Abstract

This module shows a framework for shaping and executing applied research, and offers guidelines for the various steps.
This course is a joint development of

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Applied Research Framework

- shape line-of-reasoning
  - problem-goal-solution-rationale
  - research questions

- explore literature
  - search, select, read, and use literature
  - define state-of-the-art

- determine the research design
  - what research method, how to collect and analyse the data, consider validity

- execute the research project
  - continuously keeping notes

- consolidate and conclude
  - language and style, structure, academic mores, how to discuss and conclude

iterate!
Line of Reasoning

symptoms → problem → goal

rationale

alternative solutions → solution

research questions
Multiple Levels of Academic Abstraction

meta$^0$

*bottom line:* system-of-interest

- work over system
- missile
- production line
- turbine package
- control system
- tie-in system

meta$^1$

*enabling:* systems engineering methods

- stakeholders and concerns
- ConOps
- operational needs
- need statement
- needs into requirements
- SMART requirements
- concept selection
- partitioning and interfaces
- documenting the architecture
- knowledge management
- conceptual modeling
- budget based design
- integration and verification plan
- design of qualification program

meta$^2$

*academic:* research of methods

- measuring
- experimenting
- modeling
- surveys
- interviews
- refering to literature
- argumenting
Industrial versus Academic Perspective

meta\(^0\)

*bottom line:* system-of-interest

meta\(^1\)

*enabling:* systems engineering methods

meta\(^2\)

*academic:* research of methods

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industrial goal

means

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test field

academic goal

academic means
Research Context

- People applying methods and techniques to develop process supported by stakeholders delivered to artifacts.
  - Artifacts describe concepts and patterns used to develop a system of interest.
  - System of interest concerns objectives.

Diagram:
- People applying methods and techniques to develop a process supported by stakeholders.
  - Artifacts produced.
  - Artifacts described to stakeholders.
  - Artifacts deliver concepts and patterns used to develop a system of interest.
  - System of interest concerns objectives.

Systems Engineering Course Research Methods; Framework
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SERMcontext
Some Terminology

Formalisms languages/syntax: for example, differential equations, timed or hybrid automata, finite state machines, et cetera

Models instantations of formalisms to understand, explore, optimize or verify specification or design

Techniques to get the required information from models: e.g. performance

Methods to provide guidelines how to use formalisms, create models, use techniques and apply tools

Tools to support efficient application of formalisms, techniques and methods