Systems Engineering Course Research Methods; Assignments

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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.

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Colophon
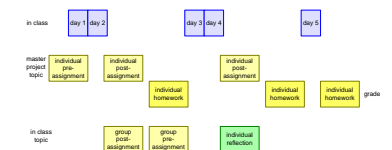
This course is a joint development of

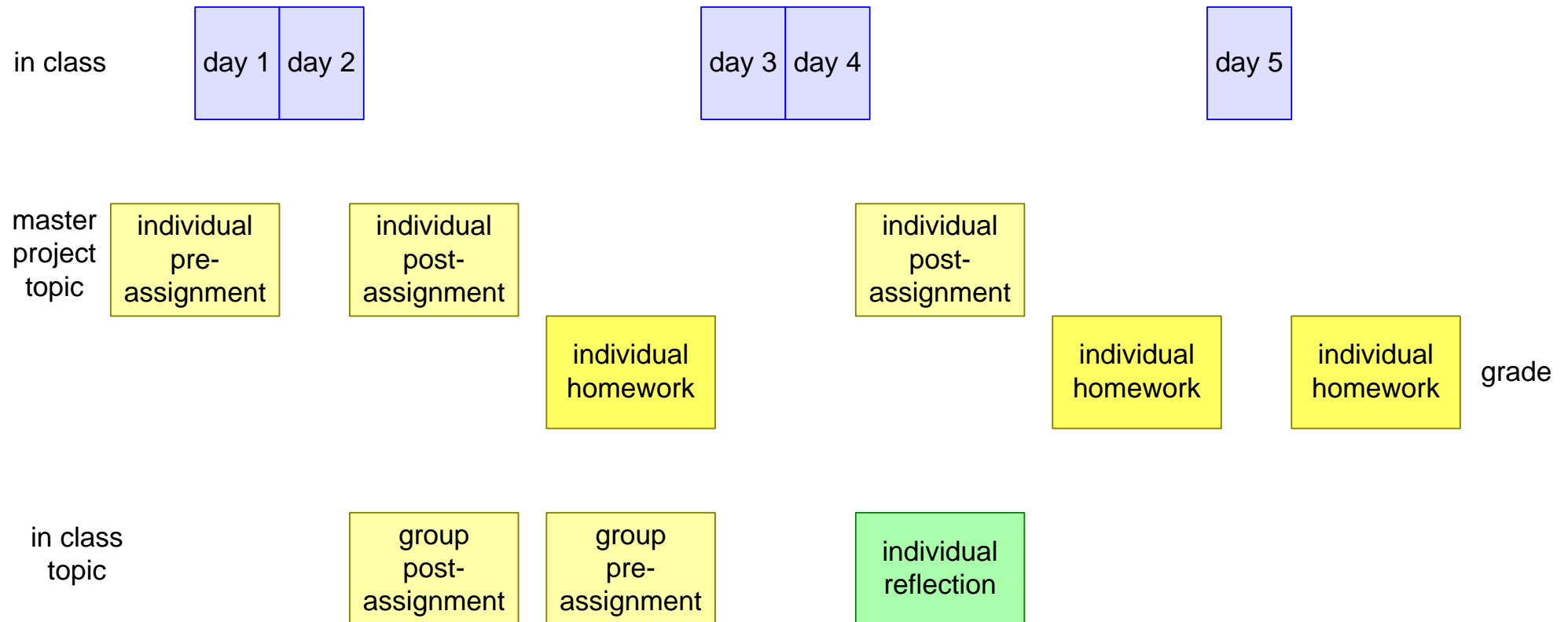Kristin Falk

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

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Flow of Assignments

in class

| day 1 | day 2 | | day 3 | day 4 | | day 5 |

master project topic

- individual pre-assignment
- individual post-assignment
- individual homework
- individual post-assignment
- individual homework
- individual homework

grade

in class topic

- group post-assignment
- group pre-assignment
- individual reflection

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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

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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

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SECRMAproblemExploration

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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 ~3 potentially interesting papers

- Make an initial assessment of these 3 papers

Keep notes on all papers you find
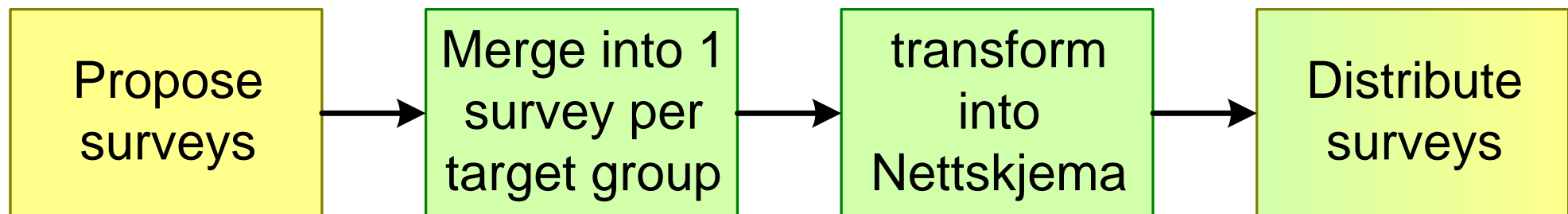
Refine Literature Search

- 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

Propose Survey Approach

- Define the target groups

- For each target group

    - Formulate survey questions

        - Propose format per question, e.g. free text, range, Likert scale

| Propose surveys | → | Merge into 1 survey per target group | → | transform into Nettskjema | → | Distribute surveys |

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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

- Finish the survey

- Distribute the survey to enough people to get a response of at least 10 respondents.

- Collect the results one week before Block 2.

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

- initial problem analysis

} 30%

- literature review Body of Knowledge

- search secondary data sources

} 60%

- read Research Methods paper

- elaborate research design

} 10%

Submit a 5 to10 page report with the above content; **maintain a detailed logbook**!

Refresh your statistics, for instance https://towardsdatascience.com/the-5-basic-statistics-concepts-data-scientists-need-to-know-2c96740377ae

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?

Statistical Analysis

- Analyze the data statistically

- Look for overall distribution and for correlations

- Capture results on a PowerPoint slide

Upload the PowerPoint file to Canvas

Re-iterate the Research Questions

- Classify your research questions according to the meta-levels and their scope

- Are the research questions specific enough?

- Do you have a logical build-up of the research questions?

- Do you have a way to find answers?
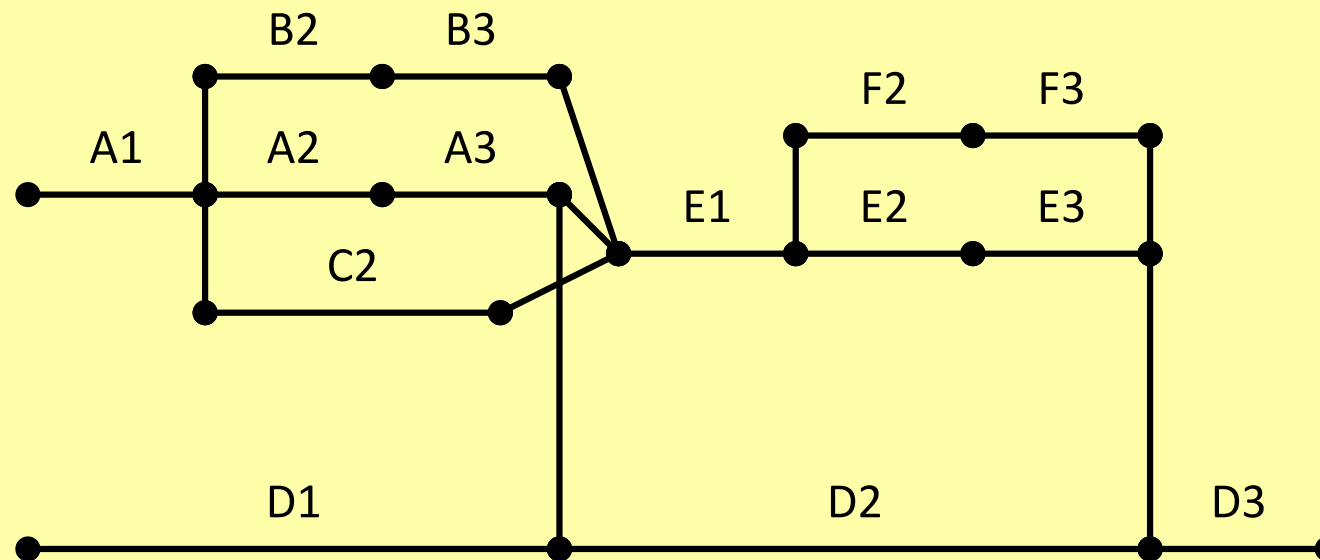
Discuss the validity of your results

- 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. ¼ page, 3 pages)

Report Main Book Plan Sizes

How many pages do you plan for:

- Line of reasoning

- Literature survey

- Research design

- Expected results

Block 2 Post-assignment Group

- Write a brief reflection on the in-class assignment:

  - What are the main findings?

  - How did you get to these findings?

  - What did you learn from doing the in-class assignment?

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

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For the individual master project topic:

effort

- continue literature review

} 50%

- 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%

Submit a 10 to15 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

Final Homework

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

- title

- abstract (100 to 150 words)

- introduction (context, line of reasoning)

- literature survey (of about 10 publications)

- research design

- discussion (risks, expected results)

- conclusion

and add appendices (which do not count for the 15 pages)

- an execution (PERT) plan

- a book plan for the final paper of the master project

use the template:
ITM5000-Master Thesis-template.doc