

IF2261 Software Engineering

System Engineering

Program Studi Teknik Informatika
STEI ITB



Overview

- Before software can be engineered:
 - the system it is part of must be understood,
 - the overall objective of the system must be determined,
 - the role of the system elements (hardware, software, people, data, etc.) must be identified, and
 - the operational requirements must be created.
- Don't take a "software-centric" view of the system; consider all system elements before focusing on software.
- Good system engineering begins with a clear understanding of the "world view" and progressively narrows until technical detail is understood.
- Complex systems are actually a hierarchy of macro-elements that are themselves systems.

* SEPA 6th ed, Roger S. Pressman



System – Definition

Webster's Dictionary

- A set or arrangement of things so related as to form a unity or organic whole
- A set of facts, principles, rules, etc., classified and arranged in an orderly form so as to show a logical plan linking the various parts
- A method or plan of classification or arrangement
- An established way of doing something; method; procedure....
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Computer-Based Systems

[PRE2005]

- A set or arrangement of elements that are organized to accomplish some predefined goal by processing information
- The goal:
 - To support some business function or to develop a product that can be sold to generate business revenue
- To accomplish the goal, a computer-based system makes use of a variety of system elements



Computer-Based System Elements

- Software
- Hardware
- People
- Database
- Documentation
- Procedures

* SEPA 6th ed, Roger S. Pressman



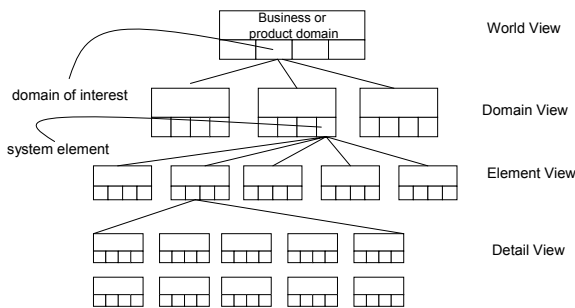
System Engineering Hierarchy

- World view $\rightarrow WV = \{D_1, D_2, D_3, \dots, D_n\}$
 - Composed of a set of domains (D_i) which can be each be a system or system of systems
- Domain view $\rightarrow DV = \{E_1, E_2, E_3, \dots, E_m\}$
 - Composed of specific elements (E_i) each of which serves some role in accomplishing the objective and goals for the domain or component
- Element view $\rightarrow EV = \{C_1, C_2, C_3, \dots, C_k\}$
 - Each element is implemented by specifying the technical component (C_k) that achieve the necessary function for an element
- Detail view

* SEPA 6th ed, Roger S. Pressman



System Engineering Hierarchy



System Modeling

The engineer creates models that:

- Define the processes that serve the needs of the view under consideration
- Represent the process behavior and the assumptions on which the behavior is modeled
- Explicitly define the exogenous (links between constituents) and endogenous (links between constituent components) input to the model
- Represent all linkages (including outputs) required to understand the view

** SEPA 6th ed, Roger S. Pressman*



System Model Restraining Factors

- Assumptions
 - reduces the number of possible variations
- Simplifications
 - enable the model to be created in a timely manner
- Limitations
 - help to bound the system
- Constraints
 - guide the manner in which the model is created and implemented
- Preferences
 - indicate the preferred architecture for all data, functions, and technology

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Systems Modeling Process

Hartley-Pirbhai Modeling

- System Context Diagram (SCD)
 - top level node in system hierarchy used to establish the boundary between the system being implemented (system model template serves as its basis)
- System Flow Diagram (SFD)
 - refinement of the process and control functions from SCD, derived by identifying the major subsystems and lines of information flow
- Initial SFD becomes the top level node of a hierarchy of more successively more detailed SFD's
- System Specification
 - developed by writing narrative description for each subsystem and definitions for all data that flow between subsystems

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System Model Template

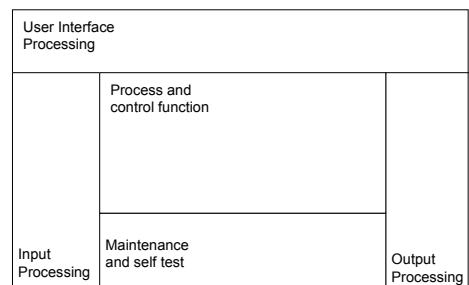
Hartley-Pirbhai Modeling

- User interface
- Input
- Process and control functions
- Output
- Maintenance and self test

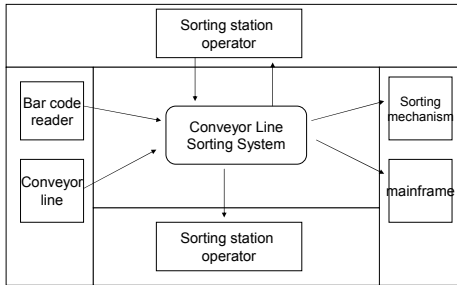
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The Template



SFD for CLSS



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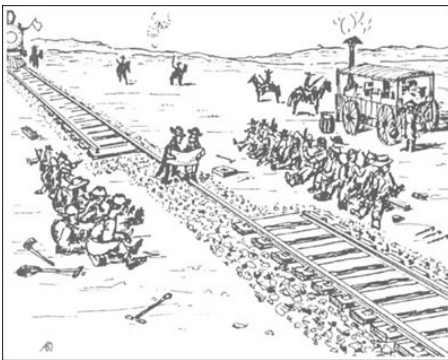
System Modeling with UML

- Deployment diagram
 - depicts hardware elements that are part of the physical architecture of the system
- Activity diagram
 - used to represent the procedural aspects of the system software elements, similar to a flowchart in that system functions are shown as nodes, decision points are shown as diamonds, and arrows are used to show flow through the system
- Class diagram
 - shows the class attributes and operations that may be applied to the class within the context of the system
- Use-case diagram
 - illustrates the manner in which an actor interacts with the system, each labeled oval within a system boundary represents one text scenario or use-case

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Business Process Engineering

- Goal
 - to define architectures that will enable a business to use information effectively
- Architectures
 - Data architecture
 - provides framework for information needs of a business or business function
 - Applications architecture
 - those system elements that transform objects within the data architecture for some business purpose
 - Technology infrastructure
 - provides foundation for the data and application architectures

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Business Process Engineering (2)

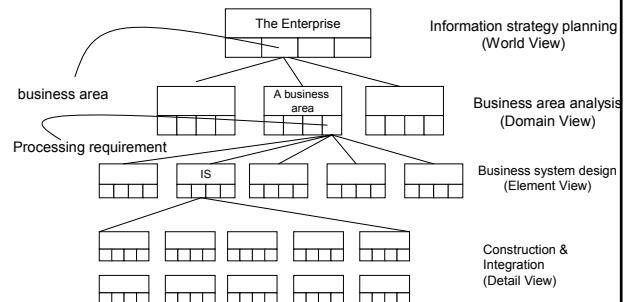
- Hierarchy
 - Information Strategy Planning (world view)
 - Business Area Analysis (domain view)
 - Business System Design (element view - software engineers)
 - Construction and Integration (detailed view - software engineers)

* SEPA 6th ed, Roger S. Pressman

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The Business Process Engineering Hierarchy



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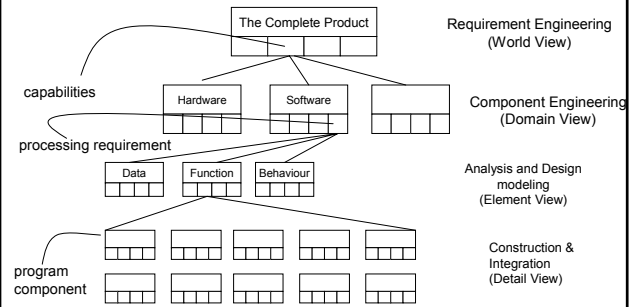
Product Engineering

- Goal
 - to translate the customer's desire for a set of defined capabilities into a working product
- Hierarchy
 - Requirements engineering (world view)
 - Component engineering (domain view)
 - Analysis and Design modeling (element view - software engineers)
 - Construction and Integration (detailed view - software engineers)

* SEPA 6th ed, Roger S. Pressman



The Product Engineering Hierarchy



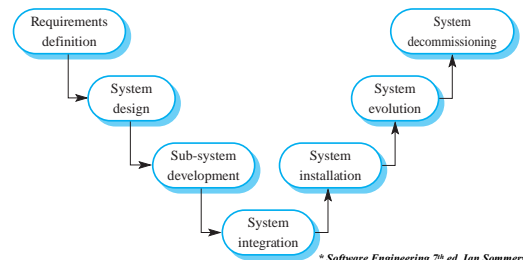
Systems engineering

- Specifying, designing, implementing, validating, deploying and maintaining socio-technical systems.
 - Systems that include technical systems but also operational processes and people who use and interact with the technical system. Socio-technical systems are governed by organisational policies and rules.
- Concerned with the services provided by the system, constraints on its construction and operation and the ways in which it is used.

* Software Engineering 7th ed, Ian Sommerville



The Systems Engineering Process



System Requirements Definition

- Three types of requirement defined at this stage
 - Abstract functional requirements.
 - System functions are defined in an abstract way;
 - System properties.
 - Non-functional requirements for the system in general are defined;
 - Undesirable characteristics.
 - Unacceptable system behaviour is specified.
- Should also define overall organisational objectives for the system.

* Software Engineering 7th ed, Ian Sommerville



System Requirements Problems

- Complex systems are usually developed to address wicked problems
 - Problems that are not fully understood;
 - Changing as the system is being specified.
- Must anticipate hardware/communications developments over the lifetime of the system.
- Hard to define non-functional requirements (particularly) without knowing the component structure of the system.

* Software Engineering 7th ed, Ian Sommerville



The System Design Process

- Partition requirements
 - Organise requirements into related groups.
- Identify sub-systems
 - Identify a set of sub-systems which collectively can meet the system requirements.
- Assign requirements to sub-systems
 - Causes particular problems when COTS are integrated.
- Specify sub-system functionality.
- Define sub-system interfaces
 - Critical activity for parallel sub-system development.

* Software Engineering 7th ed, Ian Sommerville



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System Design Problems

- Requirements partitioning to hardware, software and human components may involve a lot of negotiation.
- Difficult design problems are often assumed to be readily solved using software.
- Hardware platforms may be inappropriate for software requirements so software must compensate for this.

* Software Engineering 7th ed, Ian Sommerville



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Requirements and Design

- Requirements engineering and system design are inextricably linked.
- Constraints posed by the system's environment and other systems limit design choices so the actual design to be used may be a requirement.
- Initial design may be necessary to structure the requirements.
- As you do design, you learn more about the requirements.

* Software Engineering 7th ed, Ian Sommerville



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Sub-System Development

- Typically parallel projects developing the hardware, software and communications.
- May involve some COTS (Commercial Off-the-Shelf) systems procurement.
- Lack of communication across implementation teams
- Bureaucratic and slow mechanism for proposing system changes means that the development schedule may be extended because of the need for rework.

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System Integration

- The process of putting hardware, software and people together to make a system.
- Should be tackled incrementally so that sub-systems are integrated one at a time.
- Interface problems between sub-systems are usually found at this stage.
- May be problems with uncoordinated deliveries of system components.

* Software Engineering 7th ed, Ian Sommerville



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System Installation

- After completion, the system has to be installed in the customer's environment
 - Environmental assumptions may be incorrect;
 - May be human resistance to the introduction of a new system;
 - System may have to coexist with alternative systems for some time;
 - May be physical installation problems (e.g. cabling problems);
 - Operator training has to be identified.

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System Evolution

- Large systems have a long lifetime. They must evolve to meet changing requirements.
- Evolution is inherently costly
 - Changes must be analysed from a technical and business perspective;
 - Sub-systems interact so unanticipated problems can arise;
 - There is rarely a rationale for original design decisions;
 - System structure is corrupted as changes are made to it.
- Existing systems which must be maintained are sometimes called legacy systems.

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System Decommissioning

- Taking the system out of service after its useful lifetime.
- May require removal of materials (e.g. dangerous chemicals) which pollute the environment
 - Should be planned for in the system design by encapsulation.
- May require data to be restructured and converted to be used in some other system.

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