Aalto University
School of Engineering

MEC-E1003 Machine Design Project: Design Brief

October 02, 2020

Learning goals for the course

Students...

1. Can relate theory and exercises to practice
2. Can iterate a design from the initial concept to a working prototype
3. Can document their contribution within a team-based effort
4. Are familiar with typical issues in project management and teamwork, and ways to address those issues

Credits: 5 ECTS

Grading: 1 - 5

Duration: 02.09.20 - 11.12.20

Teachers in charge: Sven Bossuyt and Kevin Otto

Access to prototyping facilities is restricted this year, due to the corona virus pandemic, so expectations and assessment criteria for the prototype will be scaled back accordingly.
However, you must still validate your concept and iterate the design, and produce design documentation for prototyping and testing.

Schedule: Overview and milestones

Week	Deadline	Description
Weeks 36-38	18/09	Group selection and pre-questionnaire
Weeks 37-39	02/10	Stirling engine starter project (individual work)
Week 40	02/10	Design brief for group project
Week 43	23/10	Concept pitch + peer review & 1st evaluation questionnaire
Week 46	13/11	Status report + peer review & 2nd evaluation questionnaire
Week 49	04/12	Information poster
Week 50	11/12	Gala: Prototype demonstration
Week 51	18/12	Final report & final evaluation questionnaire

Group project

Students, working in teams, will complete a specific mechanical design task, representative of mechanisms used in machines. They will develop an initial concept, build a prototype to demonstrate its working, and carry out more detailed designs of critical components.

For the concept, as a team, reflect on everyday- or industry-related activities and solutions you would like to improve, or to simply try and replicate. In other words, start with an existing object, and design it to be in some way better (perhaps better by some metric that was not important for the original design, sustainability for example).

- Project-based learning in this course will be supported by the theory and exercises taught in the courses from the common studies, taught concurrently.
- In the end of the course, there will be a final gala where you will be required to demonstrate the prototype of your solution.

Previous years

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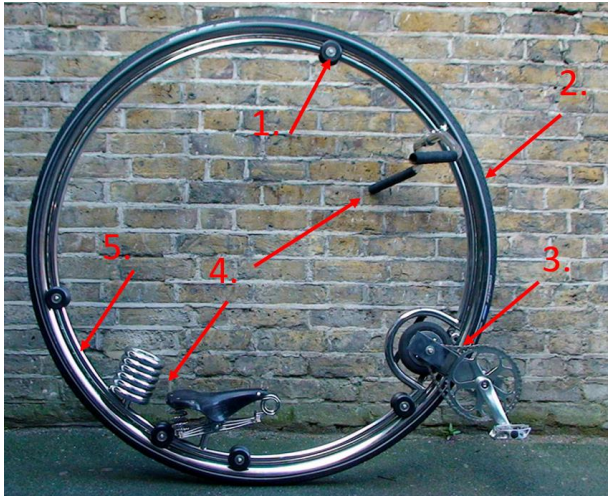

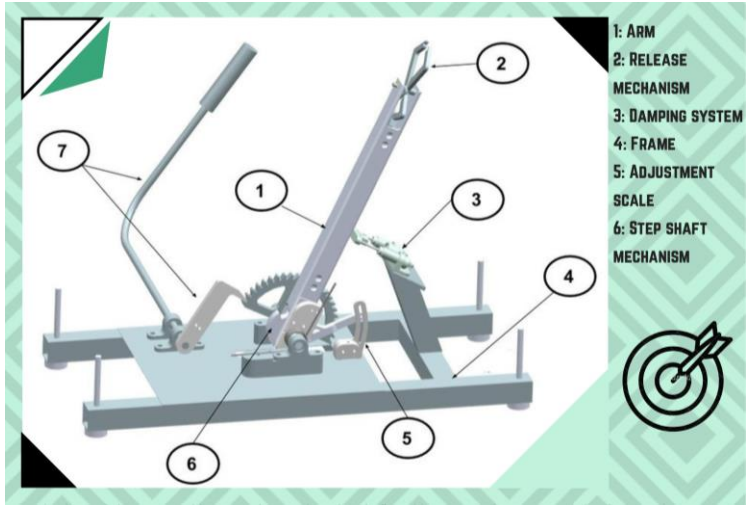

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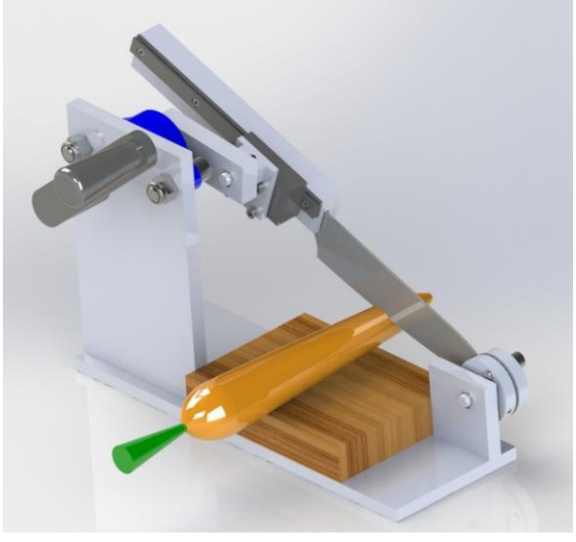
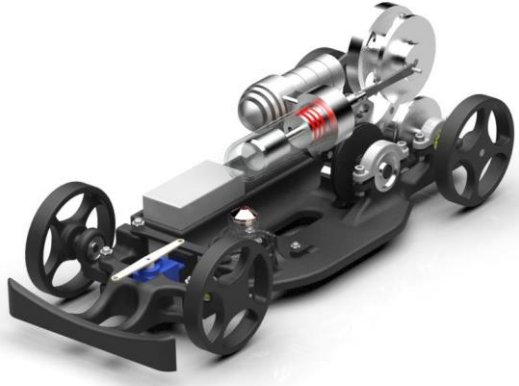




Group project: Changes this year!

- Most of the teamwork will happen online
- Iterating from initial concept to working prototype will be limited, since students cannot access the production facilities at university. Multi-body dynamics or finite element modelling can be used to iterate the design
- Some preliminary prototype with cardboard cutouts or a wireframe model is still possible
- Whether students get to a working prototype will not be a part of the evaluation criteria
- Teams still need to prepare and document a plan for manufacturing and testing a working prototype

Requirements & constraints

There are general requirements & process requirements

Requirements = Set by staff

Constraints = Set because of realities

Must = You have to do this

Recommended = You don’t necessarily have to do this

General requirements

Must include at least 5 machine design elements, like power screw, spring, bearing, gear, clutch, brake, belt, chain, coupling, linkage, and/or cam.

Must have some functionality.

Must be ready for exhibition and live demonstration on Dec 11

Recommended to focus on mechanical engineering, as the course cannot support you with electronics, programming, and other such features.

+ The course can offer limited budget for the teams

+ The course may be able to accommodate collaboration with external stakeholders who have different constraints and requirements

Process requirements

Must be modeled in 3D CAD with a meaningful structure, dimensions, and tolerances, with regard to its operation.

Must be structurally verified and analyzed with MBS.

~~**Must** be manufactured according to CAD drawings.~~

Must Include at least 1 part, whose shape is optimized with FEM, and material with Granta Edupack.

Must identify at least one part for which to verify key tolerances with appropriate measurement devices.

Recommended to use Siemens NX for concurrent development.

Schedule: Concept design

Already during weeks 39-40

- Initial ideation for your machine design project i.e., about functions, mechanism, its manufacturability etc.
- Select best ideas together as a group

Weeks 40-43: Develop concept and initial design

- Decide components, materials (Granta Edupack), verify functionality (models, MBS etc.), FEA (in critical places) and necessary steps of product design
- First draft of design documentation and manufacturing/ assembly plan

Week 43: Concept pitch in lieu of midterm exam (23rd Oct)

- Pitch the concept, design process, material selection, manufacturing plan, assembly plan or other aspects
- Student groups are allowed to playback a pre-recorded concept pitch
- Peer review: Pre-determined groups will critique the concept pitches
- In case you have a time/order preference for the pitching session, please inform the course assistant beforehand
- Submit the 1st evaluation questionnaire (23rd Oct)

Schedule: Realization

Weeks 44-45: Detailed design

- Iterate and further develop the machine concept design
- Update design documentation based on the detailed design

Manufacturability and Safety

- Start updating and elaborating the manufacturing/ assembly plan & do a safety evaluation

Week 46: Status report & kickstart prototype development

- Project status report is a work-in-progress (draft) version of your final report (by 13th Nov).
- Include the progress/current status, schedule, work distribution, design documentation, draft versions of manufacturing, assembly and testing plans
- Peer review of status reports

Complete the 2nd evaluation questionnaire (submit by 13th Nov)

Weeks 47-50: Exhibiting the prototype

- Prototype, finalize design documentation
- Advertising your project (poster for Gala by 04th Dec)
- Gala presentation on 11th Dec

Week 51: Final reporting and evaluation questionnaire (by 18th Dec)

Assessment

Final outcomes and grading

30% Stirling engine starter project

As determined by Prof. Kevin Otto

70% Final design project

Peer review for concept pitch and status report

Prototype demonstration & reporting

Report should include

- Final design documentation,
- Manufacturing and testing plans,
- Conclusions about course and demo, constructive self-evaluation by including scope for improvement

One grade for the whole report and the presentations

- Individual grades modified according to contribution to team effort

Contribution to team effort

Mutual assessment within each team

- With the help of three evaluation questionnaires
- Includes self-assessment
- May be overruled in teams where it doesn't work well

Multiplicative combination of four factors

- Timeliness
- Participation/ effort
- Quality
- Communication

Criteria for assessment of the contribution to the team effort

Criterion	Characteristics lowering the grade	Grade 3 (good)	Characteristics improving the grade
Timeliness	Work is often not ready on time	Work is usually completed on time, according to the common plan agreed	Work is always completed before the agreed deadline
Participation	Avoiding duties	Participation in the group work, attending meetings, contributing to discussions, taking their part of duties	Taking responsibility for their own duties and readily available to help others
Quality	Deliverables and tasks are incomplete, not working, or poorly documented	Deliverables and tasks are completed in a way that meets expectation	Deliverables are working reliably and are well documented
Communication	Not communicating as planned, difficulty in reaching-out via selected channels	Active communication whenever necessary via planned channels	Proactive, taking initiative in team communication

Some tips

Project management

Frequent team meetings are essential

- Ensure common goals by sharing your expectations
- Focus on good communication

Be clear who does what

- Mutually agree on work allocation
- Decide if you want a project manager in your team

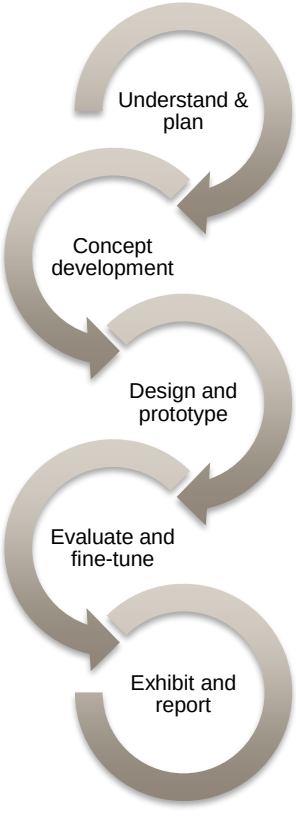
Follow a systematic process

- Maintain a project plan
- Identify, so as to mitigate potential risks
- Iteration is the key!

Document all the steps

- Have a draft report & update as the project progress

Project management



"Fail early to succeed sooner"

Don’t wait for anything, please ask!

Figure adapted from Product Design and Development process by Ulrich & Eppinger

Questions?