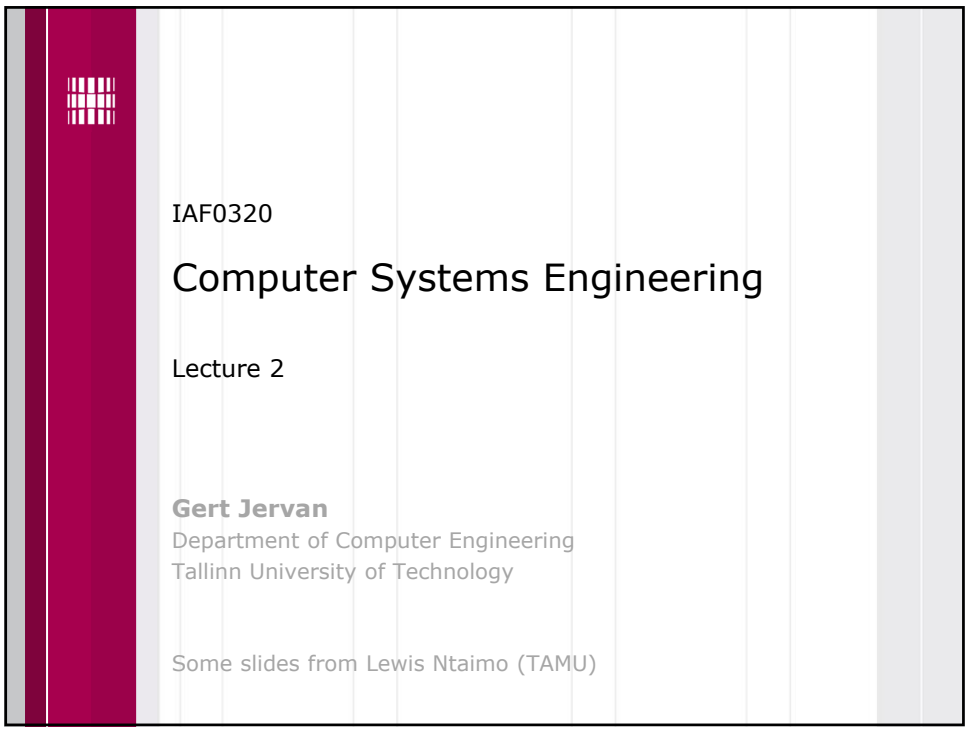

IAF0320

Computer Systems Engineering

Lecture 2

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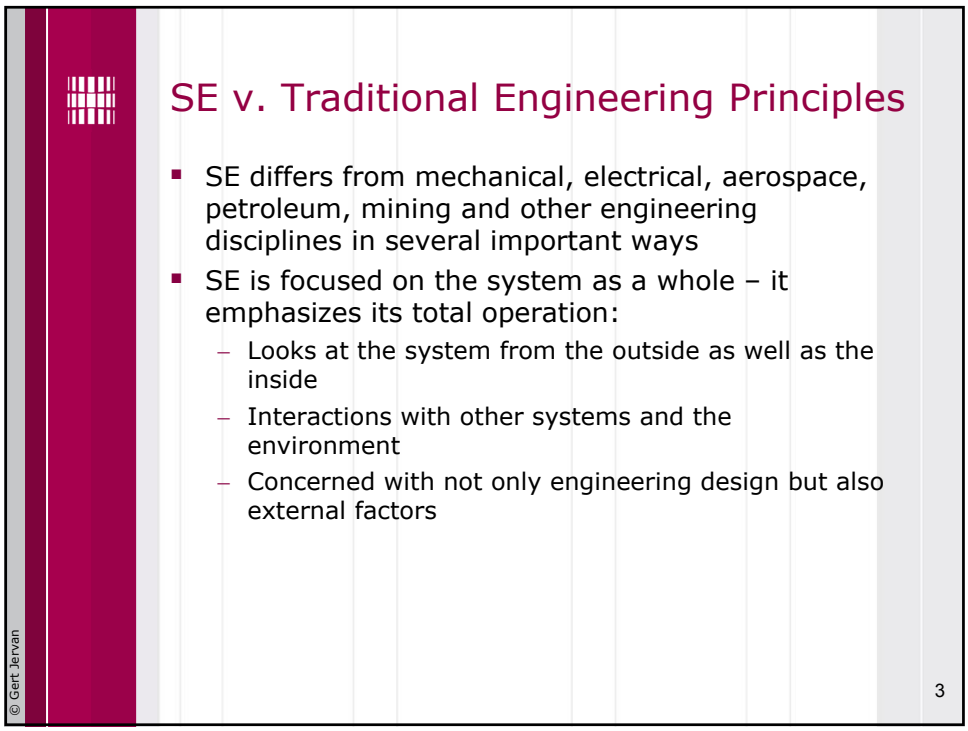
Some slides from Lewis Ntaimo (TAMU)



SE v. Traditional Engineering Principles

- SE differs from mechanical, electrical, aerospace, petroleum, mining and other engineering disciplines in several important ways
- SE is focused on the system as a whole – it emphasizes its total operation:
  - Looks at the system from the outside as well as the inside
  - Interactions with other systems and the environment
  - Concerned with not only engineering design but also external factors

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SE v. Traditional Engineering Principles

- Even though the primary purpose of SE is to guide, systems engineers play a key role in system design
  - Leading the formative (concept development) stage thru to functional design of the system reflecting the users needs
- SE bridges the traditional engineering disciplines
  - Diversity of the elements in a complex system requires different engineering disciplines in their design and development
- SE is an inherent part of project management
  - the part that is concerned with the engineering effort itself, setting its objectives, guiding its execution, evaluating the results, and prescribing necessary corrective actions to keep it on course

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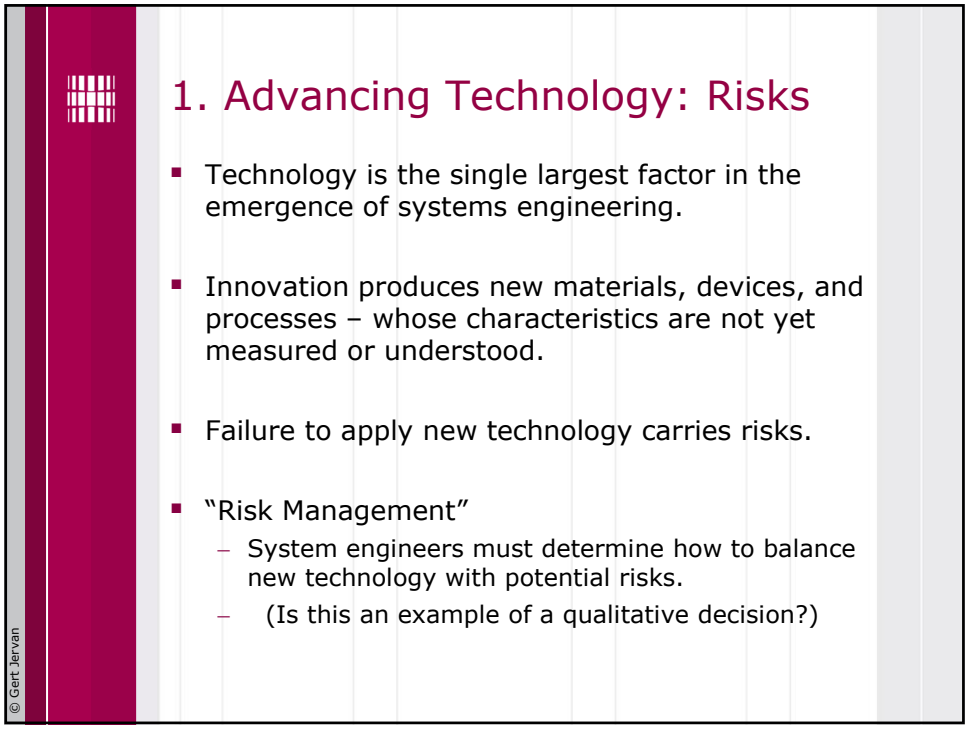
The relation of modern systems engineering to its origins is summarized in three factors:

- Advancing technology
- Competition
- Specialization


1. Advancing Technology: Risks
Technology is the single largest factor in the emergence of systems engineering.
Innovation produces new materials, devices, and processes – whose characteristics are not yet measured or understood.
Failure to apply new technology carries risks.
"Risk Management"
System engineers must determine how to balance new technology with potential risks.
(Is this an example of a qualitative decision?)
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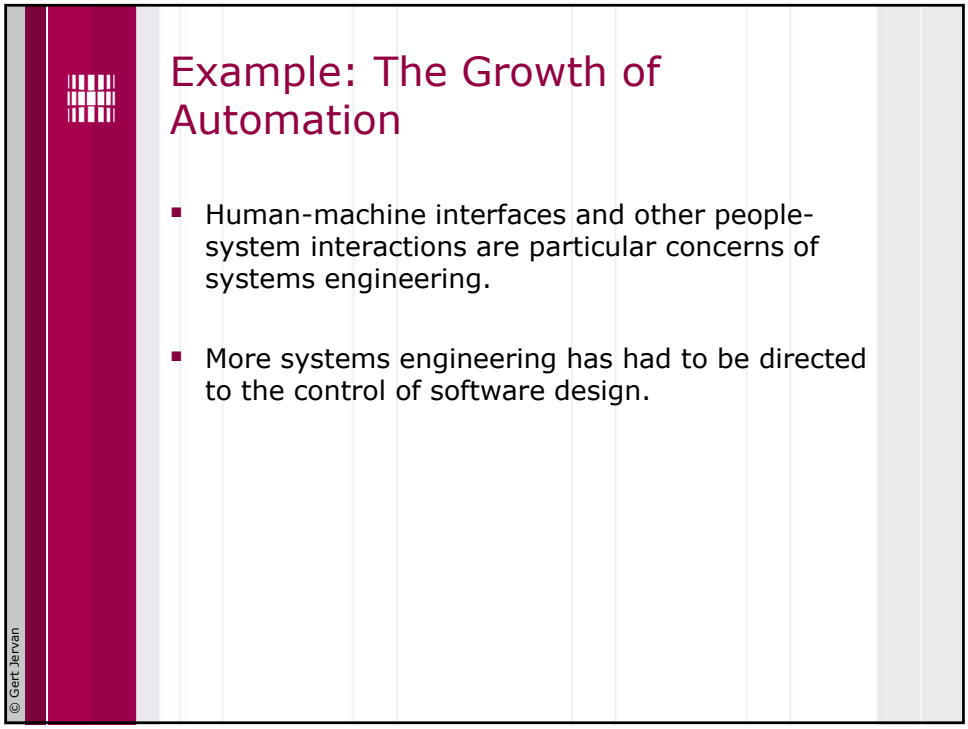
Example: The Growth of Automation
Human-machine interfaces and other people-system interactions are particular concerns of systems engineering.
More systems engineering has had to be directed to the control of software design.
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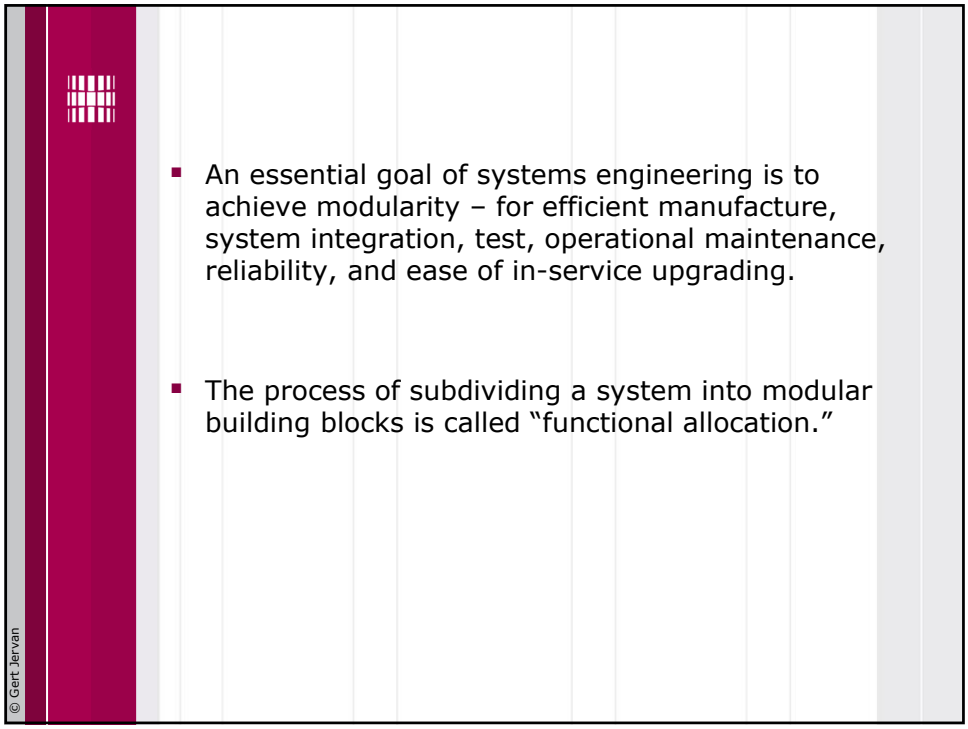
2. Competition: Trade-offs

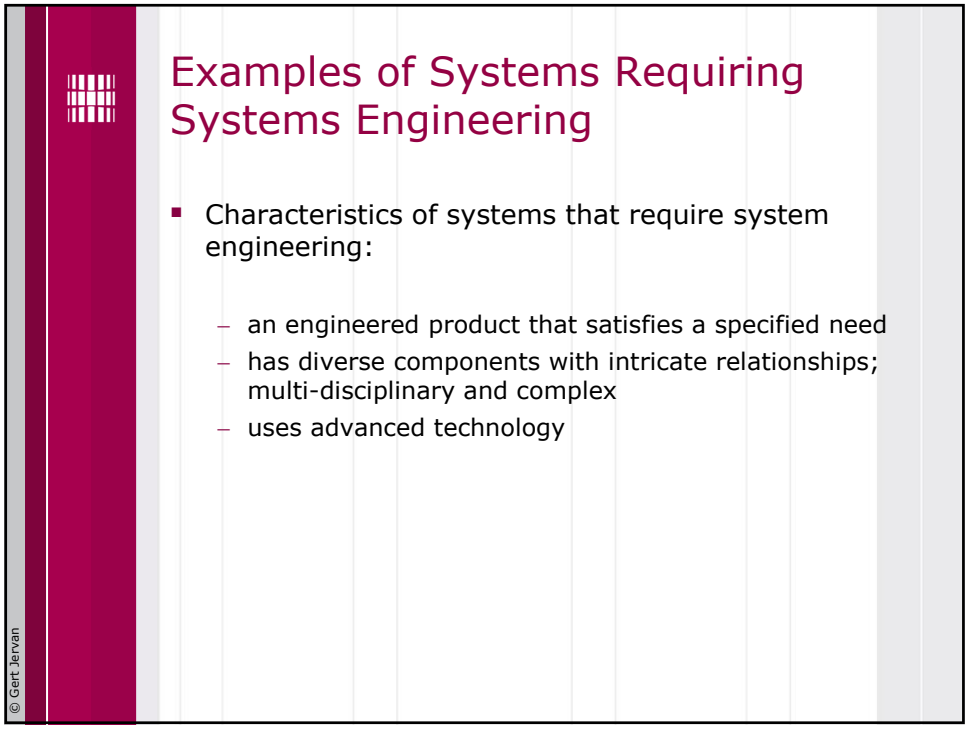
- military capabilities
- competitive contracting – new system capabilities
- Commercial products always have competition.
- "phased approach" - used in new system development.
- essential characteristics: performance, cost and schedule.
- "trade-off" analysis

3. Specialization: Interfaces

- high quality; low cost
- engineering specialization – a basic condition in the system development process
- Physical fit is accomplished at inter-component boundaries, called interfaces.
- Functional relationships are called interactions.

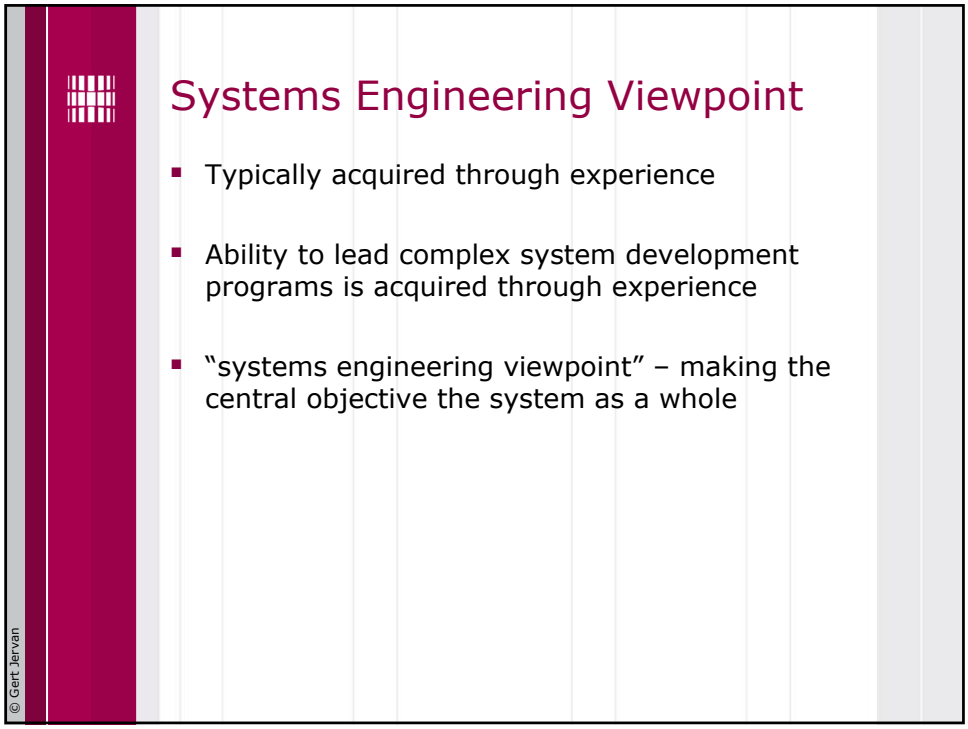


- An essential goal of systems engineering is to achieve modularity – for efficient manufacture, system integration, test, operational maintenance, reliability, and ease of in-service upgrading.
- The process of subdividing a system into modular building blocks is called "functional allocation."



Examples of Systems Requiring Systems Engineering

- Characteristics of systems that require system engineering:
  - an engineered product that satisfies a specified need
  - has diverse components with intricate relationships; multi-disciplinary and complex
  - uses advanced technology


Systems Engineering Viewpoint
Typically acquired through experience
Ability to lead complex system development programs is acquired through experience
"systems engineering viewpoint" – making the central objective the system as a whole
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A Successful System
Success of a system:
meets requirements and development objectives
successful operation in the field
has a long, useful operating life
Innovation
Select the most promising technological approaches.
Combine risk-taking and risk-mitigation.
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SE Point of View

- Makes the central objective the system as a whole and the success of its mission
- Takes a "big picture" or holistic, or gestalt, view of large-scale problems and their proposed technological solutions
- A Balanced system:

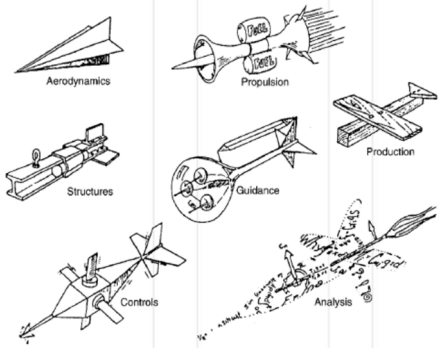

Fig. 1-2 The ideal missile design from the viewpoint of various specialists.

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SE Point of View: The "Best" System

- "The best is the name of the good"
- "SE is the art of the good enough"
  - SE seeks the "best" possible system, which often is not the one that provides the best performance
  - SE views performance as only one of several critical attributes: affordability, timely availability to the user, ease of maintenance, adherence to an agreed-upon development schedule, …
- The Systems Engineer seeks the "best balance" of the critical attributes

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Law of Diminishing Returns

Performance of a System as a Function of the Cost of the Expended Development Effort

Really one-dimension?

Slope: a measure of price vs. performance

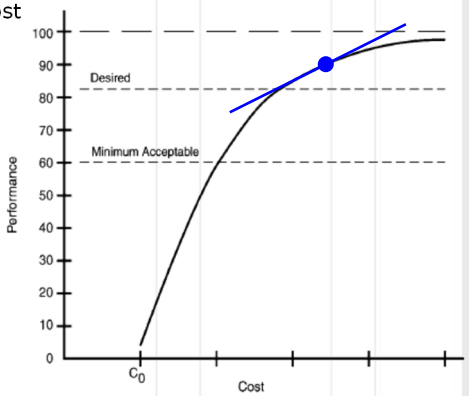

Fig. 1-1a Performance vs. cost.

The performance-to-cost ratio is equivalent to the concept of cost effectiveness.

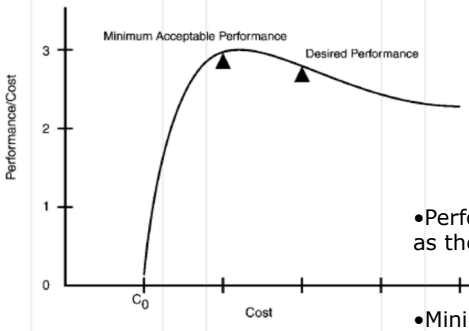

Fig. 1-1b Performance/Cost vs. cost.

- Performance/Cost is the same as the slope from Fig. 1-1a
- Minimum Acceptable Performance – Best?

A Balanced Viewpoint

- Virtually all critical attributes are interdependent.
- Characteristics are typically incommensurable.
- Systems engineers have different skills than design specialists or managers.

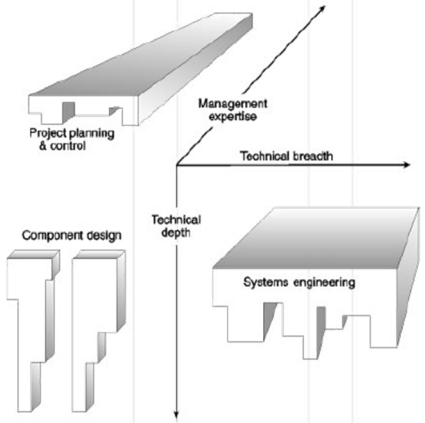

Fig. 1-3 The dimensions of design, systems engineering, and project planning and control.

Teamwork session

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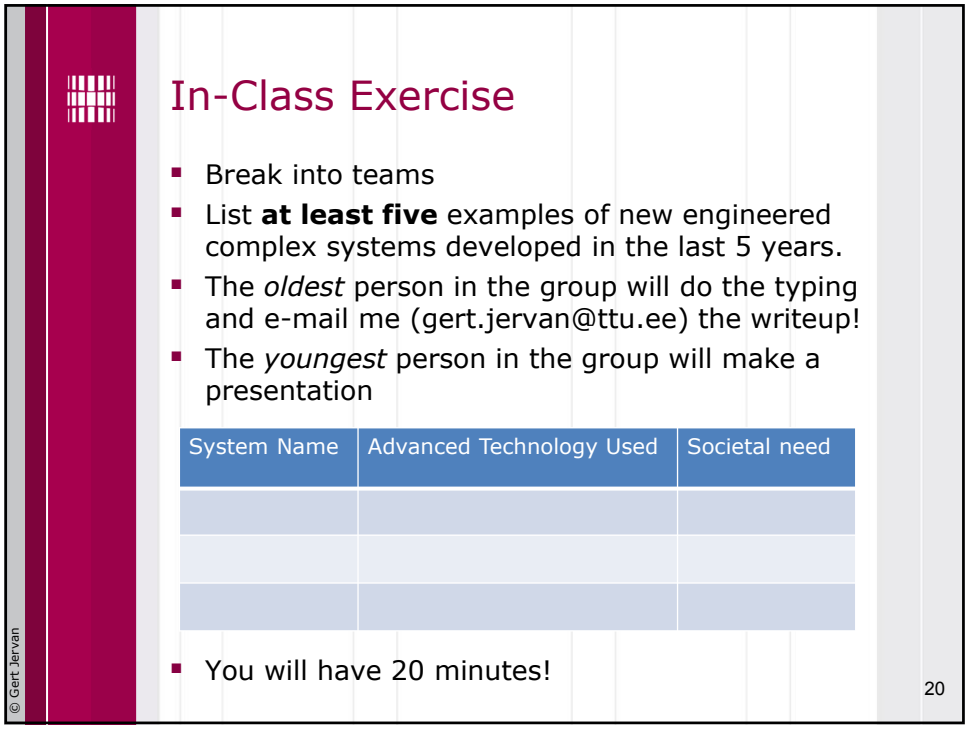

In-Class Exercise

- Break into teams
- List **at least five** examples of new engineered complex systems developed in the last 5 years.
- The *oldest* person in the group will do the typing and e-mail me (gert.jervan@ttu.ee) the writeup!
- The *youngest* person in the group will make a presentation

System Name	Advanced Technology Used	Societal need

- You will have 20 minutes!

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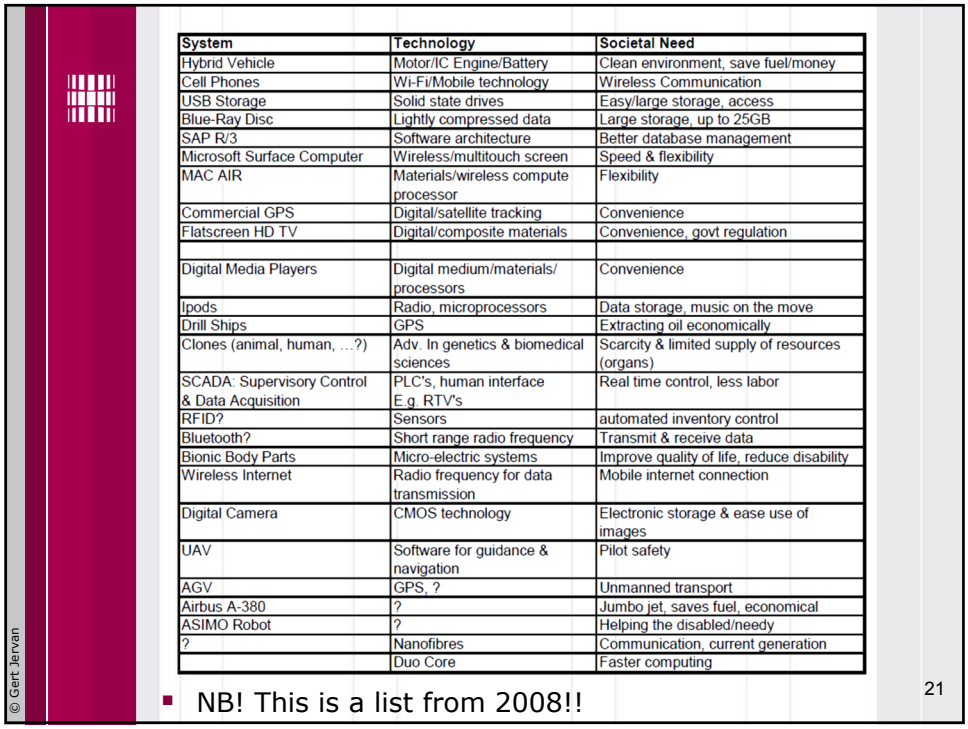

System	Technology	Societal Need
Hybrid Vehicle	Motor/IC Engine/Battery	Clean environment, save fuel/money
Cell Phones	Wi-Fi/Mobile technology	Wireless Communication
USB Storage	Solid state drives	Easy/large storage, access
Blue-Ray Disc	Lightly compressed data	Large storage, up to 25GB
SAP R/3	Software architecture	Better database management
Microsoft Surface Computer	Wireless/multitouch screen	Speed & flexibility
MAC AIR	Materials/wireless compute processor	Flexibility
Commercial GPS	Digital/satellite tracking	Convenience
Flatscreen HD TV	Digital/composite materials	Convenience, govt regulation
Digital Media Players	Digital medium/materials/ processors	Convenience
Ipods	Radio, microprocessors	Data storage, music on the move
Drill Ships	GPS	Extracting oil economically
Clones (animal, human, ...?)	Adv. In genetics & biomedical sciences	Scarcity & limited supply of resources (organs)
SCADA: Supervisory Control & Data Acquisition	PLC's, human interface E.g. RTV's	Real time control, less labor
RFID?	Sensors	automated inventory control
Bluetooth?	Short range radio frequency	Transmit & receive data
Bionic Body Parts	Micro-electric systems	Improve quality of life, reduce disability
Wireless Internet	Radio frequency for data transmission	Mobile internet connection
Digital Camera	CMOS technology	Electronic storage & ease use of images
UAV	Software for guidance & navigation	Pilot safety
AGV	GPS, ?	Unmanned transport
Airbus A-380	?	Jumbo jet, saves fuel, economical
ASIMO Robot	?	Helping the disabled/needy
?	Nanofibres	Communication, current generation
	Duo Core	Faster computing

- NB! This is a list from 2008!!

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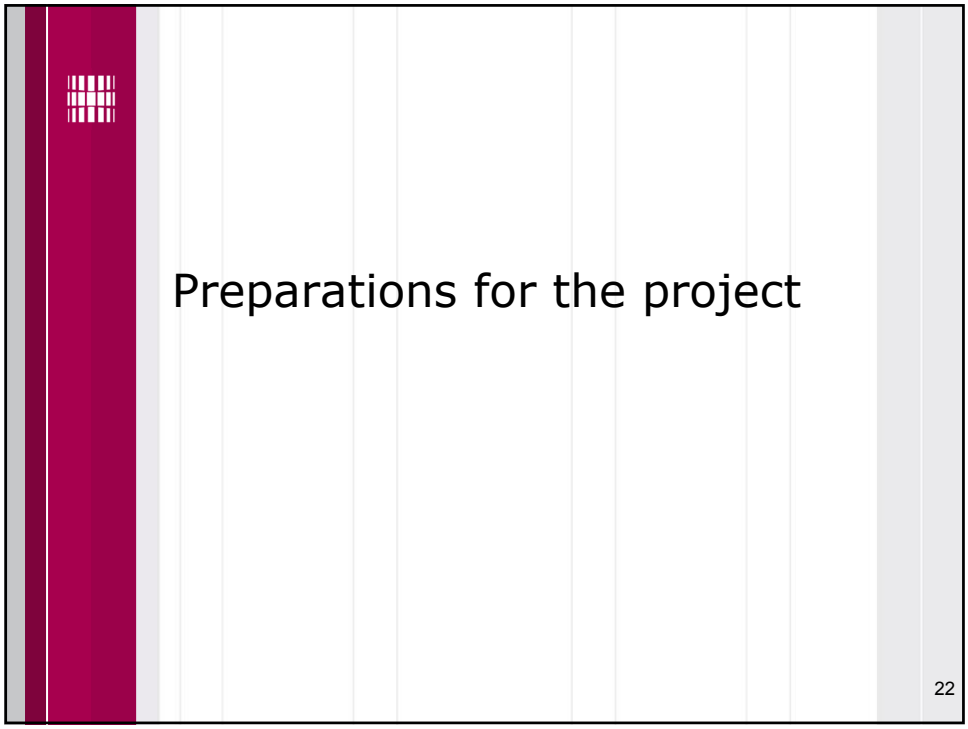
Preparations for the project
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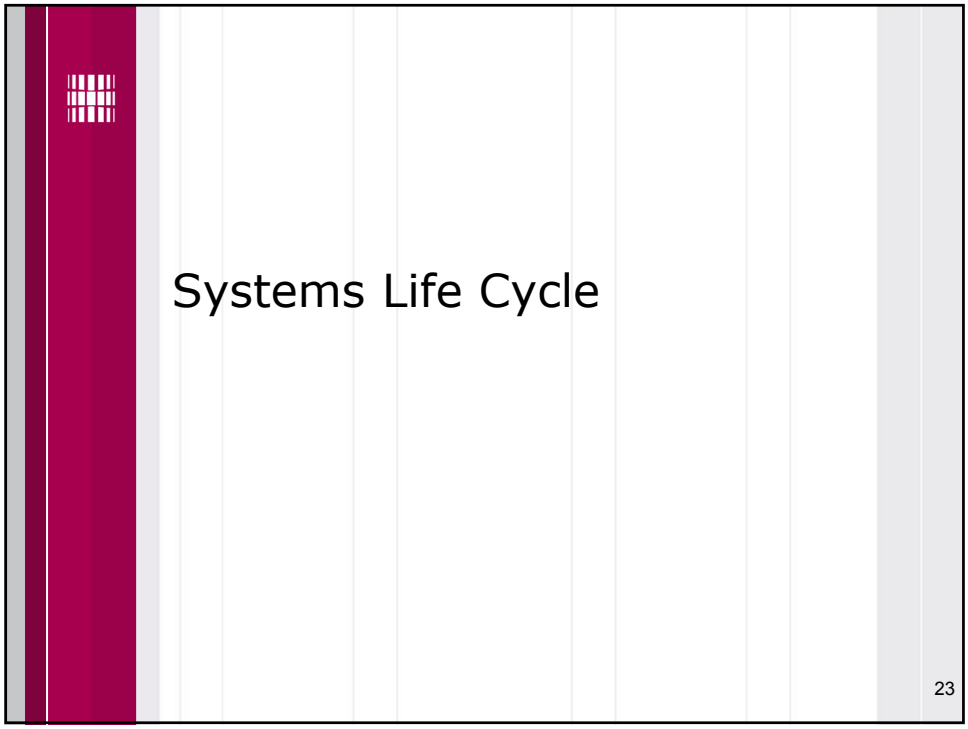
Systems Life Cycle
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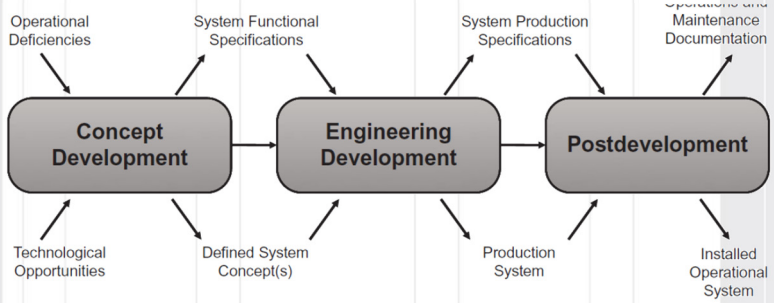
Principal stages in a system life cycle



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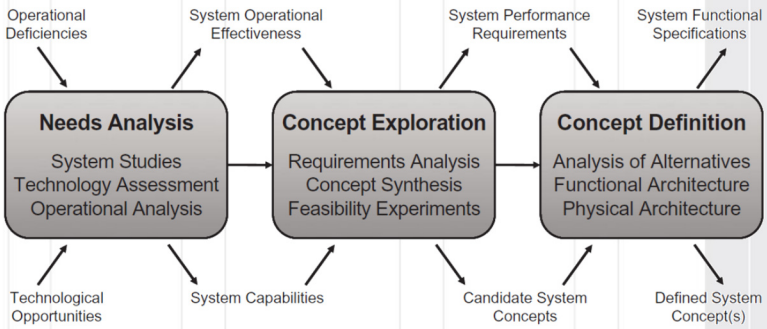
Concept development



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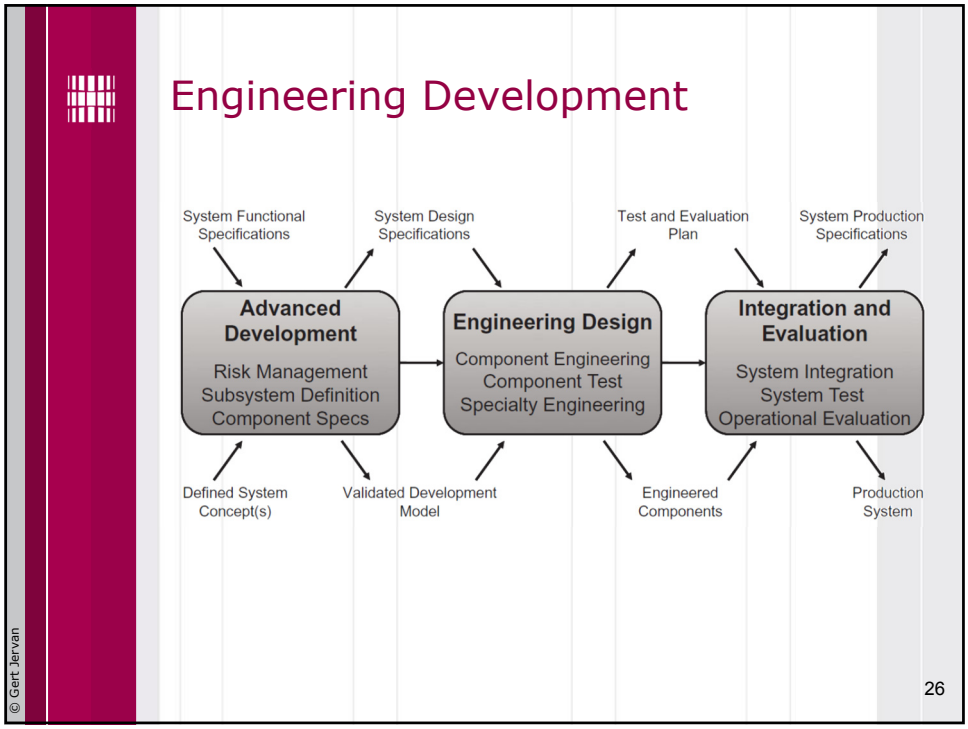
Engineering Development
System Functional Specifications
System Design Specifications
Test and Evaluation Plan
System Production Specifications
Advanced Development
Risk Management
Subsystem Definition
Component Specs
Engineering Design
Component Engineering
Component Test
Specialty Engineering
Integration and Evaluation
System Integration
System Test
Operational Evaluation
Defined System Concept(s)
Validated Development Model
Engineered Components
Production System
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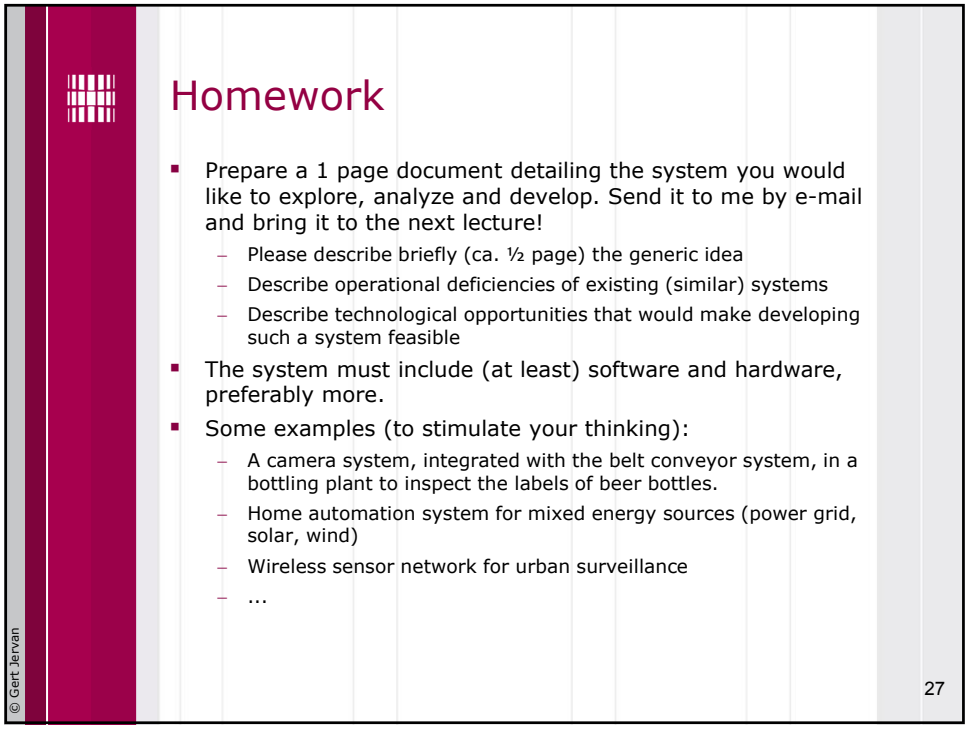
Homework
Prepare a 1 page document detailing the system you would like to explore, analyze and develop. Send it to me by e-mail and bring it to the next lecture!
Please describe briefly (ca. ½ page) the generic idea
Describe operational deficiencies of existing (similar) systems
Describe technological opportunities that would make developing such a system feasible
The system must include (at least) software and hardware, preferably more.
Some examples (to stimulate your thinking):
A camera system, integrated with the belt conveyor system, in a bottling plant to inspect the labels of beer bottles.
Home automation system for mixed energy sources (power grid, solar, wind)
Wireless sensor network for urban surveillance
...
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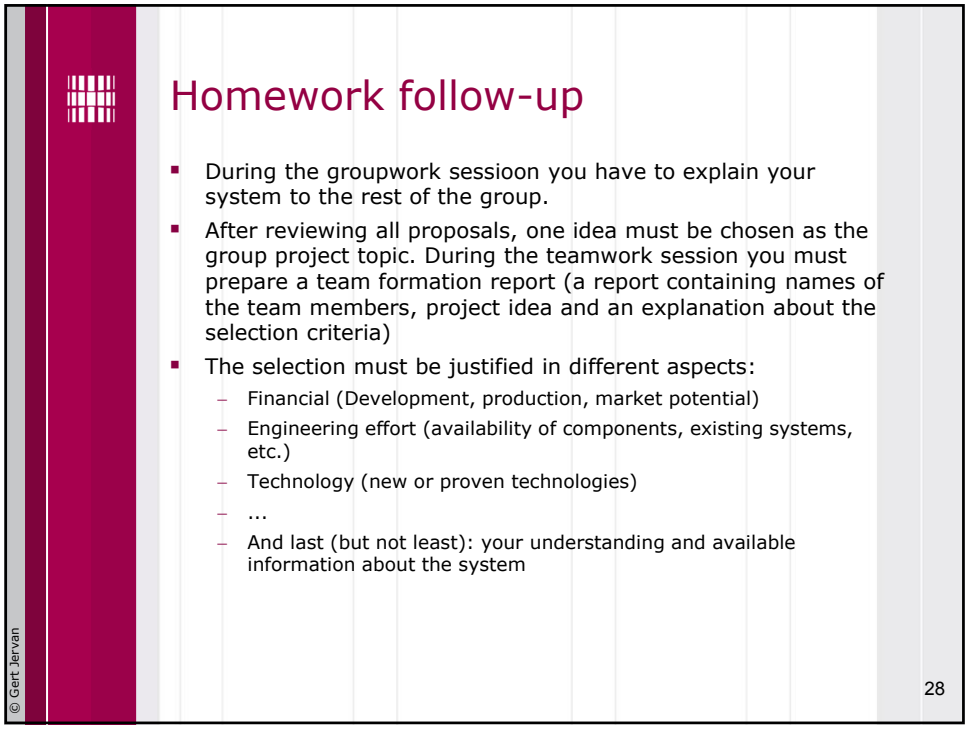
Homework follow-up
During the groupwork sessioon you have to explain your system to the rest of the group.
After reviewing all proposals, one idea must be chosen as the group project topic. During the teamwork session you must prepare a team formation report (a report containing names of the team members, project idea and an explanation about the selection criteria)
The selection must be justified in different aspects:
Financial (Development, production, market potential)
Engineering effort (availability of components, existing systems, etc.)
Technology (new or proven technologies)
...
And last (but not least): your understanding and available information about the system
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