

# Systems Engineering Course Research Methods; Assignments

by *Gerrit Muller* University of South-Eastern Norway

e-mail: `gaudisite@gmail.com`

`www.gaudisite.nl`

## Abstract

This course teaches research methods for systems engineering and related disciplines, such as industrial economy, engineering management, innovation, and technology management. This field of research needs research methods combining the traditional scientific methods ("hard") and methods from social sciences ("soft").

The course prepares students for their master thesis.

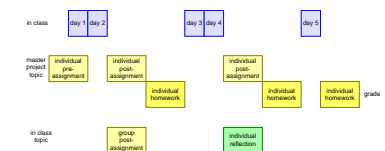
## Distribution

This article or presentation is written as part of the Gaudí project. The Gaudí project philosophy is to improve by obtaining frequent feedback. Frequent feedback is pursued by an open creation process. This document is published as intermediate or nearly mature version to get feedback. Further distribution is allowed as long as the document remains complete and unchanged.

March 21, 2021

status: preliminary  
draft

version: 0.8



This course is a joint development of

Kristin Falk

Satya Kokkula

Elisabet Syverud

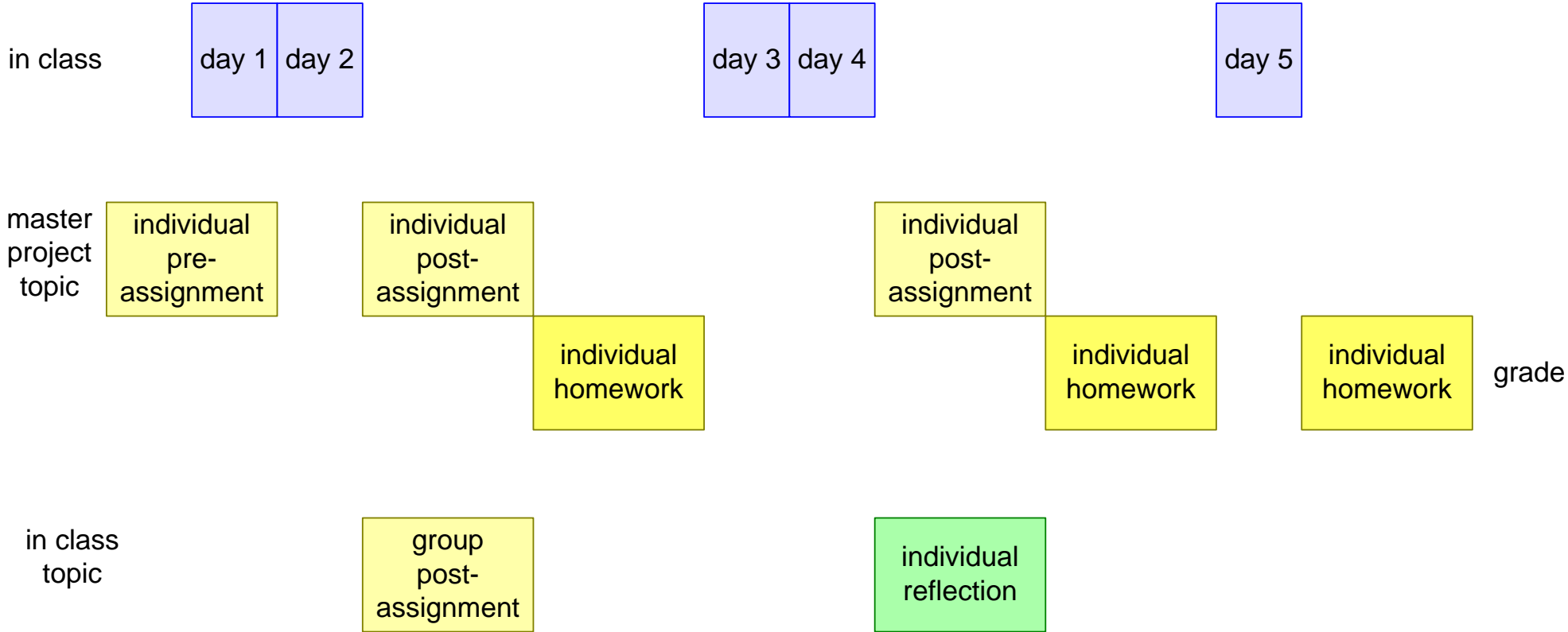
and Gerrit Muller

# Research Methods Course Pre-assignment

---

- Determine a topic for the master project
- Position the topic in its context (e.g. in your company, in ongoing projects)
- Discuss the topic with its stakeholders
- Try to formulate the line of reasoning:
  - problem, goal, envisioned solution, rationale, open research questions

# Flow of Assignments



# What Specific Problem Triggers this Research?

---

- Describe what problem triggers your research
- Be as specific as possible, for instance asking:
  - Why, what, how, who, when, where
- If you find it difficult to describe the problem, then start with listing symptoms and challenges, or identifying dilemmas

# Problem Exploration

---

- Who are the stakeholders related to this problem
- What can you ask them to explore the problem
- What can you tell them to introduce your research
- Transform the answers into a script for interviews of stakeholders

# Formulate an Initial Set of Research Questions

---

- Transform the **problem statement** into a main **research question**
- What sub-questions will help you to answer the main research question?

Good research questions are **open questions**, e.g. allowing an answer in terms of how well, how much, etc.

You typically need one main question and **3 to 5** sub-questions.

Make all questions as **specific** as possible. The main question may invite some generalization.

# Feasibility of this Study

---

- Define the scope of the research, fitting in the available time and effort
- What do you need (e.g. information, contacts, access to people, tools, ...) to perform the study?
- What risks do you see for the research?



# Search Literature

---

- Use the research questions to determine 5 to 10 key words or phrases
- Search for relevant literature
- Identify ~10 potentially interesting papers
- Read the abstracts
- Sort on relevancy, based on abstract
- Read at least one paper

Keep notes on all papers you find

# Refine Literature Search

---

- Refine the 5 to 10 key words or phrases
- Look for literature reviews
- Look for founding papers
- Use these to search for relevant papers
- Order on relevancy based on abstract

Keep notes on all papers you find

# Make an Initial Research Design

---

- What will you do, when and where with who?
- What will you look for and look at?
- How can you analyse what you did and observed?
- How will this help you to answer the research questions?

# Block 1 Post-assignment Group

---

Capture for the in-class case:

- the line-of-reasoning
- including the research questions
- the scoping, required resources, and risks
- search criteria
- list of most relevant papers
- one paragraph summary for the 4 most relevant papers

in 2..4 A4s

- appendix with all literature notes

# Block 1 Post-assignment Individual

---

- Refine the topic for the master project
- Position the topic in its context (e.g. in your company, in ongoing projects)
- Discuss the topic with its stakeholders
- Reformulate the line of reasoning:
  - problem, goal, envisioned solution, rationale, open research questions

# Homework Block 1

For the individual master project topic:

- |                                       | effort |
|---------------------------------------|--------|
| • initial interview and/or survey     | 30%    |
| • initial problem analysis            |        |
| • literature survey Body of Knowledge | 60%    |
| • search secondary data sources       |        |
| • read Research Methods paper         | 10%    |
| • elaborate research design           |        |

Submit a 5 to 10 page report with the above content

maintain a detailed logbook!

# Analysis of the Survey Data

---

- Download the Excel spreadsheets with survey data
- Discuss what you can do with this data for analysis
- Discuss how you can use this data

# Relate the Data and the Research Questions

---

- Take the research questions that you defined in the post-assignment.
- Does the survey give you any new insights in the research questions?
- Do you want to adapt the research questions?
- Do you want to run another survey? If so, what are the questions for the new survey?



# Revisit Individual Master Project

---

- Revisit your research design
- What data do you need?
- How can you collect that data?
- What are the main challenges for your master project?

# Assess your Current Project Definition

---

- How good is your scope [1 = very poorly defines.. 5 = very well defined]
- How good are your research questions [ same 1 to 5]
- How confident are you that you can execute the project [1 to 5]
- What are the main hurdles?

- Analyze the data statistically
- Look for overall distribution and for correlations
- Capture results on a PowerPoint slide

Upload the PowerPoint file to Canvas

# Discuss the validity of your results

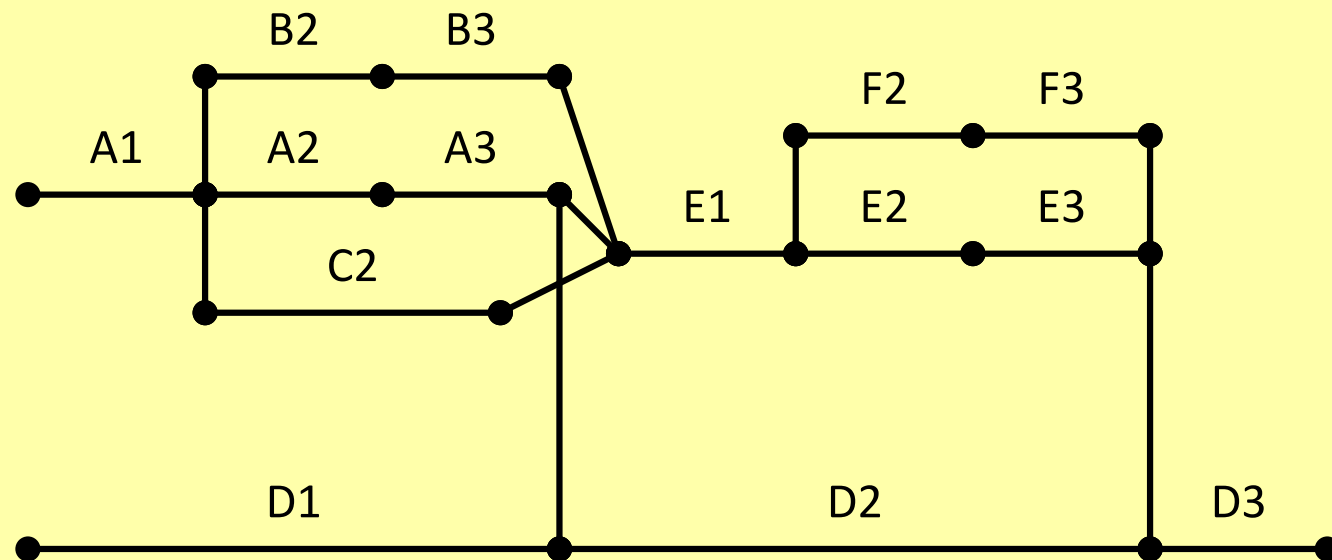
---

- Only from statistical perspective
- Including the survey process
- Capture results on a PowerPoint slide

Upload the PowerPoint file to Canvas

# Make a PERT plan for Master Project Execution

- Strive for >20 activities
- Show dependencies



# Assess your PERT plan

---

- How many activities did you define so far?
- How concrete are the activities? [1 = highly generic, 5 is very specific (e.g. system, phase, stakeholder, properties, etc. defined)]

# Make a Book Plan for your Course Paper

---

- Define the sections
- Define the subsections
- Define the content per (sub)section in keywords
- Define the size of subsections in #pages (e.g.  $\frac{1}{4}$  page, 3 pages)

# Report Main Book Plan Sizes

---

How many pages do you plan for:

- Line of reasoning
- Literature survey
- Research design
- Expected results



- Write a brief reflection on:
  - the Leadership survey
  - the Dental Health survey

max 2 A4s

# Block 2 Post-assignment Individual

---

Maximum two A4 pages in total

- Update the line of reasoning for your master project topic, including the research questions, according to your current understanding.
- Write down your research plan, include
  - Research design
  - Research method(s)
  - Explain how to collect what data
  - Explain how to analyze data

# Homework Block 2

For the individual master project topic:

- continue literature survey
  - write critic of 2..3 papers
  - identify challenges and risks in problem definition 15%
  - make research design more concrete 30%
  - make book plan for the course paper 5%
- effort  
50%

Submit a 10 to 15 page report with the above content

maintain a detailed logbook!

# Write an Abstract of your Course Paper

---

Write an abstract

in 3 paragraphs

use 2 sentences per paragraph

100..150 words in total

# Annotate the Book Plan

---

annotate the book plan of the Research Methods paper with keywords for

- content
- scope

# Make a Diagram Visualizing the Research Design

---

Make a diagram to visualize the research design, e.g.

- the research actions
- the collected data
- the results from the analysis

for instance in the form of a flow diagram

write a course paper, as an academic paper of ca 15 pages, containing:

- line of reasoning
- literature survey
- research design
- expected results

and make

- an execution plan
- a book plan of the final paper