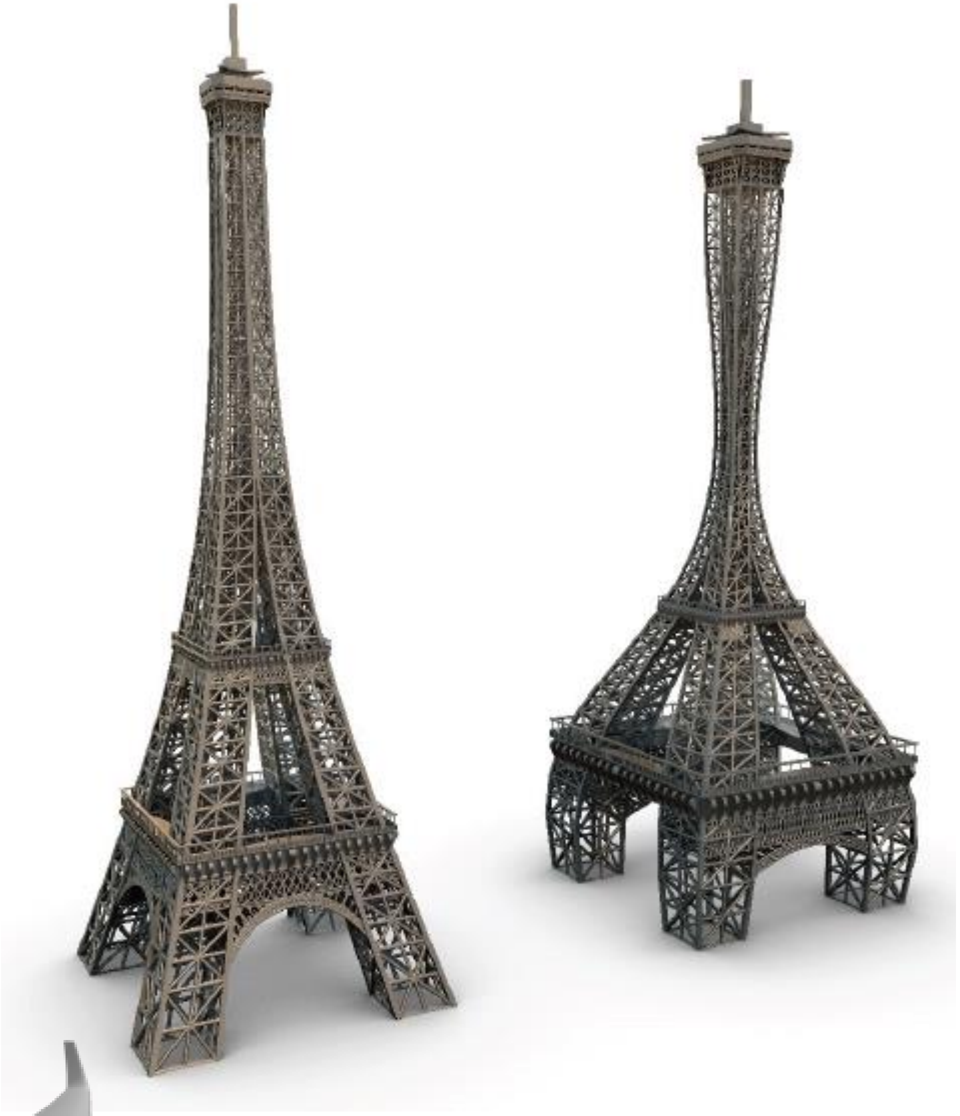






TMKT57 Product Modeling

- Flexible CAD-Models
  - Minimize repetitive work
  - Optimization



- CATIA
- VBA
- EXCEL

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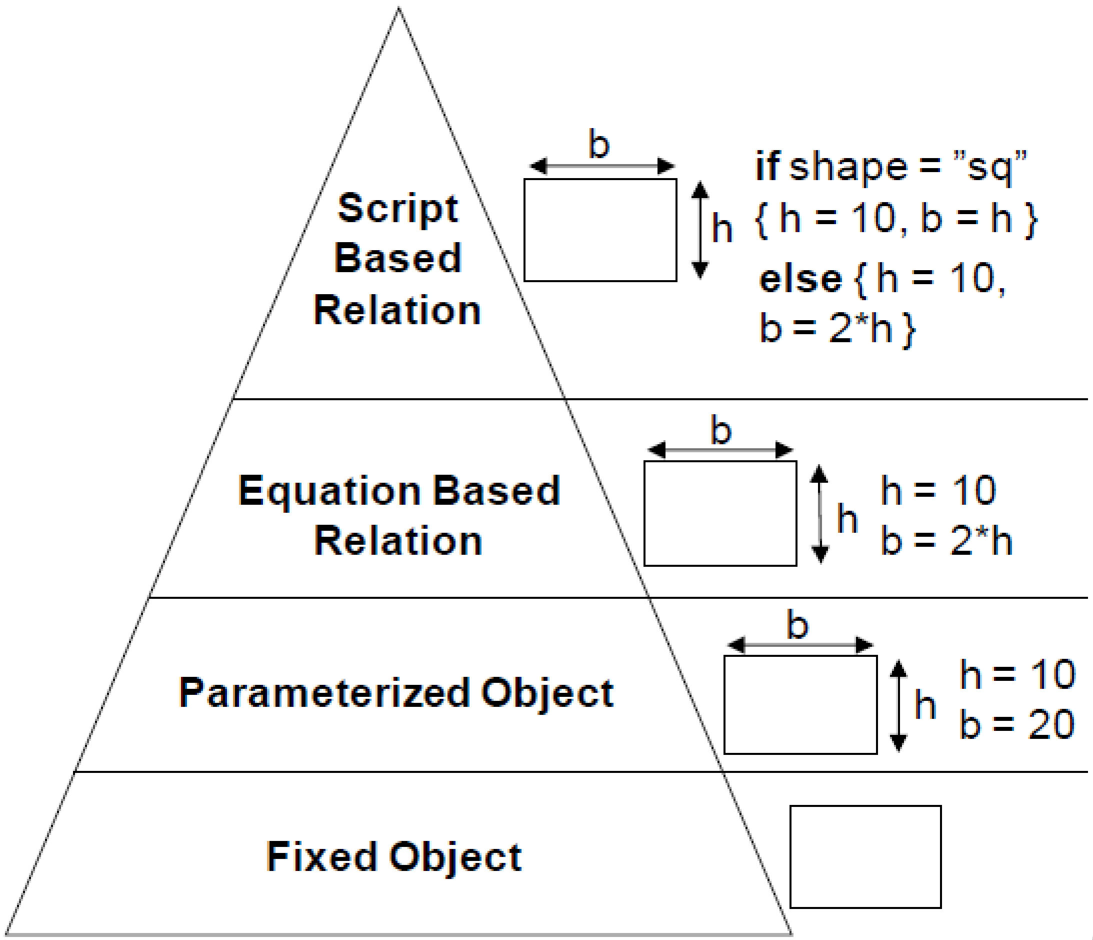
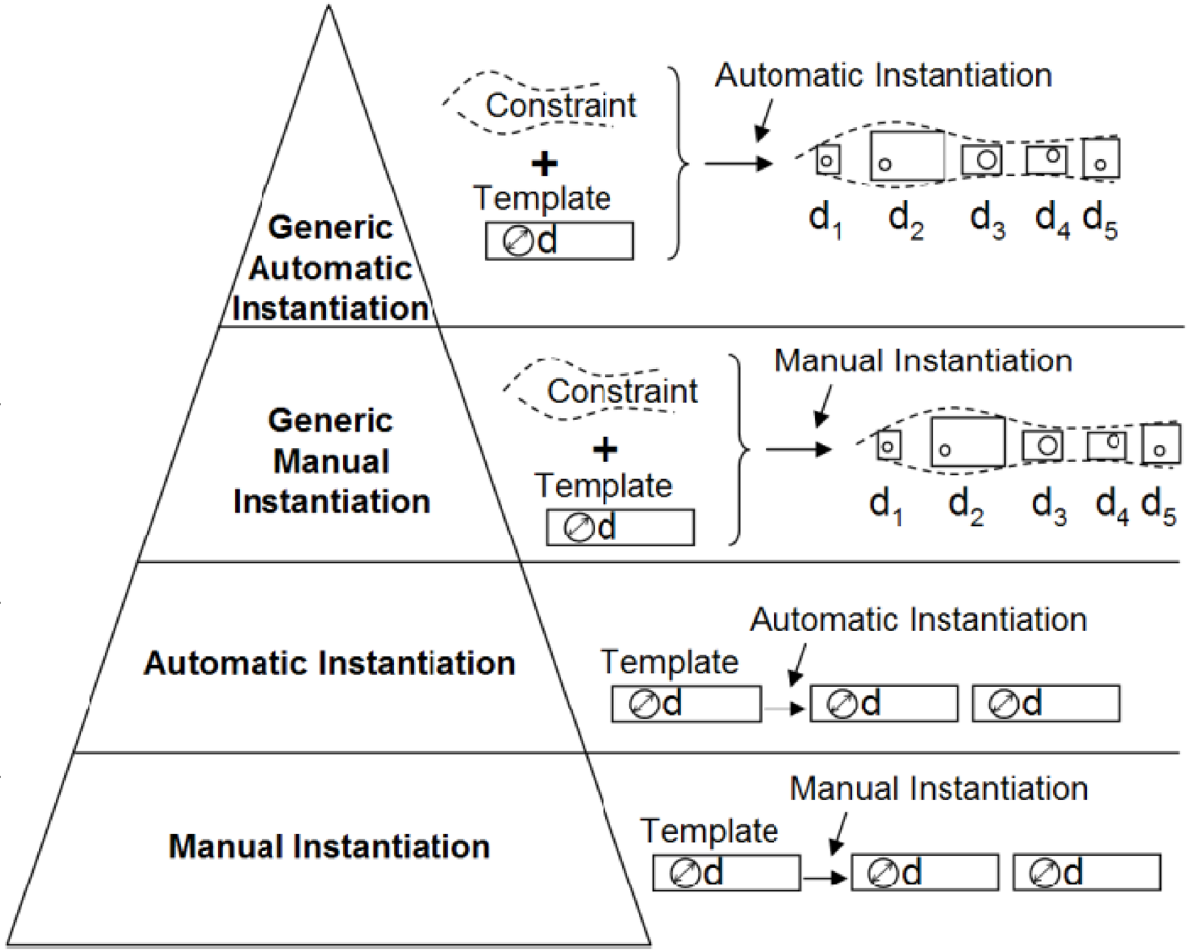
TMKT57 Product Modeling

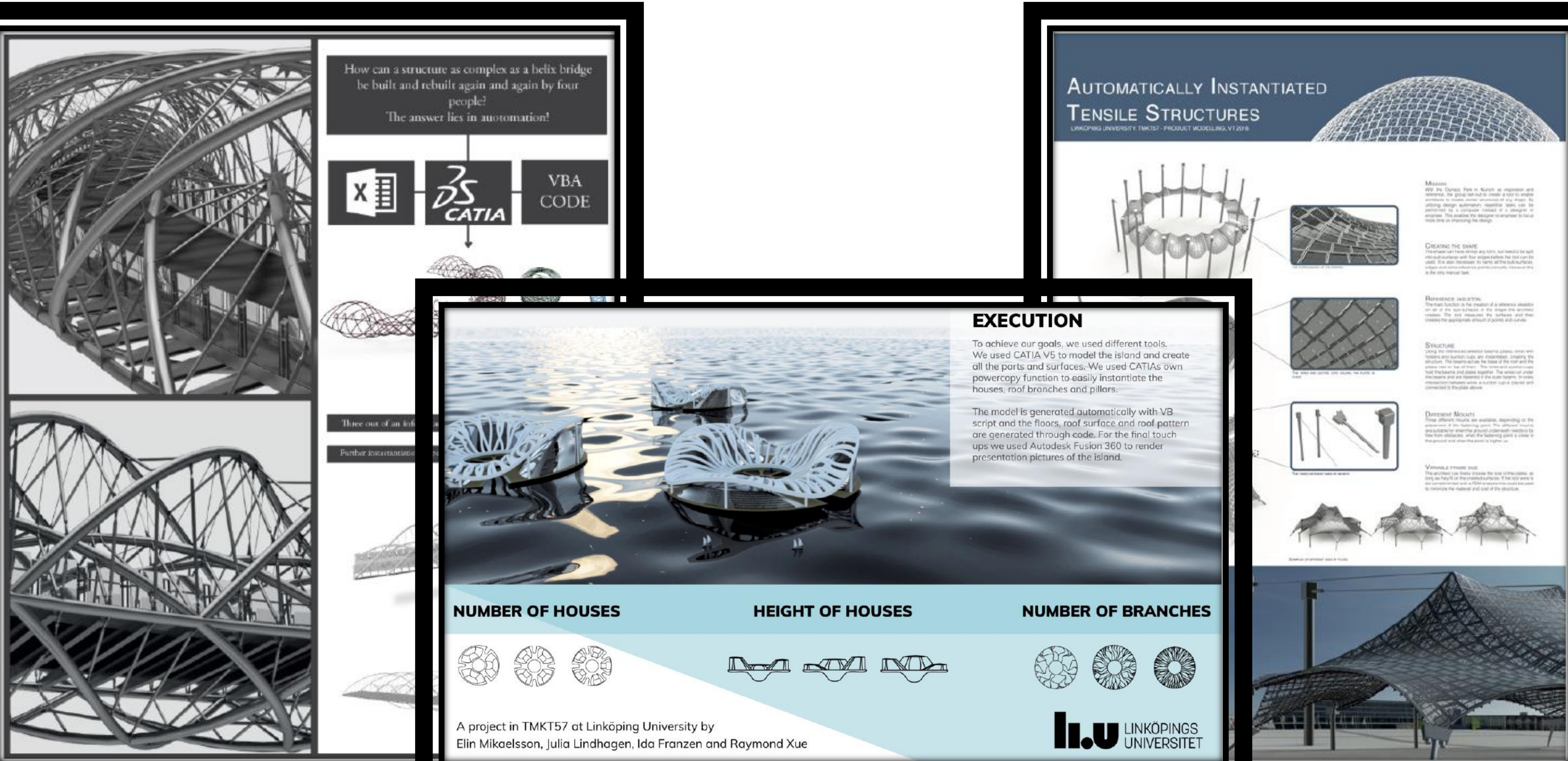


Morphological Changes



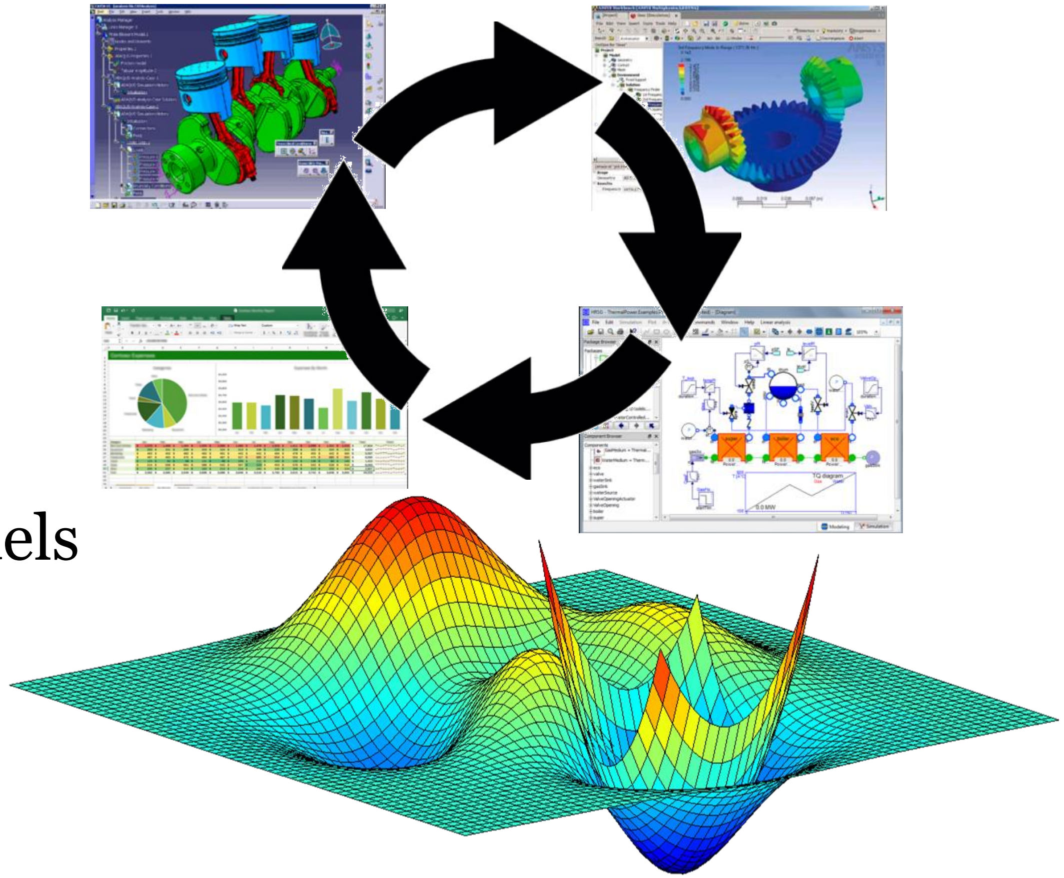
Topological Changes

TMKT57 Product Modeling



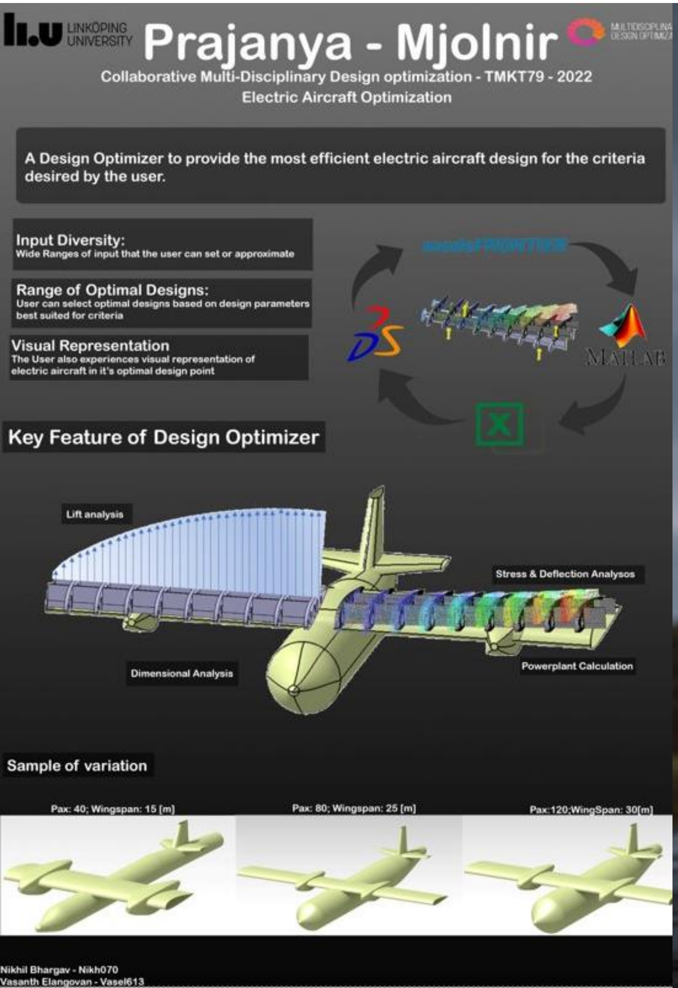
TMKT79 Collaborative Multidisciplinary Optimization

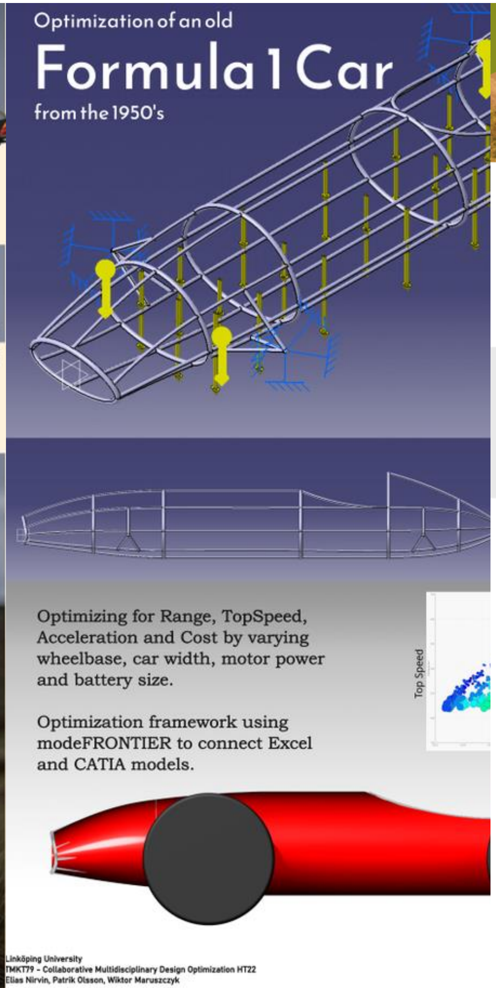
- Practice MDO
- Integrate
  - CAD
  - FEM
  - Performance Models
- Speed up with Surrogate/Meta models
- modeFRONTIER

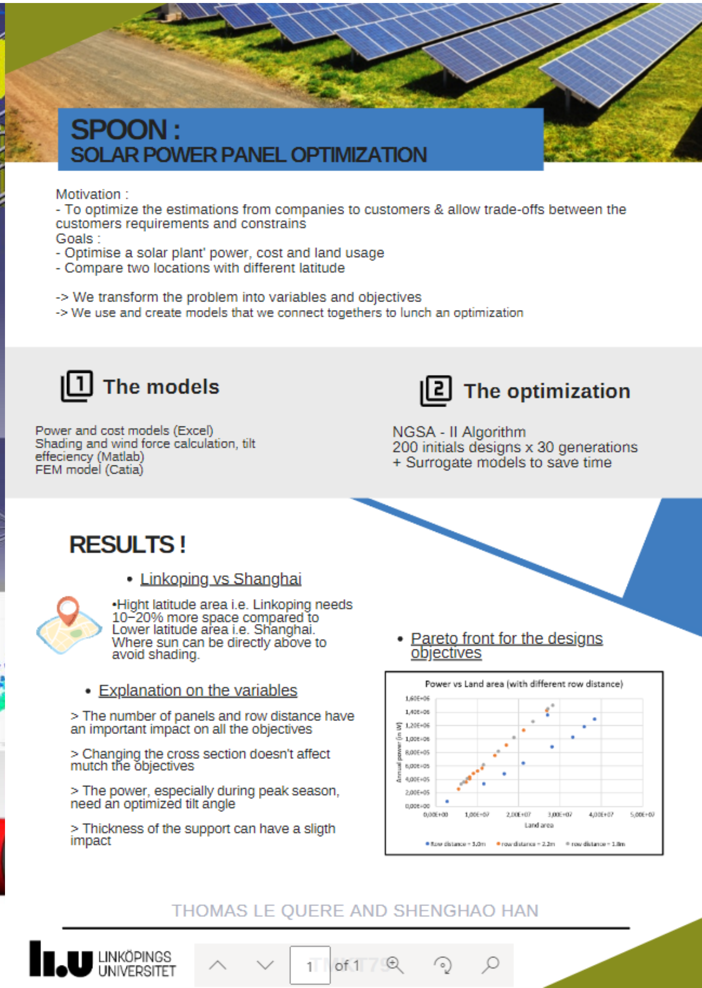


TMKT79 Collaborative Multidisciplinary Optimization

- Tutorials on a wind power plant– then own projects



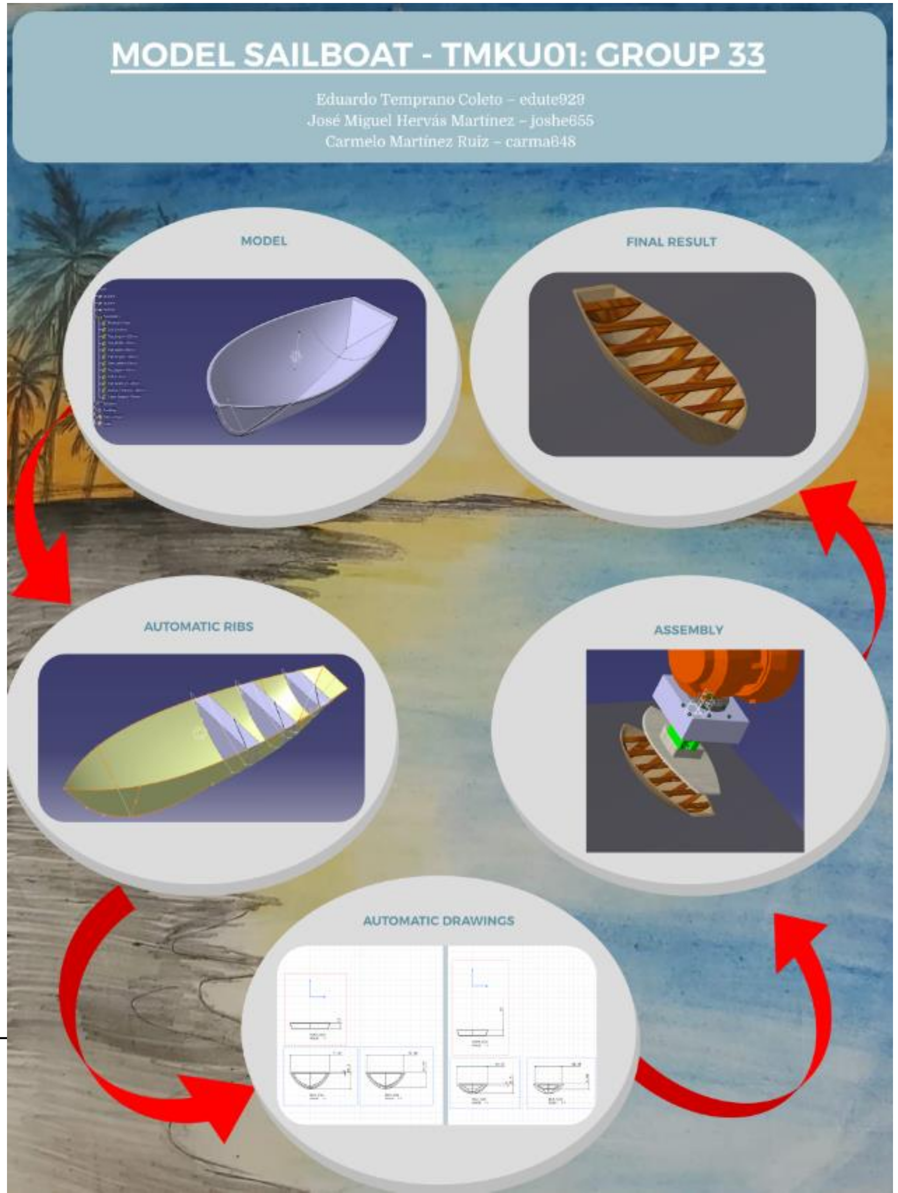




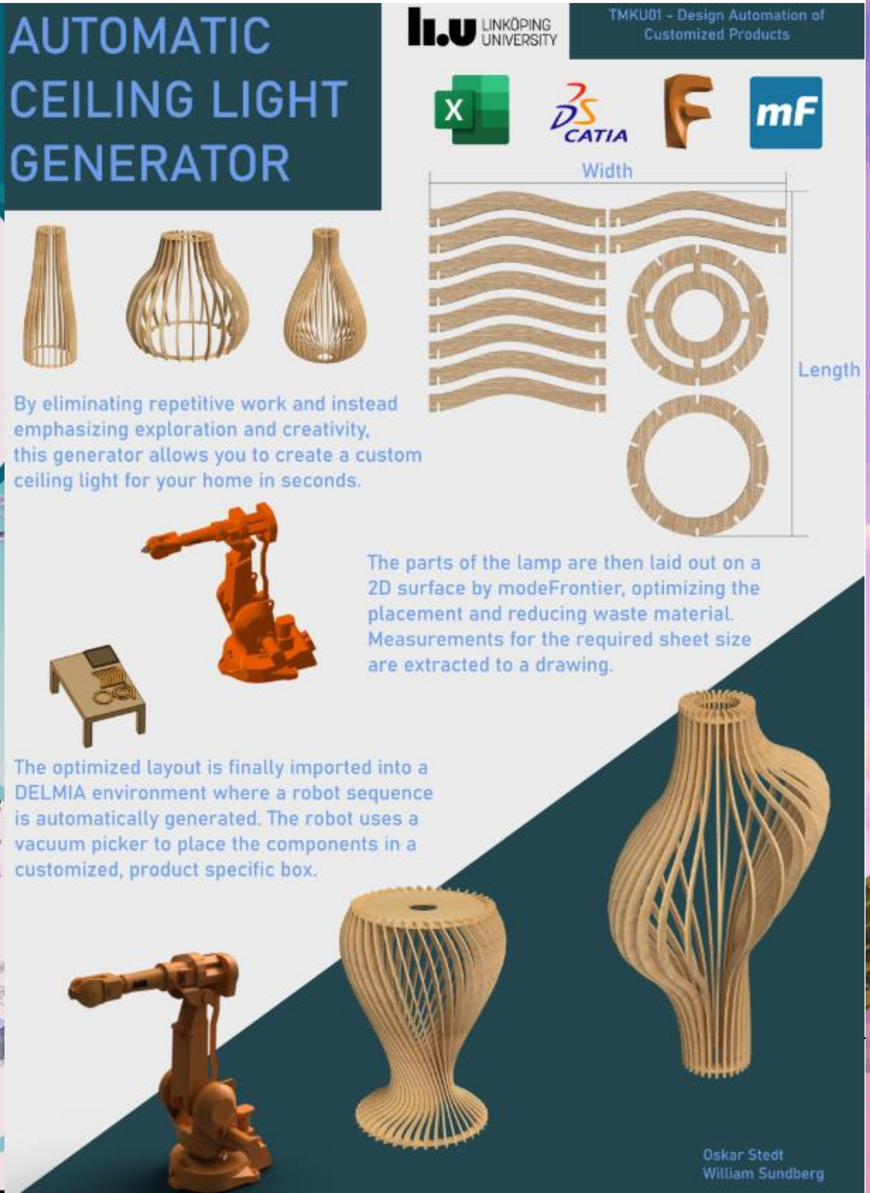
TMKU01 Design Automation for Customized Products

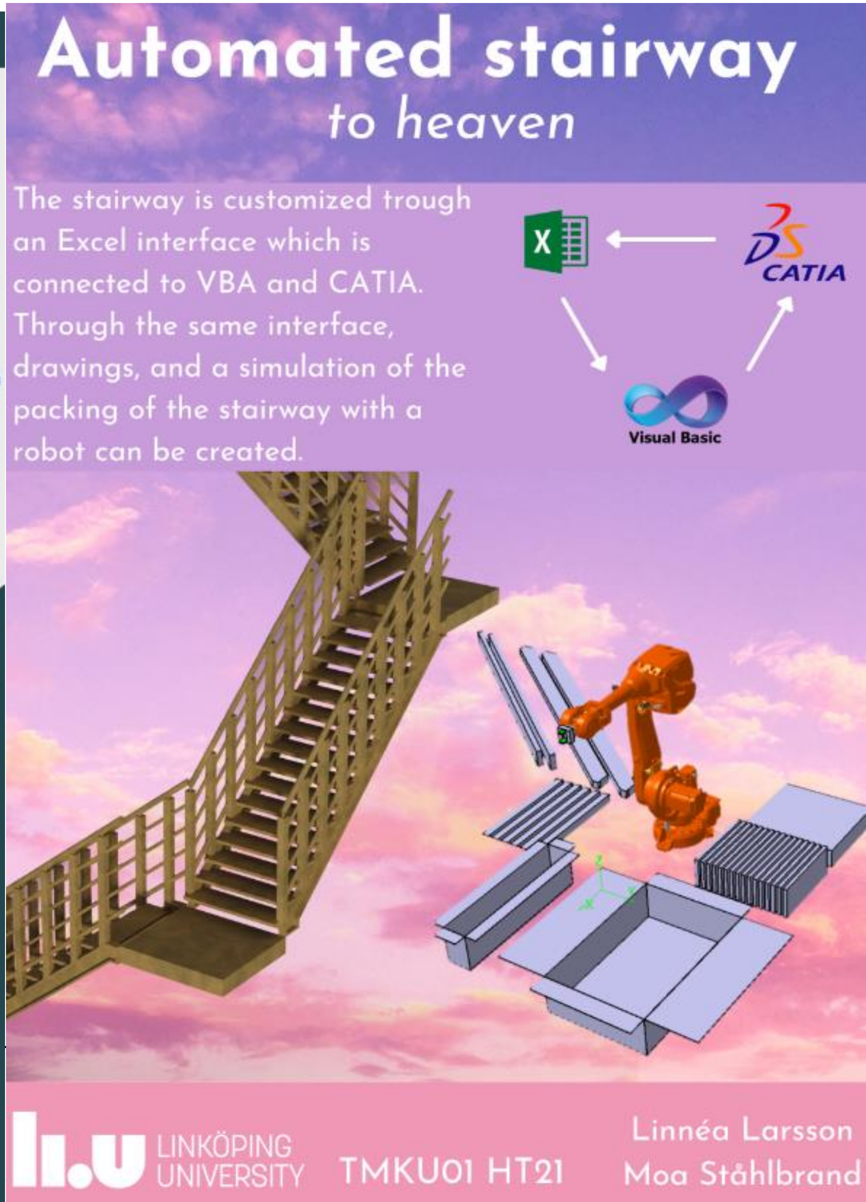
- Customer adapted products
- Automatical frameworks
  - CAD-models
  - Drawings
  - Assembly instructions
- Digital twin

- Excel
- CATIA
- Visual Studio



TMKU01 Design Automation for Customized Products





Challenges

- What will be important in the future?
- Programming
  - Included in all our courses
  - The students usually have low programming skills before our courses

- What software to teach?
  - Easy to use?
  - Open Source?
  - Used in the Industry?

- Repetitive Design – exemples from the courses
  - https://repetitivedesign.com/

- Design Automation Laboratory – our research and results from our courses
  - https://liu.se/forskning/design-automation-lab

- Johan.persson@liu.se

www.liu.se

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