IAF0320

Computer Systems Engineering

Concept Exploration

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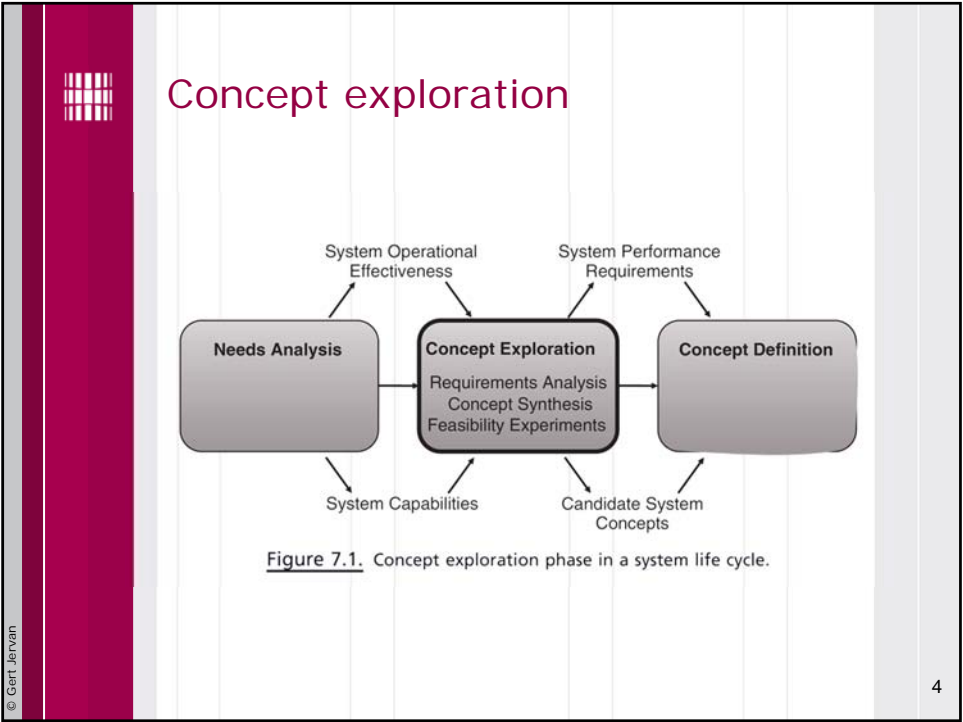Tallinn University of Technology
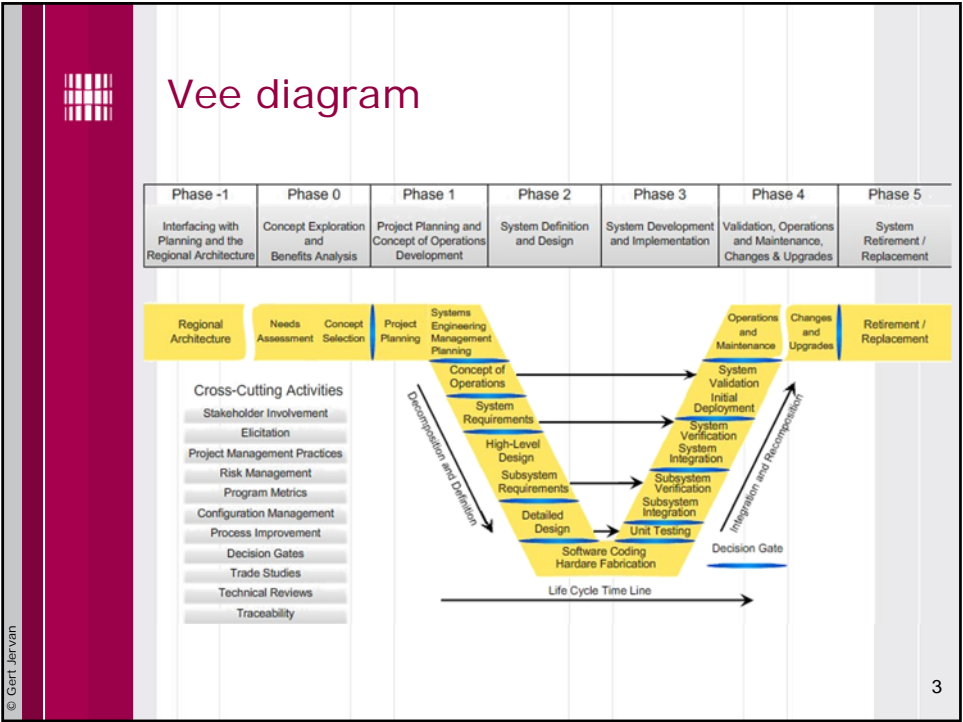
Plan for the lecture

- Concept stage

- Concept exploration and benefits analysis

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Vee diagram

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Concept exploration

Figure 7.1. Concept exploration phase in a system life cycle.

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Concept stage

- The Concept Stage is executed to assess new business opportunities and to develop preliminary system requirements and a feasible design solution

- In-depth studies that evaluate multiple candidate concepts and eventually provide a **substantiated** justification for the system concept that is selected

- Mockups may be built or coded, engineering models and simulations may be executed and prototypes of critical components may be built and tested

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Concept stage

- Early validation efforts align requirements with stakeholder expectations.
- Many projects are driven by eager project champions who want "to get on with it."

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System Materialization

TABLE 6.1. Status of System Materialization at the Needs Analysis Phase

		Phase				
		Concept development		Engineering development		
Level	Needs analysis	Concept exploration	Concept definition	Advanced development	Engineering design	Integration and evaluation
System	Define system capabilities and effectiveness	Identify, explore, and synthesize concepts	Define selected concept with specifications	Validate concept		Test and evaluate
Subsystem		Define requirements and ensure feasibility	Define functional and physical architecture	Validate subsystems		Integrate and test
Component			Allocate functions to components	Define specifications	Design and test	Integrate and test
Subcomponent		Visualize		Allocate functions to subcomponents	Design	
Part				Make or buy		

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Process activities

- Define vision
  - Write one paragraph describing in non-technical terms what the system will do. The idea is to allow lots of stakeholders to review it quickly.
- Define goals and objectives
  - Describe what the potential project should accomplish from the point of view of different stakeholders.
- Identity constraints
  - The constraints come from the operational environment and inputs from the stakeholders (Needs Assessment). They will be used to determine feasibility. Constraints may include technical, organizational, funding, schedule, legal, and other considerations.

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Process activities

- Define evaluation criteria
  - Evaluation criteria derive from the goals and objectives, and are the measures of effectiveness used to compare alternatives. Examples are ease-of-use of the user interface, system start-up time and similar.
- Identify candidate solutions
  - Create a toolkit of technologies and procedures that may help meet the goals.
- Identify alternative concepts
  - Build project concepts from the candidate solutions. Consider several alternative system concepts that have a wide range of capabilities. Initially, keep these alternatives at a high level for comparison purposes.
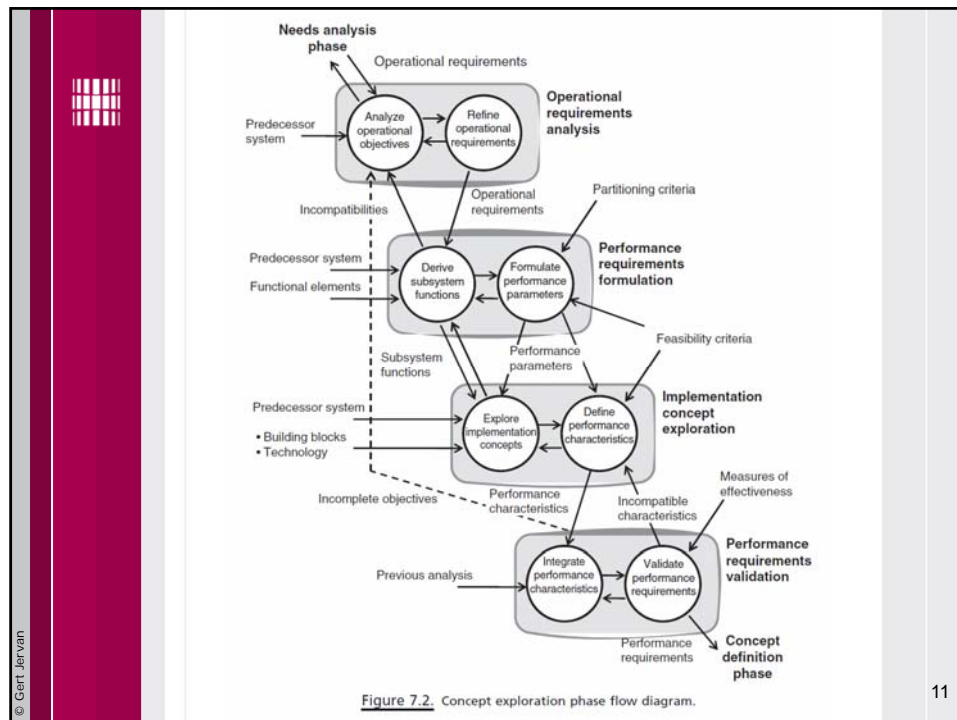
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Process activities

- Evaluate alternatives
  - Evaluate benefits, cost, and gaps then compare these alternatives.
- Document results
  - Document conclusions and rationale in a report.

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Figure 7.2. Concept exploration phase flow diagram.

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Concept exploration

- Operational Requirements Analysis (Requirements Analysis). Typical activities include:
  - analyzing the stated operational requirements in terms of their objectives;
  - restating or amplifying, as required, to provide specificity, independence, and consistency among different objectives, to assure compatibility with other related systems, and to provide such other information as may be needed for completeness.

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Concept exploration

- Performance Requirements Formulation (Functional Definition). Typical activities include:
  - translating operational requirements into system and subsystem functions
  - formulating the performance parameters required to meet the stated operational requirements.

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Concept exploration

- Implementation Concept Exploration (Physical Definition). Typical activities include:
  - exploring a range of feasible implementation technologies and concepts offering a variety of potentially advantageous options,
  - developing functional descriptions and identifying the associated system components for the most promising cases, and
  - defining a necessary and sufficient set of performance characteristics reflecting the functions essential to meeting the system's operational requirements.

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Concept exploration

- Performance Requirements Validation (Design Validation). Typical activities include:
  - conducting effectiveness analyses to define a set of performance requirements that accommodate the full range of desirable system concepts
  - validating the conformity of these requirements with the stated operational objectives and refining the requirements if necessary
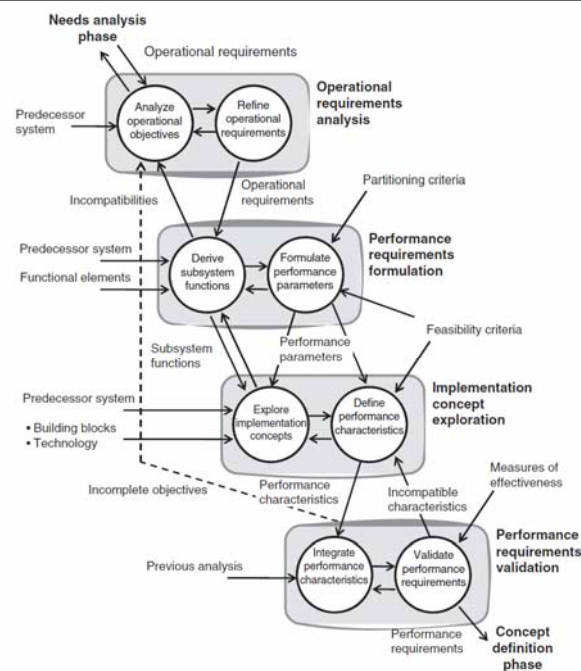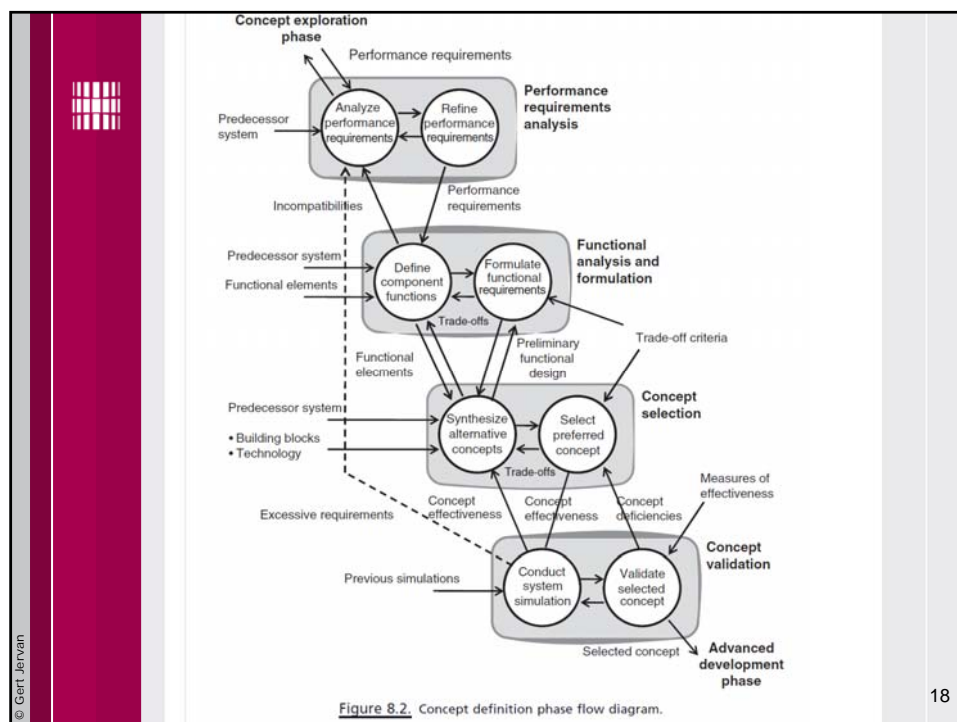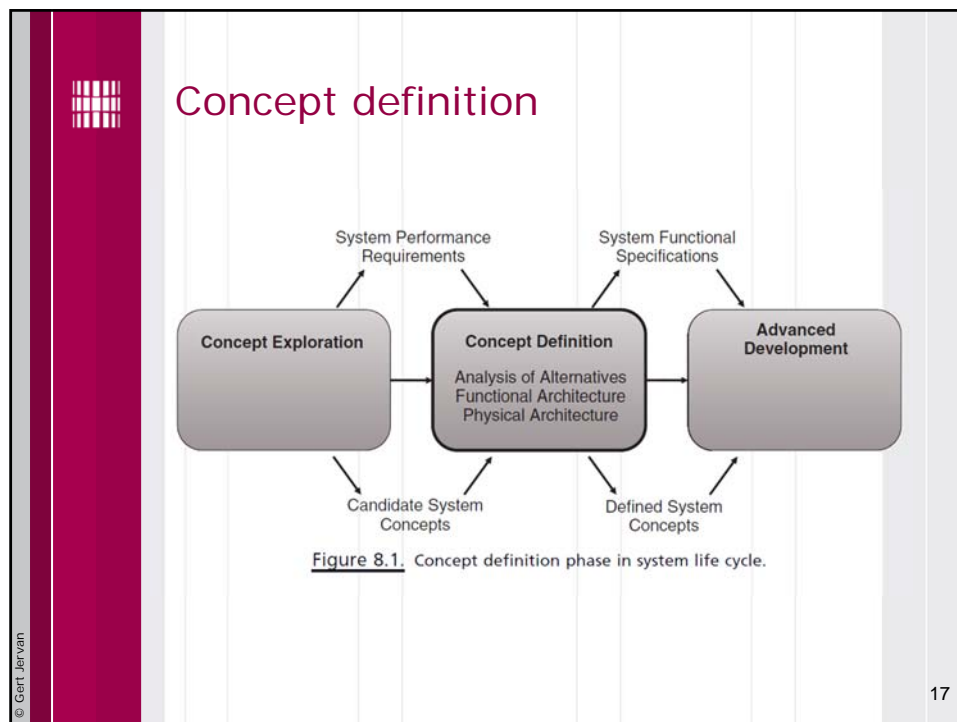
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Figure 7.2. Concept exploration phase flow diagram.

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Figure 8.1. Concept definition phase in system life cycle.

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Figure 8.2. Concept definition phase flow diagram.

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Concept definition

- Performance Requirements Analysis (Requirement Analysis). Typical activities include:
  - analyzing the system performance requirements and relating them to operational objectives and to the entire life cycle scenario
  - refining the requirements as necessary to include unstated constraints and quantifying qualitative requirements where possible.

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Concept definition

- Functional Analysis and Formulation (Functional Definition). Typical activities include:
  - allocating subsystem functions to the component level in terms of system functional elements and defining element interactions
  - developing functional architectural products
  - formulating preliminary functional requirements corresponding to the assigned functions.

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Concept definition

- Concept Selection (Physical Definition). Typical activities include
  - synthesizing alternative technological approaches and component configurations designed to performance requirements
  - developing physical architectural products
  - conducting trade - off studies among performance, risk, cost, and schedule to select the preferred system concept, defined in terms of components and architectures.
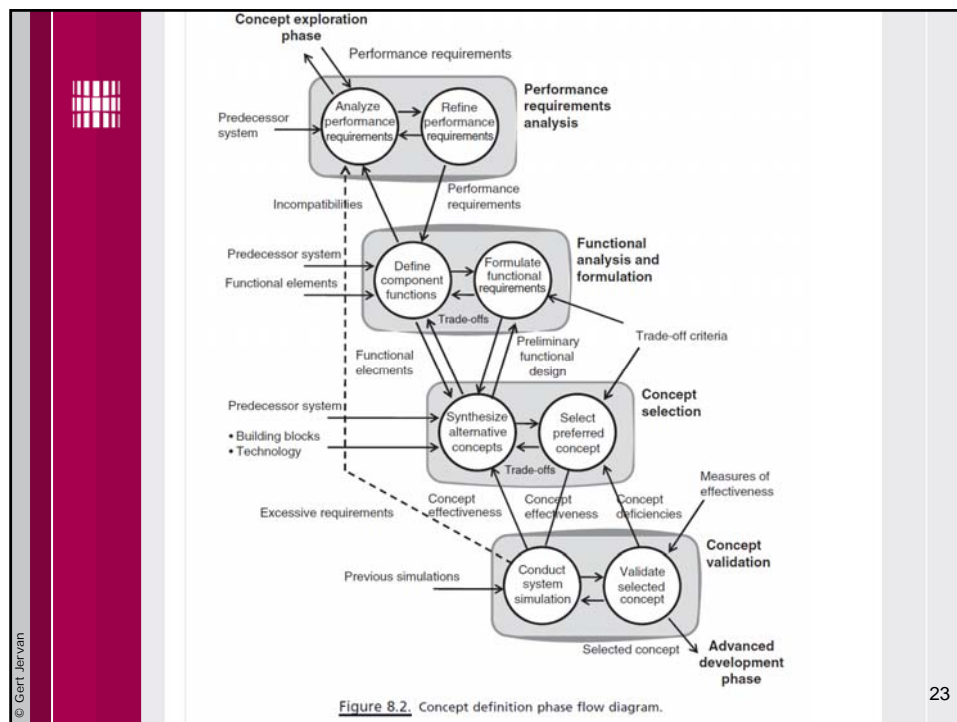
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Concept definition

- Concept Validation (Design Validation). Typical activities include:
  - conducting system analyses and simulations to confirm that the selected concept meets requirements and is superior to its competitors
  - refining the concept as may be necessary.

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Figure 8.2. Concept definition phase flow diagram.

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Developing alternative concepts

- Comes by synthesizing the candidate solutions into complete systems that work together to meet some of the needs. Be sure the list includes a broad range of approaches. The following are some possible classes of alternative analysis:
  - **Do nothing** This is one comparison case, the choice of just leaving everything as is. A business case needs to be developed that the project will generate benefit commensurate with its costs
  - **Do everything** This is the high-end system
  - **Simple and cheap** This is the cost-conscious system, possibly an evolutionary step toward a later "do everything" system
  - **Single need Focus** on the one most essential need
  - **Centralized** Operate from a central point
  - **Distributed** Operate from local points that co-ordinate
  - **Procedural** Solve the problem without technology e.g., regulatory

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Checklist: Are all the bases covered?

- Is there a validated statement of vision, goals, and objectives?
- Have constraints been collected from all key stakeholders?
- Has the evaluation criteria in comparing alternatives been selected, validated, and documented?
- Is there a comprehensive list of candidate solutions, both technical and procedural?
- Is there a comprehensive and varied list of alternative concepts?
- Is the "Do Nothing" case one of the alternatives?
- Has the comparison approach been documented and validated?
- Has the selected concept, and the rationale for its selection, been documented; and has it been reviewed by the stakeholders?
- Does the documentation satisfy relevant reporting standards, if any, for example, for a Feasibility Study Report if required by the state?
- Do the conclusions and recommendations flow in a clear and defensible manner from the needs, alternatives selection, and analysis?

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Outcomes

- Comprehensive document covering all different stages of your project (the work done so far, incl. concept exploration and concept definition phases)

- One presentation from each team (15-20 minutes)

- A short test (based on the presented reading material and lectures)

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Questions?

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