UNIVERSITY OF TWENTE.

Systems Engineering and Academia
INCOSE-NL Network event

20240418

Chair of Systems Engineering and Multidisciplinary Design (SEMD)

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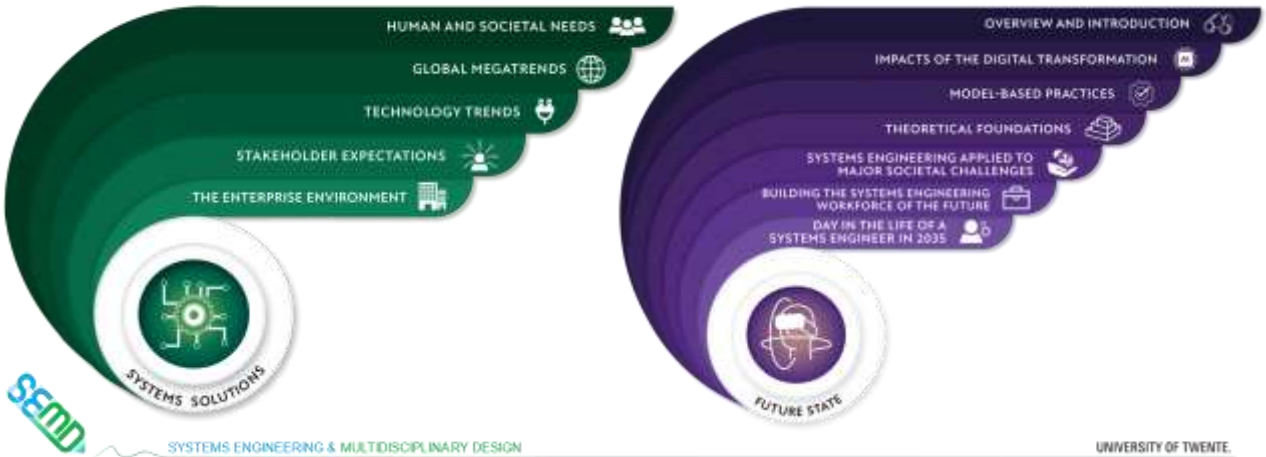
Agenda

- SE vision
- Systems Engineering & Multidisciplinary Design:
  - Research
  - Education
- Systems Engineering Knowledge Centre Twente

- Workshop

(https://sdgs.un.org/2030agenda, 20230630)

INCOSE vision 2035 http://sevisionweb.incose.org/

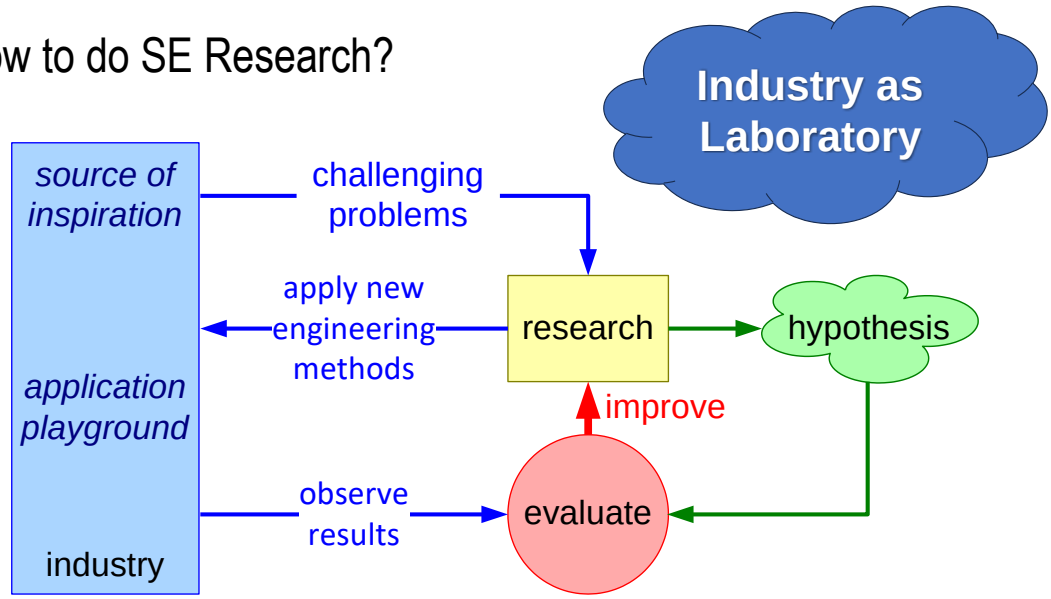


SEMD Aims

1. Make existing Systems Engineers more productive,
2. Make Systems Engineers productive faster,
3. *Produce* more Systems Engineers.

- Research
- Education

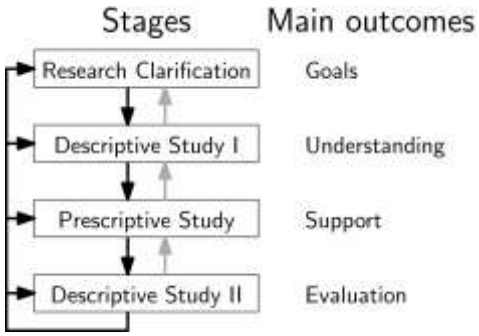
How to do SE Research?



Source: Gerrit Muller's gaudisite.nl, https://gaudisite.nl/figures/IALAindustryAsLaboratory.html

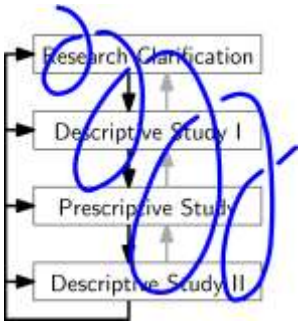
Underlying Methodology

Design Research Methodology



Blessing, L. T. M. and A. Chakrabarti (2009). DRM, a Design Research Methodology, Springer Publishing Company, Incorporated.

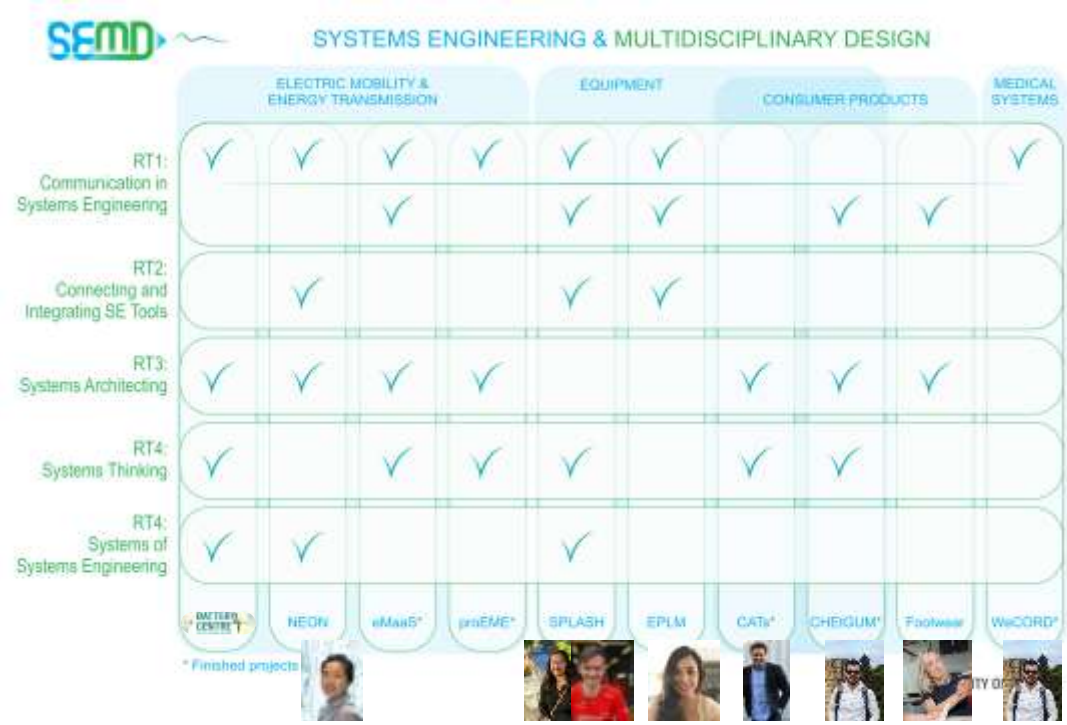
Spiral Approach to SE Research



Bonnema, G. M., M. V. Pereira Pessoa and K. Nizamis (2022). Spiral Approach for SE Research (SASER) - mating research to practice -. CSDM 2022, Paris, Springer.

SEMD Research: our Research Topics (RT)

1. Communication in Multidisciplinary Development
2. Methods and Tools for connecting and integrating (systems) engineering tools
3. Systems Architecting
4. Systems Thinking
5. Systems of Systems Engineering



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BATTERY CENTRE TWENTE — four interdisciplinary pillars

Next Generation Materials and Cells

- Li-based and beyond Li chemistries and cell design
- Understanding material phenomena

Prof. Mark Huijben

Advanced Manufacturing

- Smart and sustainable manufacturing processes, process chains, factories
- Digital twins, automated production

Prof. Sebastian Thiede

Energy Efficient Packs & Systems

- Power electronics design and electromagnetic compatibility
- Cell and module diagnostics for safety, state of health, state of charge

Prof. Thiago Batista Soeiro

Smart Applications & Systems Design

- Designs for maritime, electric aviation, and heavy-duty applications
- Grid stabilization, localized energy hubs
- Business models and 2nd life applications

Prof. Maarten Bonnema

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How do we make progress?

- Student projects
  - Programs Mechanical Engineering, Industrial Design Engineering, Electrical Engineering (and others)
  - Bachelor thesis (~10 weeks)
  - Master thesis (~7 months)
- Examples:
  - Interactivity for A3AOs (Frank Brussel, https://doi.org/10.1016/j.procs.2015.03.046)
  - Tailored A3AO (Daniel 't Hooft, https://doi.org/10.1002/j.2334-5837.2020.00715.x; Rien Kooistra https://research.utwente.nl/en/publications/a3-architecture-overviews-for-systems-of-systems)
- PhD projects
  - Examples:
  - SPLASH with ASML (Jan and Sherly)
  - EPLM2 with Thales (Gisela)
  - Can be facilitated via subsidy
- EngD (more about that later)
- Long term relationships with industry (Thales, ASML, your company)

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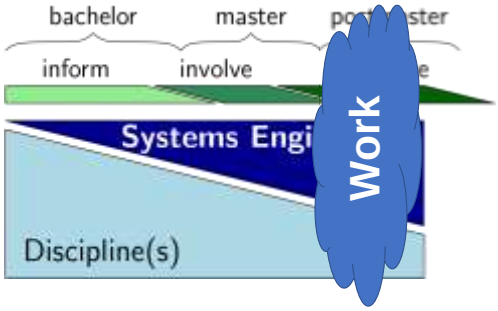
Systems Engineering Education



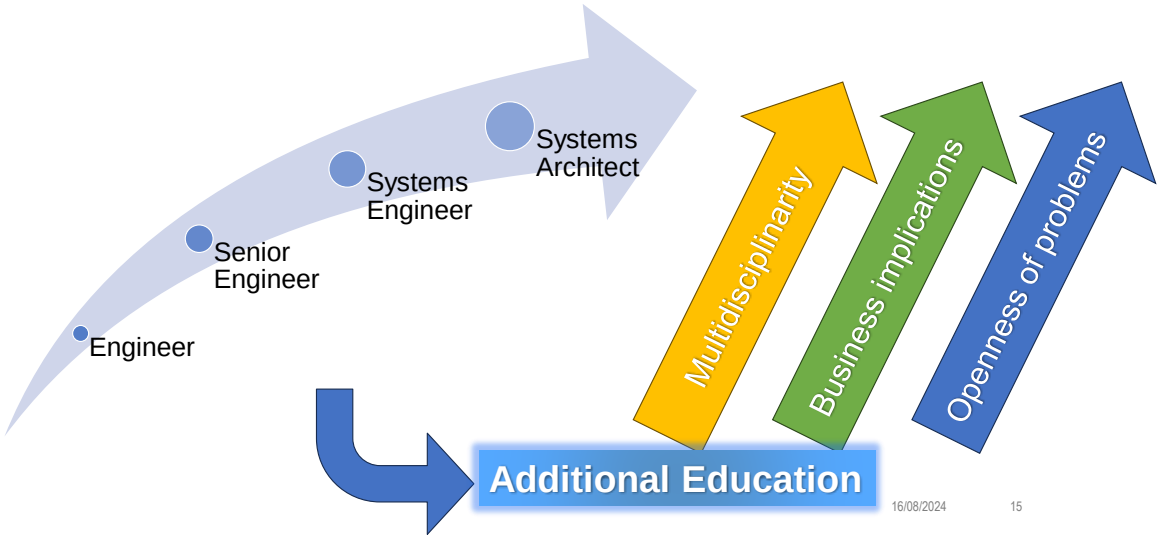
- EngD in Systems Engineering and Architecting
- Engineering Doctorate (EngD)
- SESAM @ASML
- Lifelong Learning (LLL)

Education *within* regular Curricula

- Bachelor
  - Introductory Course on SE
  - Using SDE book
  - For 3rd years EE, ME, IDE
  - Embedded in education for Civil

- Master
  - SE course using SDE book and Faulconbridge
  - Robotics, Embedded Systems, Mechanical Eng., IDE
- Postmaster
  - SDE course on SDE, Value Engineering, Societal Embedding, Requirements Management and more
  - For all UT EngD programmes

TYPICAL DEVELOPMENT OF A SE



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Lifelong Learning

- In-company trainings
- Building on experience with ASML and @UT
- Content:
  - Process
  - Tools
  - Thinking

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Engineering Doctorate (track within existing Robotics EngD)

Overall Learning Goal:

Acquire integrated, innovative, fit-for-purpose competencies (knowledge, skills, methodologies, tools) to design and develop systems as solutions to complex sociotechnical problems and deploy them within organizational architectures by using engineering and management skills.

Engineering Doctorate

- 2 year program (120EC)
- 45-50 EC courses
  - Broadening
  - Deepening
  - Personal Development
- 70-75 EC project
  - Starts at day one
  - Increases in attention over the 2 years
- 2 center courses:
  - Systems Design & Engineering
  - Advanced Architecting

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SYSTEMS ENGINEERING KNOWLEDGE CENTRE TWENTE

www.utwente.nl/sekct

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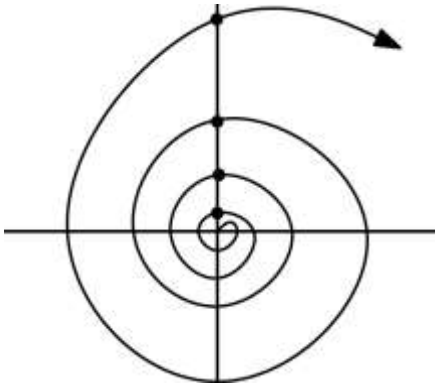
Scale up and expand

SE education and training

Sharing SE knowledge

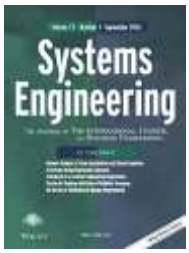
Giving SE advice



Some examples - results of SEKCT research

Practical evidence-based tools

e.g. SE toolbox for Civil Engineering Industry and A3AO



Scientific publications

e.g. in Systems Engineering

Books for wider audience, education & training

e.g. Maarten / Robin

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