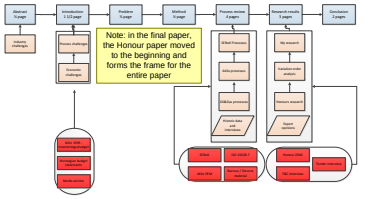
Systems Engineering Research; Examples of Flow and Methodology

by *Gerrit Muller* University of South-Eastern Norway-NISE
e-mail: gaudisite@gmail.com
www.gaudisite.nl

Abstract

Research in System Engineering requires a mixture of research methods. It is a challenge to capture the various aspects in a logical flow. The research methodology is also a significant challenge. This presentation shows examples of past research of visualizing the paper flow and the research methodology.

October 26, 2021
status: draft
version: 0.3



Examples from Price Winning Paper

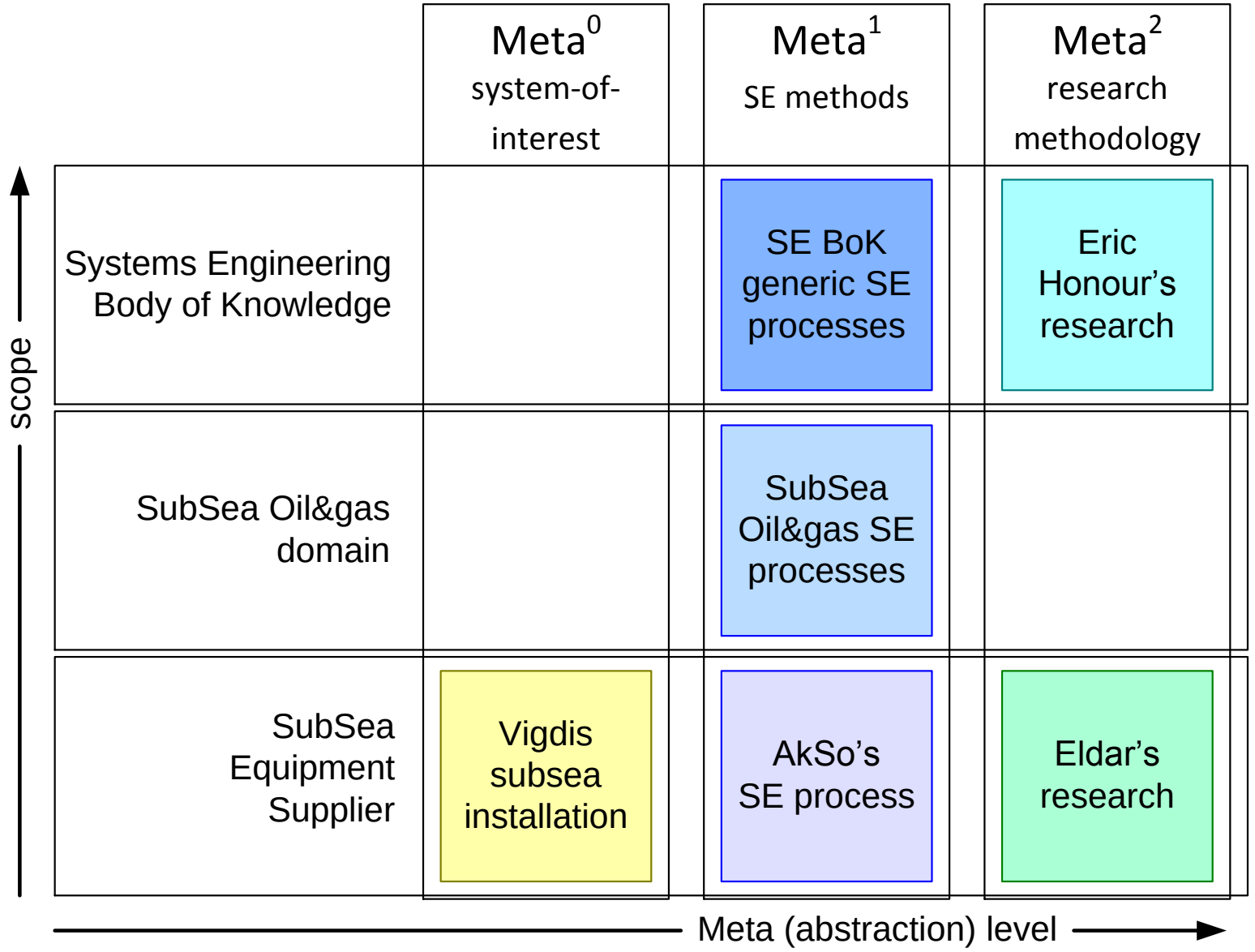
Eldar Tranøy won the **Best Student Paper Award** at INCOSE 2014 in Las Vegas with the paper

"Reduction of Late Design Changes Through Early Phase Need Analysis"

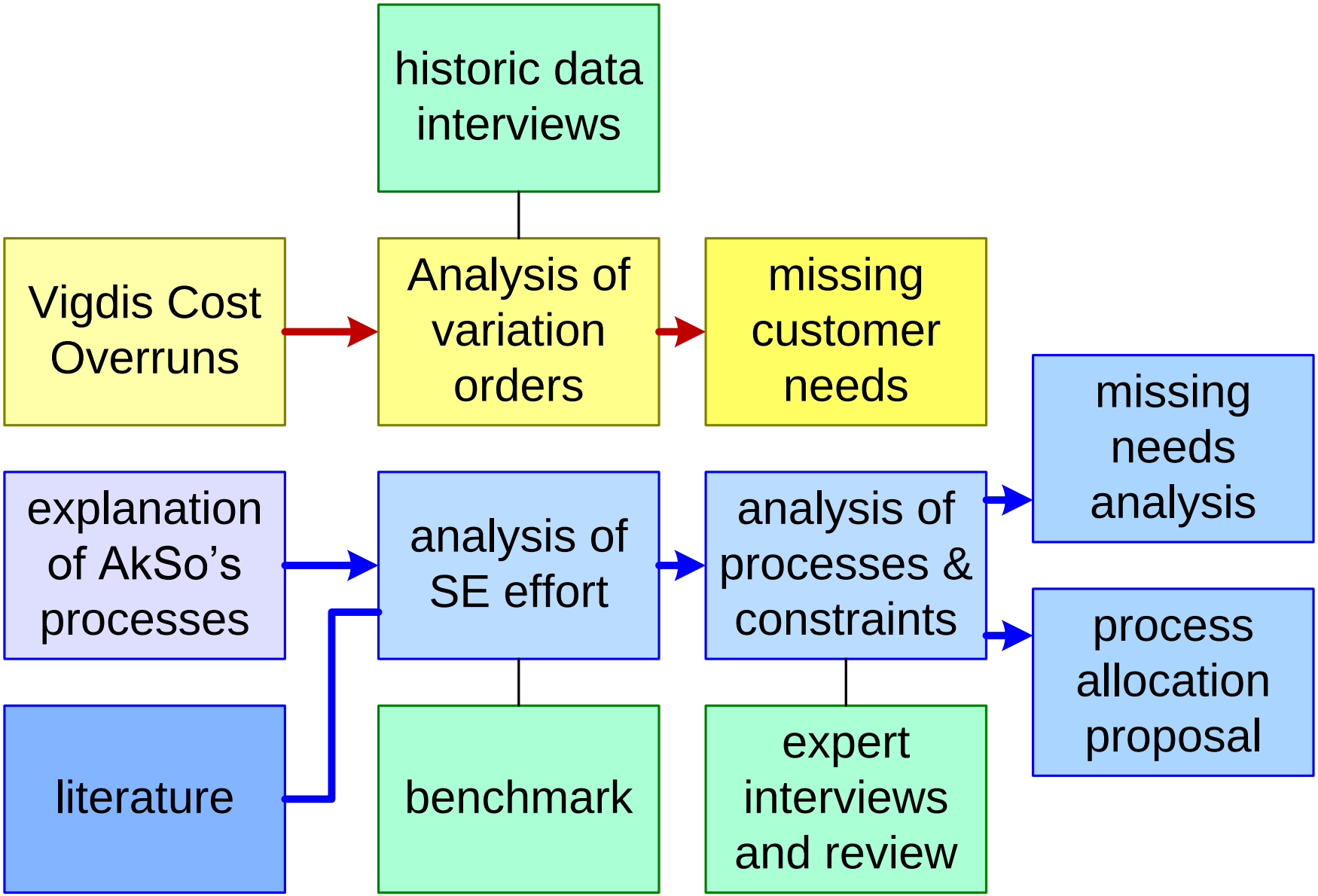
available at http://gaudisite.nl/INCOSE2014_Tran%C3%B8y_Muller_ReductionOfLateDesignChanges.pdf

The following slides show some of the attempts of finding the flow for this paper by Eldar Tranøy and the academic supervisor.

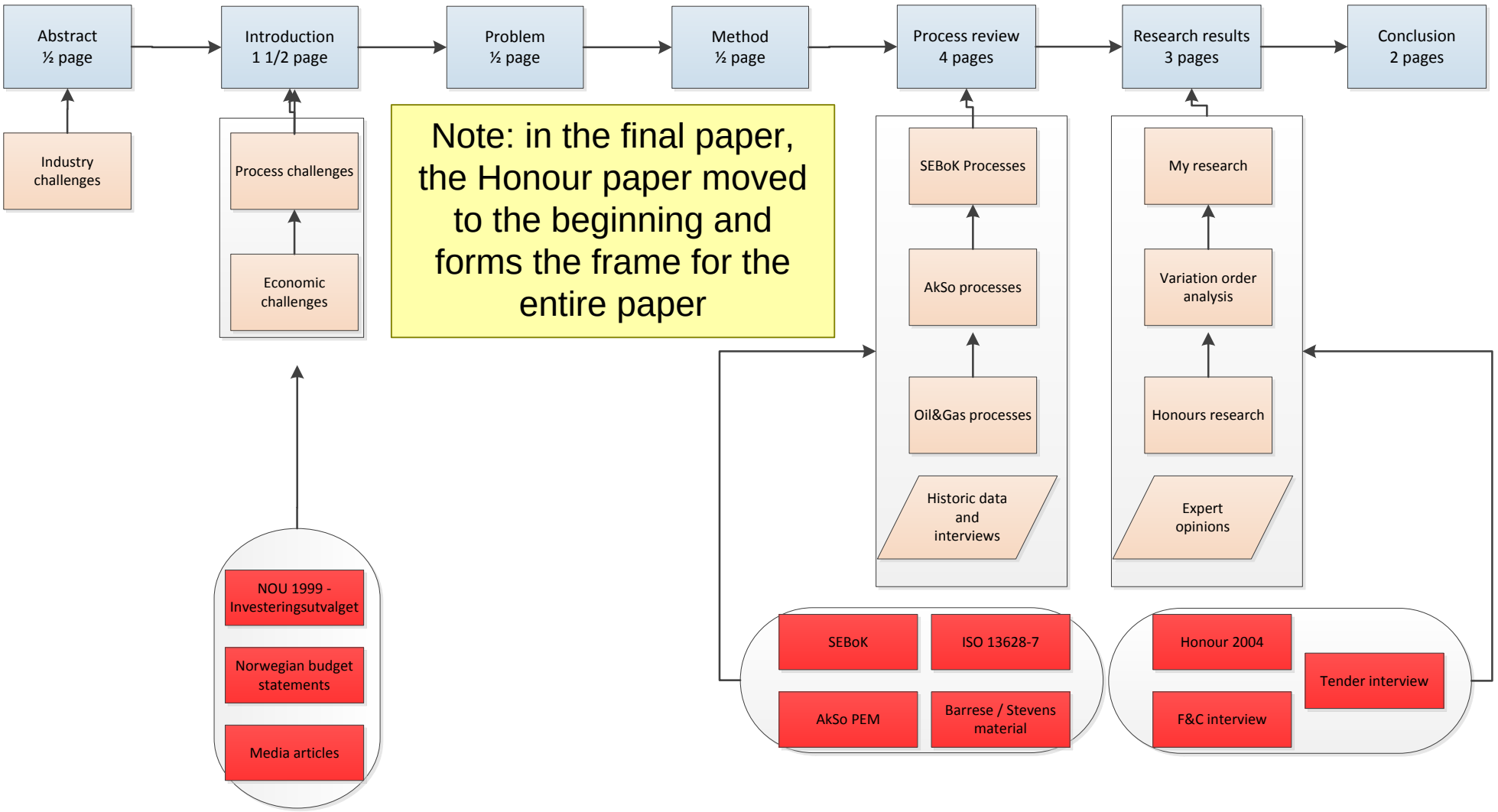
Meta Levels and Scopes by Supervisor



Paper Flow Proposed by Supervisor



The Book Plan that Eldar Made at the Start



Example Research Methodology

Linda Lønmo wrote the paper

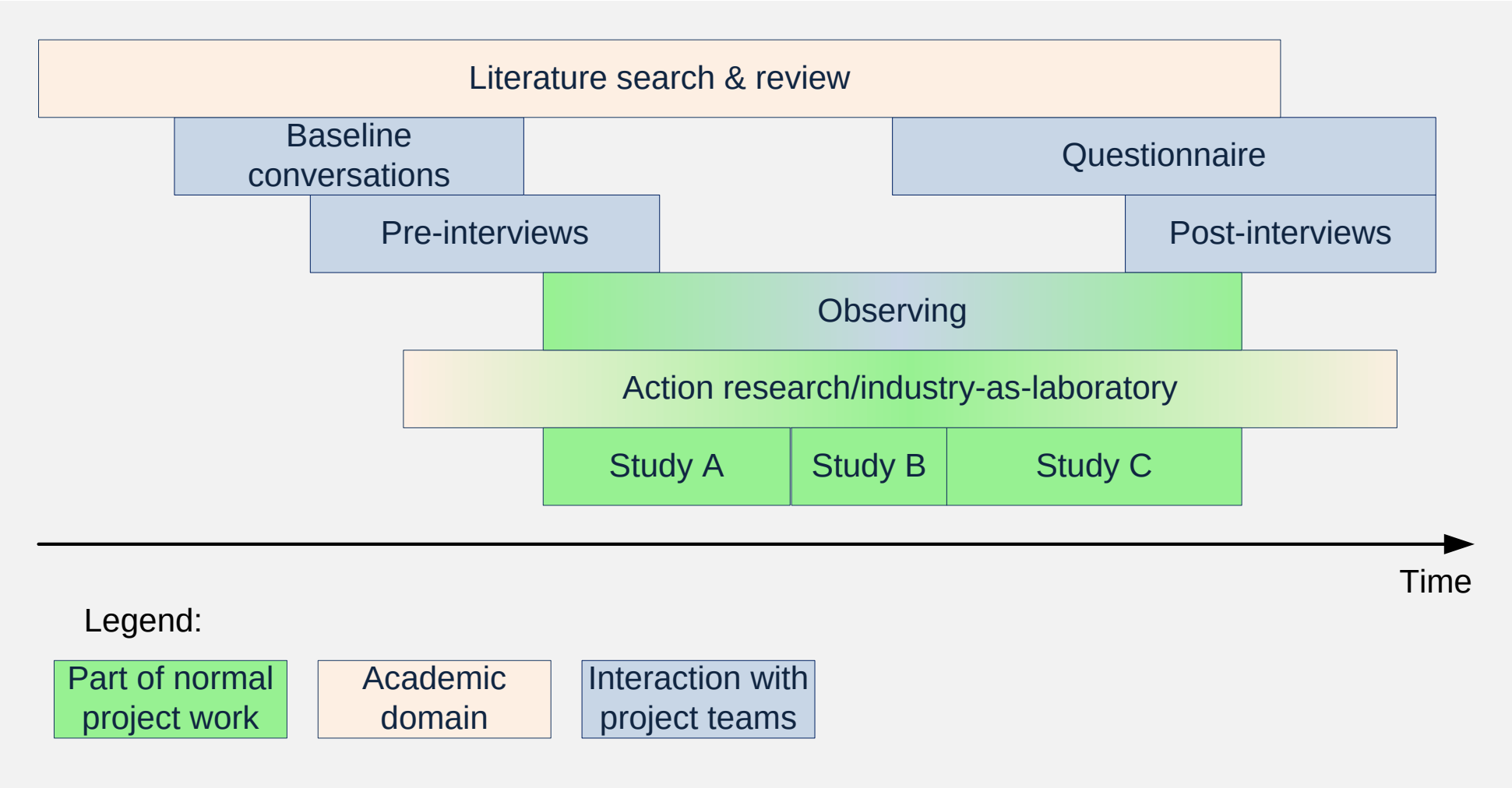
"Concept Selection - Applying Pugh Matrices in the Subsea Processing Domain"

for INCOSE 2014 in Las Vegas

available at http://gaudisite.nl/
INCOSE2014_Lonmo_Muller_ConceptSelection.pdf

The following slide shows the visualization of the research methodology by Linda Lønmo.

Example Research Methodology by Linda



from: "Concept Selection - Applying Pugh Matrices in the Subsea Processing Domain" by Linda Lønmo
INCOSE 2014 in Las Vegas http://gaudisite.nl/INCOSE2014_Lonmo_Muller_ConceptSelection.pdf

Example Research Method

Anders Viken wrote the paper

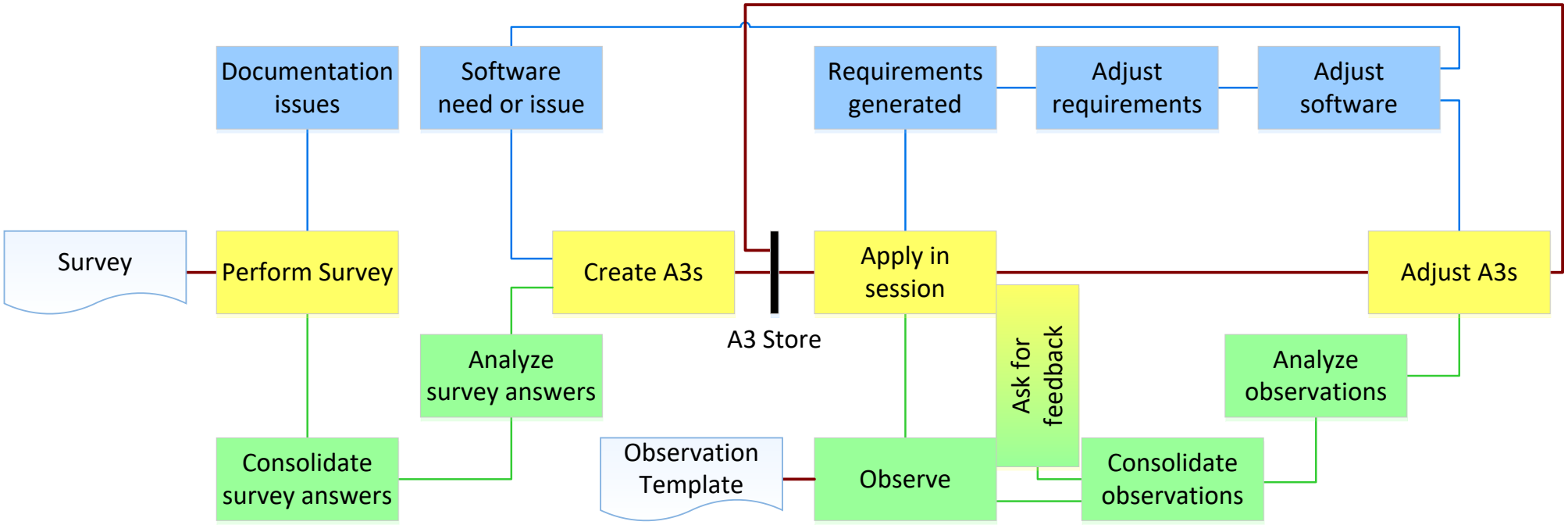
"Creating and Applying A3 Architecture Overviews: A Case Study in Software Development"

for INCOSE 2018 in Washington, DC, USA

available at http://gaudisite.nl/INCOSE2018_Viken_MullerA3.pdf

The following slide shows the visualization of the research methodology by Anders Viken.

Example Research Method by Anders



Example Book Plan that Else Dalby made

Industry Evaluation of a SW Test Framework Implemented at Unit level

- Title + authors - ¼ page
- Abstract - ¼ page
- Introduction - 1 page
  - Introduction to Company
  - Problem statement -> testing is costly and time consuming
  - Introduction to method -> framework with automated testing
  - Introduction to the case -> JUnit test framework
  - Short how the original problem will be solved
  - Short how the method serves the goal
- Current situation and problems - 2 page
  - Explain deeper the reasons why the department is interested in framework + automated testing (1 page)
  - How testing of SW is done in the department today (1 page)
- Research methodology - 1 ¼ page
  - Action research
  - Industry-as-laboratory
  - How I did my research => experiment + interviews + literature
  - How reliable and objective are the results of my research?
- Literature review - 1 page
  - Automated testing framework domain – what has been done?
- Main body - 6 pages
  - JUnit testing framework (*1 ¼ page*)
    - How and what to test with JUnit
    - How and what to test with EasyMock extension
  - Use of a test framework in the department *(3 ¾ pages)*
    - How testing of SW in the department is performed in the experiment *(3/4 page)*
    - Observations and findings *(1 ½ page)*
      - Summary of data collected in the experiment and during interviews
    - Cost and effort *(1 ½ page)*
      - Analysis of data collected – Is the case "JUnit implementation" a success? Best practices, limitations, benefits, drawbacks. (How well is the problem solved?)
  - Use of test frameworks in industry *(1 pages)*
    - Results – Evaluation of the SE method based on analysis of the data collected from the case. (How well does the method fit and serve its goal?)
- Conclusions - 1 ½ pages
  - Repeat: mention that the JUnit test framework can be recommended to the department with some restrictions
  - Repeat and summary from results how well the SE method fits and serves the goal of reducing cost and time of testing
  - Repeat and summary from results about limitations, benefits and drawbacks to the method
  - Reflection (*1/2 page*)
    - Lessons learned
    - Mention of how the research methodology worked out
- Future research - 1/2 page
  - Research to be done next is to find the error reduction rate with use of a test framework versus manual testing
  - Long term research was limited due to time constraints ,therefore it was hard to find data about how much money we can save with automated testing and how much resources the automated test frameworks will cost us to maintain
  - Experiment with implementation of JUnit in more than one unit was limited due to effort and time constraint
- References - 1 page

legend

case
system-of-interest

Body of Knowledge
systems engineering method

research method

Else Dalby's Book plan of
her master project in 2013

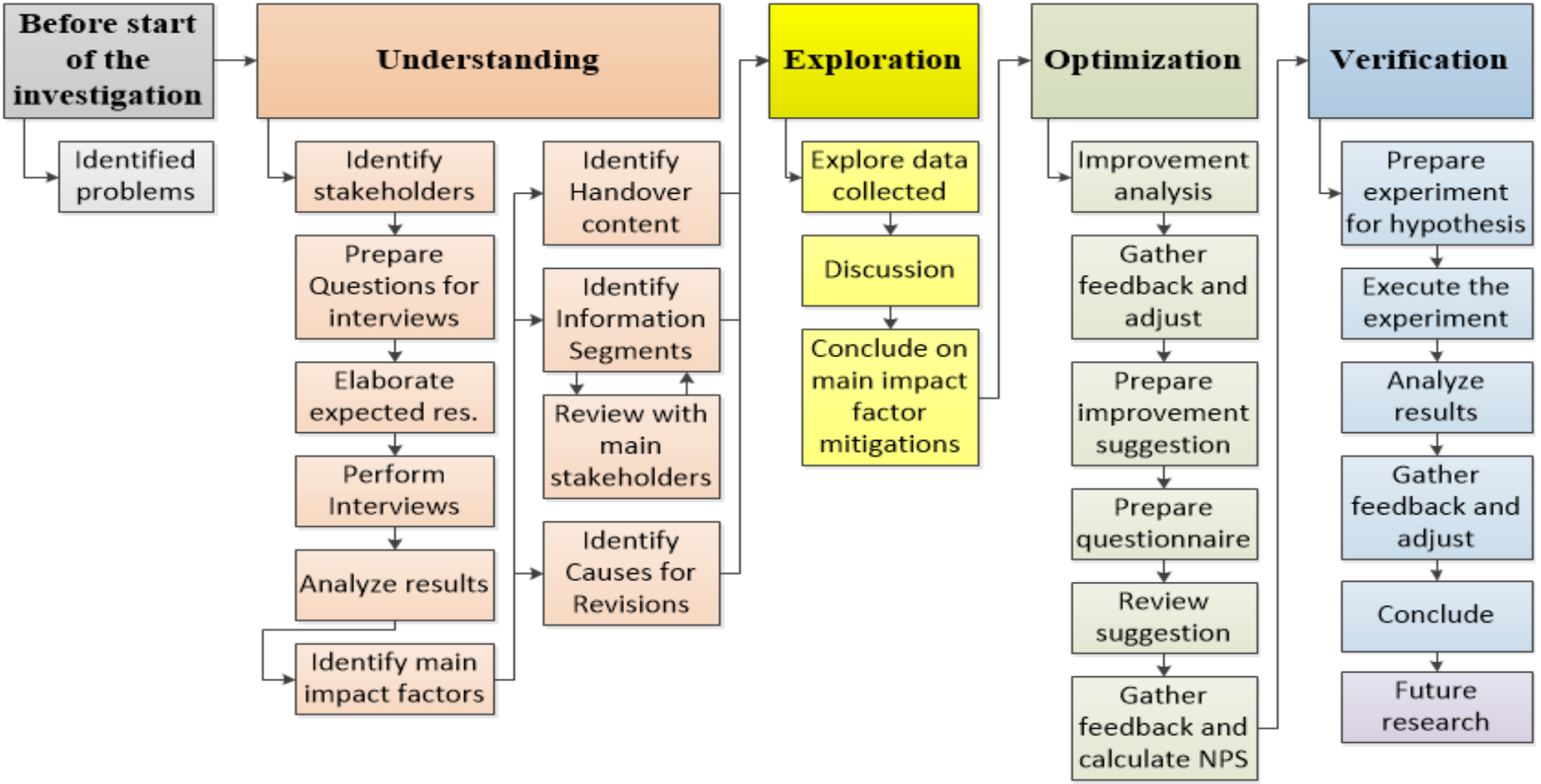
Example Research Design and Verification

Erik Thygesen won the **Best Student Paper Award** at INCOSE 2019 in Orlando with the paper

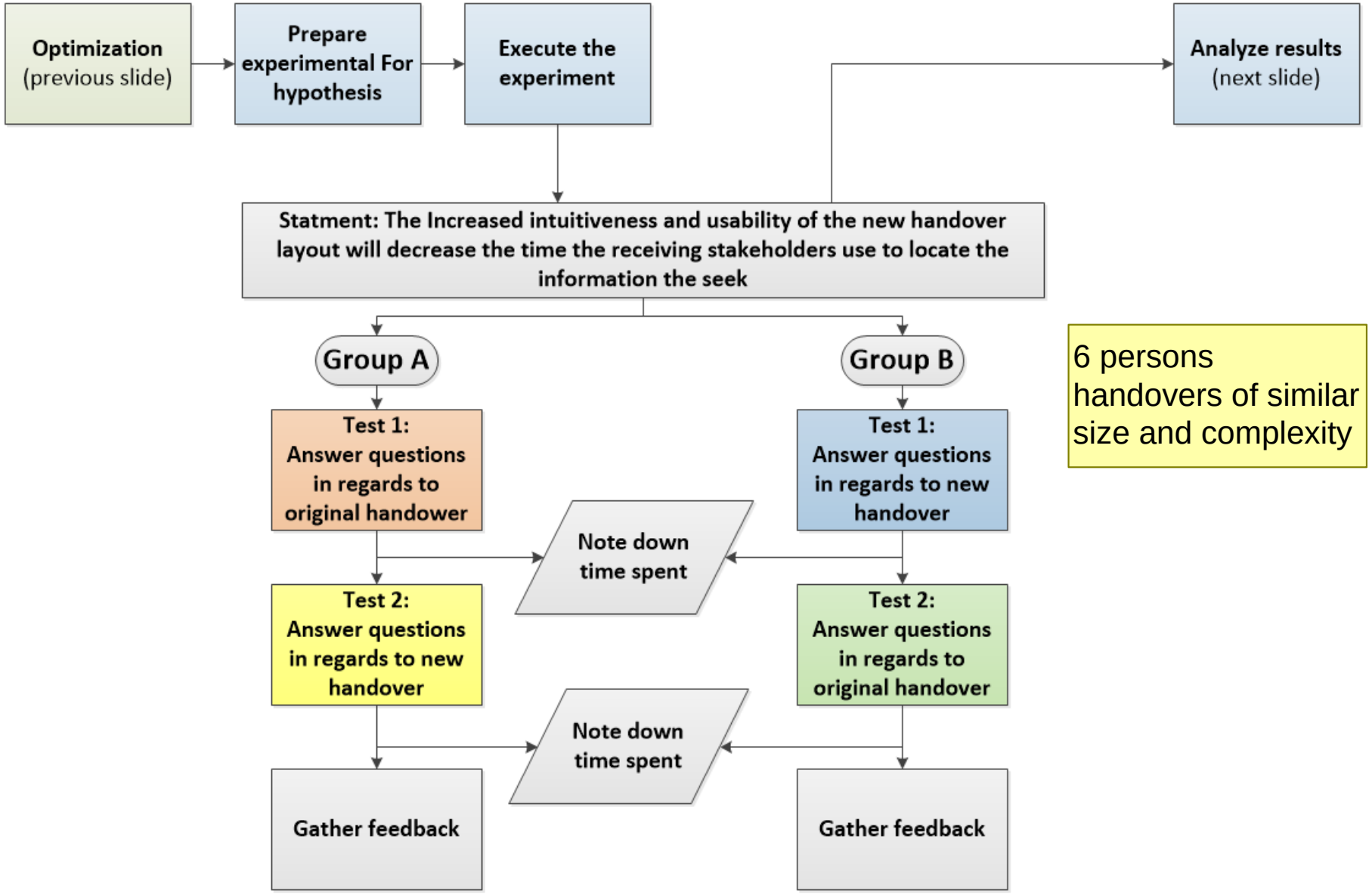
“Improving the information transfer between engineering and installation; case study at AS Nymo”

available at https://gaudisite.nl/
INCOSE2019_ThygesenEtAl_InformationTransferToInstallation.pdf

Example Research Design Erik Thygesen



Example Research Verification Erik Thygesen



6 persons handovers of similar size and complexity