Abstract
The master study Systems Engineering is completed by performing a thesis project. This document describes objectives and guidelines for the project and the thesis.
Objectives of Master Project

Apply SE methods, techniques, and concepts in practice and reflect on its application, while providing value to the industrial sponsor.
The goals of the Final Project are:

- **the students have to prove again their professional competence and the acquired command of the systems engineering discipline by applying it to a selected problem.**

- **the selected problem has to be relevant in the context of the company in which the student works, so that knowledge is truly put into practice.**

- **to facilitate the students to make the step from “just applying” to “critical reflection”.**

- **to verify that students are capable to operate at academic level.**
Stakeholders of the Master Project

- Academic supervisor
  - Coaching
  - Quality
  - Grading

- Master project

- Student research paper

- Company supervisor
  - Coaching
  - Industrial case

- Industrial company
  - Sponsor
  - Industrial context
  - Usable results

Academic → Industrial
### Scoping is Crucial

<table>
<thead>
<tr>
<th>What methods, techniques, tools, concepts</th>
<th>Systems Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>What (sub)systems, releases, functions, qualities, aspects, disciplines, technologies</td>
<td>industrial</td>
</tr>
<tr>
<td>What timing of activities and deliverables</td>
<td>planning</td>
</tr>
<tr>
<td>What resources (student time, means, advisors)</td>
<td>planning</td>
</tr>
<tr>
<td>What approach, criteria</td>
<td>research</td>
</tr>
</tbody>
</table>
organizational and operational context

Case Positioning

System 1

sub-system

component

component

component

System n

sub-system

component

component

component

number of details

system requirements

design decisions

parts connections

lines of code

10^0

10^1

10^2

10^3

10^4

10^5

10^6

10^7
Depth, Breadth and Reflection

SE body of Knowledge

reflection

organizational and operation context
user needs and system requirements

breadth

depth

design and realization

connect

case

SE body of Knowledge

organizational and operational context

System 1

Sub-system 1

Component 1

System n

Sub-system n

Component n

organizational and operational context

system requirements

design decisions

parts connections
lines of code

case

number of details

10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7

Systems Engineering Master Project

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Difference Academic and Industrial Goals

SE body of Knowledge

organizational and operation context
user needs and system requirements

design and realization

case

connect

academic perspective

means

reflection

breadth

depth

goal

industrial perspective

means

goal

SE body of Knowledge

reflection

breadth

depth

goal

industrial perspective

means

academic perspective
Buskerud Research Agenda

Systems Engineering

<table>
<thead>
<tr>
<th>Trends</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>time to market</td>
<td>overview</td>
</tr>
<tr>
<td>dev. cost</td>
<td>feature interaction</td>
</tr>
<tr>
<td>features</td>
<td>complexity</td>
</tr>
<tr>
<td>performance expectations</td>
<td>amount of software</td>
</tr>
<tr>
<td>number of products</td>
<td>integration effort</td>
</tr>
<tr>
<td>release cycle time years months</td>
<td>reliability</td>
</tr>
<tr>
<td>openness interoperability</td>
<td>uncertainty</td>
</tr>
<tr>
<td>hype and fashion</td>
<td>dynamics</td>
</tr>
<tr>
<td>globalization use</td>
<td></td>
</tr>
<tr>
<td>globalization in development and logistics</td>
<td></td>
</tr>
</tbody>
</table>

Multi-disciplinary design
system modeling and analysis
system design methods

Reliability / Robustness
in harsh environments

Innovation
Responsiveness to change

capturing core know-how
DR

capturing customer understanding
KDA

certainty level
KA

change analysis
Maritime

SW in system
FMC

shopfloor automation
VAN

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BCURRagendaGraph
Mapping Master Projects on the Research Agenda

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RCBEprojectsZoom
### Process of Master Project

<table>
<thead>
<tr>
<th>Step</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pick subject</td>
<td></td>
</tr>
<tr>
<td>Secure supervisors (BUC, industry)</td>
<td></td>
</tr>
<tr>
<td>Write proposal, project plan; for paper write abstract</td>
<td></td>
</tr>
<tr>
<td>Perform project; involve supervisors regularly</td>
<td></td>
</tr>
<tr>
<td>Write paper and iterate with supervisors</td>
<td></td>
</tr>
<tr>
<td>Grading by academic supervisor and sensor</td>
<td></td>
</tr>
<tr>
<td>Graduation</td>
<td></td>
</tr>
<tr>
<td>Publication in journal or conference</td>
<td></td>
</tr>
</tbody>
</table>
Master Project Milestones

- proposal
  - system
  - SE need company
- abstract
  - academic contribution
- book plan
  - introduction
  - check structure, style
- final paper/report
  - presentation

Tentative dates for milestones for IM students:
- September
- November
- February
- May
control system architecture and design
incremental build mathematical models, simulate various inputs
analyze stakeholders, requirements, analyze system concepts and context
"simple" context model, analyze system impact and adapt requirements
verify system performance
write phase report
report layout
write draft paper and include findings
finalize paper

70%-1.5wks
1 wk
~2 wks
70%-6wks
~4 wks
50%-5wks
~4 wks
20%-5wks
20%-2wks
20%-11wks
20%-1wks
1 wk
~2 wks
~4 wks
~4 wks
20%-2wks
10%-1wks
10%-10wks
60%-2wks

Systems Engineering Master Project
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"A good abstract should answer three questions:

What did I do,
what did I learn,
and why is that important?

The key is to identify something or things that can be reused in the future."

Prof. Michael Pennotti, Stevens Institute of Technology
Needed: Time Machine

"fast forward" yourself into the future
what do you expect to be the project outcome?

Students write an initial abstract at the start to think through what can happen. At the end of writing the paper, you write the real abstract. The academic supervisor has to accept the initial abstract before starting the project.
<table>
<thead>
<tr>
<th>Project Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>maintain a project log</strong></td>
</tr>
<tr>
<td><strong>keep supervisors involved</strong></td>
</tr>
<tr>
<td><strong>time box and iterate</strong></td>
</tr>
<tr>
<td><strong>early feedback on paper</strong></td>
</tr>
</tbody>
</table>
1. Explanation of the subject; what is the goal of the project?

2. Positioning of the subject in the academic context and literature; what does this paper add to the Body of Knowledge?

3. How is the project performed, what has been done.

4. Evaluation of the project, reflection on the results and the project itself.

5. Paper should be submittable to a refereed conference or to a journal; the academic supervisor may accept a report as well.
1. Clearly introduce the problem that the manuscript is discussing/addressing,

2. Discuss the problem background. That is, discuss the research that has been previously conducted by you or others in the field (or related fields) to solve/address the same or similar problem,

3. Develop a succinct argument for the methods or ideas proposed in your manuscript,

4. Present a clear and understandable justification of why the proposed methods or ideas contribute to a superior or different solution to the problem. A clear statement of your contributions is often crucial to reviewers. Clear specify this when possible. And finally,

5. Discuss the likely future directions of the research being conducted by you (your group).

Final Presentation at the end of the project

- student presentation of master project
  - ~30 minutes presentation
  - ~20 minutes questioning by examinators
  - ~10 minutes examinators conclude

committee:
- academic supervisor
- at least one other academic staff member of SE
- (optional) sensor
- (optional) company supervisor or representative
- at least 3 people
Publication Process

Company screens paper for sensitive or confidential issues, see http://www.gaudisite.nl/BuskerudSEpublicationProcedureSlides.pdf

Select target journal or conference, typical choices are:
INCOSE symposium, CSER, Journal of SE, Systems Research Forum

Transform the paper into the prescribed format or template

Review of the paper by BUC and Company, adapt paper

Submit paper to journal or conference

Process journal or conference feedback

Final review by company

Submit final version

Visit conference and present paper
If a third party is involved, e.g. a customer or supplier,
then ask the third party to agree with publication procedure:


and ask who will be reviewer for the third party
Conventions for Submitting Project Deliverables

Submission instructions

use for all deliverables the following conventions:

filename: SEMP <your name> <subject>.<version>.<extension>

   e.g. SEMP John Student abstract.2.doc

where subject = {proposal | abstract | plan | presentation | paper | ...}

email to:   <gerrit . muller @ gmail . com>
subject:   SEMP <subject>
cc:        <gunnarkb  @ gmail . com>

"standard" file types preferred, e.g. pdf, jpg, doc, xls, ppt
workshop 1 in June
workshop 2 in August
workshop 3 in September
  Master Project; Writing an Abstract: http://www.gaudisite.nl/MasterProjectWritingAnAbstract.pdf
  Master Project; Execution Phase: http://www.gaudisite.nl/MasterProjectProjectExecution.pdf
Validation of Systems Engineering Methods and Techniques in Industry
Systems Engineering Research Methods (paper)
Published Master Project papers: http://www.gaudisite.nl/MasterProjectPapers.html
Workshop Academic Writing http://www.gaudisite.nl/RPacademicWritingSlides.pdf
Stevens Institute guidelines: https://www.stevens.edu/mpt/content/masters-project-guidelines