System Engineering

Instructor: Dr. Jerry Gao
System Engineering

**System engineering:**

*Software engineering occurs as a consequence of a process.*

**System engineering focuses on:**

- system and its elements, including hardware, software, …
- product, service, technology

**System engineering process is called information engineering when the context of the engineering work focuses on a business enterprise.**

**Product engineering focuses on product construction.**

**System engineering encompasses:**

- a collection of top-down and bottom-up methods to navigate the hierarchy in Figure 10.2
The System Engineering Hierarchy

- Business or Product Domain
  - World View
    - Domain View
      - Element View
        - Detailed View
System Modeling

System engineering is a modeling process.

The created models:
- define the process
- represent the process behavior
- define both exogenous and endogenous input to the model
- represent all linkages

Considering factors for creating models:
- assumptions
- simplifications
- limitations, such as hardware limitations
- constraints, such as computation constraints
- preferences (solutions, architecture, ..)
Information Engineering: An Overview

Information engineering (IE)
- define architectures that will enable a business to use information effectively.

Three different architectures:
- data architecture
  -> provides a framework about the business information
- application architecture
  -> encompasses the elements in a system.
- technology infrastructure
  -> provides the foundation for the data and application architecture.

Information strategy planning (ISP) --> world view
Business area analysis (BAA) ---> domain view
  1. Focus on a specific business domain
  2. Define data objects, relationship, and data flow
Software engineering:
  - business system design (element view)
  - construction and integration
    focuses on ---> detail implementation
The Information Engineering Hierarchy

The Enterprise

Information Strategy Planning
(World View)

Business Area Analysis
(Domain View)

A business area

Processing requirement

Information system

Business System Design
(Element View)

Construction & Integration
(Detailed View)
Information Engineering

The first step: Information Strategy Planning (ISP)

Objectives:
- to define strategic business objectives and goals
- to isolate the critical success factors
- to analyze the impact of technology and automation on the goals and objectives
- to analyze existing information to determine its role in achieving goals and objectives

ISP also creates a business-level data model that defines key data objects and their relationship to one another and to various business areas.

Enterprise modeling:
- Addresses the organizational structure and the functions
- Decomposes business function to isolate the processes
- Relates to objectives, goals, and CSFs (critical success factors)

A business function:
- some ongoing activity that must be accomplished to support the overall business.

A business process:
- a transition that accepts specific inputs and produces specific outputs.
Business-Level Data Modeling

Business-level data modeling is an enterprise modeling activity
- focuses on the data objects

At the business level, typical data objects include:
- producers and consumers of information
- occurrences of events
- organizational roles
- organizational units
- places
- information structures

![Diagram with relationships between Product A, Salesperson, and Customer]

- Product A describes Salesperson
- Customer purchases Product A
- Salesperson sells Product A to Customer
- Customer Inquires about Product A
- Salesperson contacts Customer
- Salesperson assists Customer
Business Area Analysis

Business area analysis (BAA)
- establishes a detailed framework for building an information-based enterprise.
- uses diagrams and matrices to model and record the data and activities

A number of different models can be used:
- data models
- process flow models
- process decomposition diagrams
- a variety of cross-reference matrices

Process Modeling:
- considering a set of functions in a business process
- partition them and refine them

Sales function:
- Establish customer contact
- Provide product literature and related information
- Address questions and concerns
- Provide evaluation product
- Accept sales order
- Check availability of configuration order
- Prepare delivery order
- Confirm configuration, pricing, ship data with customer
- Transmit delivery order to fulfillment department
- Follow-up with customer
Product Engineering

Business area analysis (BAA)
- establishes a detailed framework for building an information-based enterprise.
- uses diagrams and matrices to model and record the data and activities

Product engineering is a problem solving activity.

Uncover, analyze and allocate:
- product data, function, behavior for each engineering component
- function, performance, constraints
- allocation of functions to components

Trade-off criteria:
- project consideration
- business consideration
- technical analysis
- manufacturing evaluation
- human issues
- environmental interfaces
- legal considerations

System engineering also consider off-the-shelf solutions to the customer’s problem.
- Does an equivalent system already exist?
- Can major parts of a solution be purchased from a third party
System Analysis

Objectives of system analysis:
- Identify the customer’s need
- Evaluate the system concept for feasibility
- Perform economic and technical analysis
- Allocate functions to hardware, software, people, database, and other elements
- Establish cost and schedule constraints
- Create a system definition

Identifying the needs:
- meet with the customer, users, and marketing people
- understand the product’s objective(s)
- define the goals to meet the objective(s)

Product evaluation:
- Does the technology exist to build the system?
- What are the required development and manufacturing resources?
- What is the potential market for the product?
- How does this product compare with competitive products?
- What position does this product take in the overall product line of the company?
System Analysis

Feasibility Study:

- Economic feasibility - an evaluation of development cost against the ultimate income or benefits
- Technical feasibility - a feasibility study of function, performance, and constraints
- Legal feasibility - a determination of any infringement, violation, or liability of the product
- Alternatives - an evaluation of alternative approaches to the development of the product

Ideal results of feasibility study:
- obvious economic justification,
- technical risk is low
- few legal problems
- no reasonable alternatives

Technical feasibility:
- Development risk
- Resource availability
- Technology

Legal feasibility:
- contracts, liability, infringement, myriad, …

Feasibility report is reviewed by project management and upper management.
Technical Analysis

Technical analysis focuses on the assessment of the technical viability of the proposed system.

- What technologies are required to accomplish system function and performance?
- What new material, methods, algorithms, or processes are required?
- What is their development risk?
- How will these technology issues affect cost?

It is important to note that

    analytical evaluation is not always possible.

Modeling is an effective mechanism for technical analysis of computer-based systems.

A set of criteria for the use of models in technical analysis of systems:

- representation capability of dynamics of the system
- easy understand and simple
- highlight factors relevant to the problem
- comprehensive for all factors
- support implementation
- easy to change and extend
Modeling The System Architecture

Every computer-based system can be modeling as
- an information transform using an input - processing - output architecture
- two additional features:
  - user interface processing and maintenance and self-test processing.

To develop the system model:
- architecture template:
  1) user interface, 2) input, 3) system function and control,
  4) output, and 5) maintenance and self-test

Models:
- Architecture context diagram (ACD)  Figure 10.11
Establish the information boundary between the systems (sub-systems) in the environment

- Extended ACD  Figure 10.12
ACD + external entities and information flow

- Architecture Flow Diagram (AFD)  Figure 10.13
Shows the major subsystems and important information flow

- AFD Hierarchy  Figure 10.14
AFD + Hierarchy
System Specification

The system specification document serves as the foundation for hardware/software engineering, database engineering and human engineering.

It describes:
- system functions
- system performance requirements
- system constraints
- system architecture
- system information flow (input and output of the system)

System specification outline in Figure 10.15.