

Software Engineering I CSC-382



Lecture 3

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- Lecture 3
- What we will cover: (Systems Engineering)
 - Chapter 6 (up to 6.5) in Pressman
 - Encompasses the technical part of the generic process planning phase
- Systems Engineering's objective is to:
 - Define what the **software** is responsible for, what the **hardware** and **other subsystems** are, and what the **interfaces** between these look like.

What is a System

- Elements of a computer-based system
 - Software
 - Hardware
 - People
 - Database
 - Documentation
 - Procedures

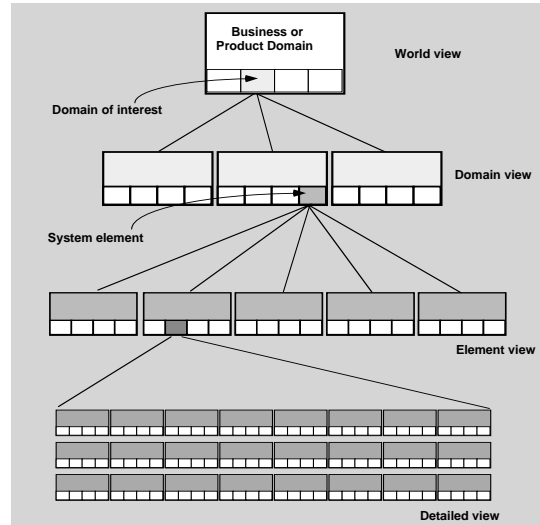
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What is a System II

- Definitions of a System:
 - “A set or arrangement of elements that are organized to accomplish some pre-defined goal by processing information”
 - “A purposeful collection of interrelated components that work together to achieve some objective” – Somerville
 - A hierarchy of macro-elements, or sub-systems

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The Systems Hierarchy



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What is System Engineering

- It includes the following activities related to a system:
 - Specifying
 - Designing
 - Implementing
 - Validating
 - Deploying and maintaining

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What is System Engineering II

- Differences between systems and software engineering:
 - Limited ability to rework a system during development
 - E.g. developing a ATC radar site does not allow moving the radar in the middle of the development
 - The increases in software in systems is because it can provide some flexibility to work around other issues
 - Interdisciplinary involvement
 - Can require many diverse branches of engineering, such as electrical engineers, mechanical engineers, software engineers, etc.

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Key Issues in Systems Engineering

- Every system must be analyzed in a context
 - The context can be (and often is) very general
 - This ***context*** is critical to capturing key requirements that have the potential to make or break the product/solution
- The hierarchy must be analyzed in a top-down and bottom-up approach to ensure all requirements are addressed.

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Key Issues in Systems Engineering II

- The hierarchical nature means one person's requirements are another person's design.
 - **There is no clear rule where requirements definition ends and design begins in a system hierarchy.**
- The system design must be performed before the software requirements can be developed.
 - There will be an iterative up and down process through system design to software requirements, and back to system design to address issues that may have been forgotten.

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System Architectures

- Three different architectures must be analyzed and designed within the context of the system objectives and goals:
 - *data* architecture
 - *applications* architecture
 - *technology* infrastructure

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System Architectures II

- ***Data architecture*** provides a framework for the information needs of the application.
- ***Application architecture*** encompasses those elements of a system that transform objects within the data architecture for some purpose.
- ***Technology infrastructure*** provides the foundation for the data and application architectures.

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System Application Patterns

- Two application *patterns* that define the majority of the systems:

**Business
Process
Engineering
(e.g. IT systems)**

**Product
Engineering
(e.g. automotive)**

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Business Process Engineering

- Identifies how information systems can best meet the strategic goals of an enterprise
- Focuses first on the *enterprise* and then on the business area. An enterprise is:
 - The overall business entity, its purpose, its people, its processes, its existing infrastructure,...
 - The study of enterprise architecture is an entire discipline in itself
 - There is a very popular methodology called the Zachman Framework

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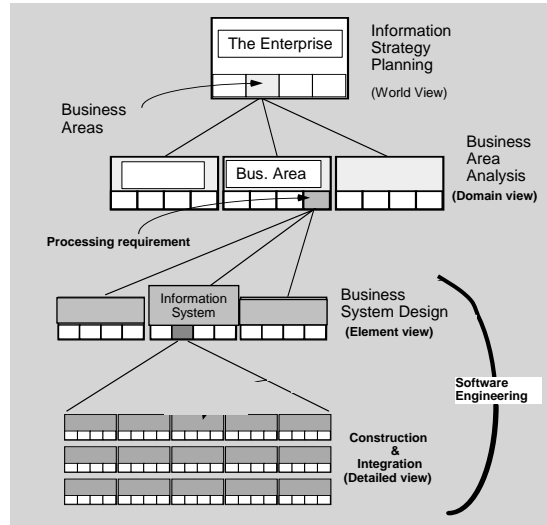
Business Process Engineering II

- Goal is to create:
 - **Enterprise models,** - addresses **who, when,** and **why**
 - **Data models** - addresses **what**
 - **Process models** - addresses **how**
 - **Infrastructure models** - addresses **where**

These are the three areas we will focus on in this class

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Business Process Engineering III



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The BPE Systems Engineering Hierarchy

- Information strategy planning (ISP)
 - Strategic goals defined
 - Success factors/business rules identified
 - Enterprise model created
- Business area analysis (BAA)
 - Processes/services modeled
 - Interrelationships of processes and data

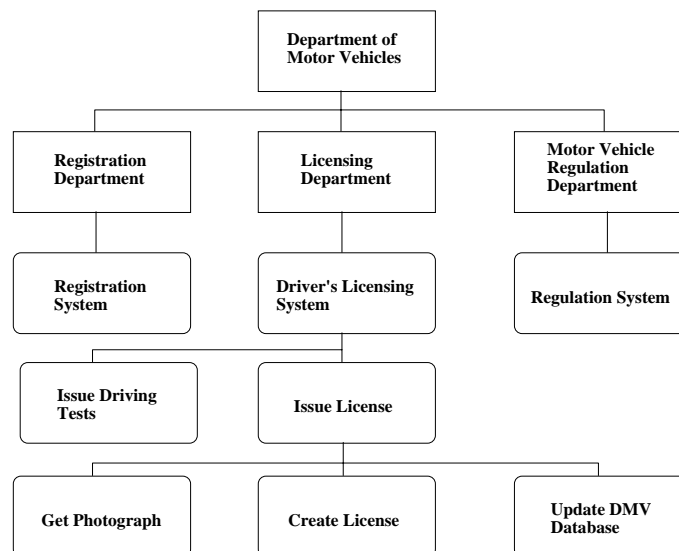
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The BPE Systems Engineering Hierarchy II

- Application Engineering
 - A.k.a ... software engineering
 - Modeling applications/procedures that address (BAA) and constraints of ISP
- Construction and delivery
 - Coding, testing, Users Manuals, etc.

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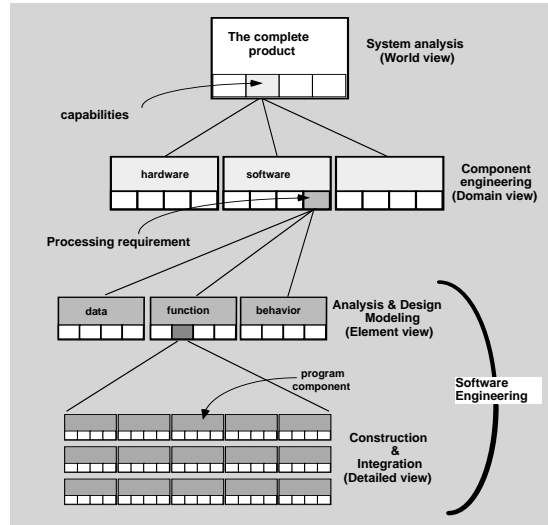
Example Business Process Hierarchy



From: <http://www.sims.berkeley.edu/courses/is208/s01/Decomposition.doc>

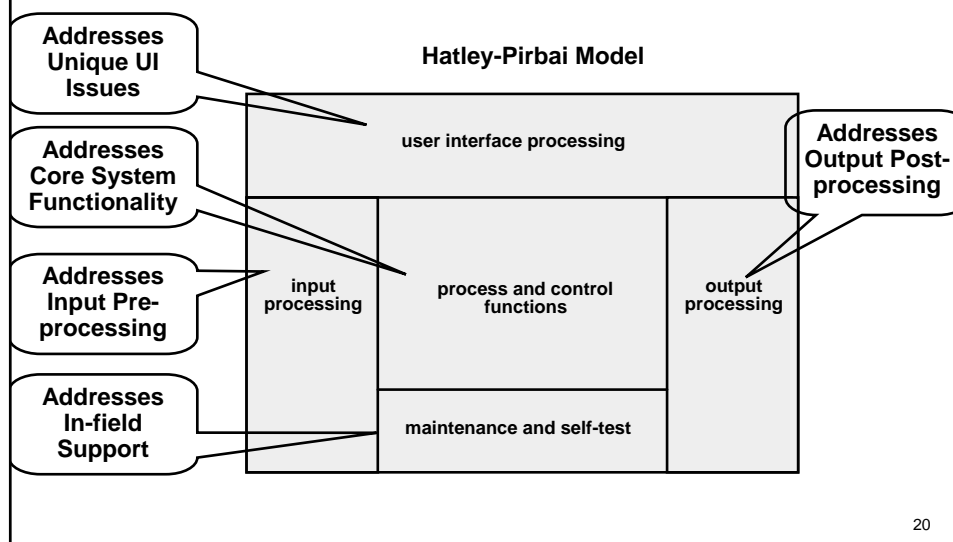
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Product Engineering



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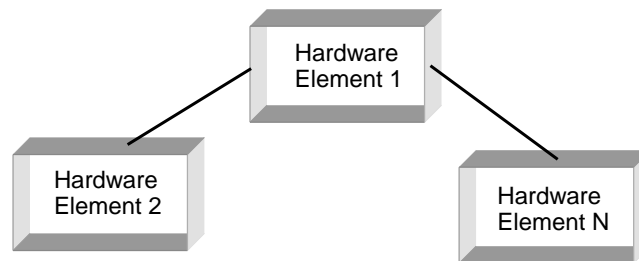
System Modeling Template I



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System Modeling Template II

**UML Model Uses a Deployment Diagram
Models the Hardware Elements of the System**



We will see more UML modeling in OO SW analysis

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In-class Systems Engineering Exercise: SafeHome



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Project Initiation: SafeHome



How a Project Starts

The scene: Meeting room at CPI Corporation, a (fictional) company that makes consumer products for home and commercial use.

The players: Mal Golden, senior manager, product development; Lisa Perez, marketing manager; Lee Warren, engineering manager; Joe Camalleri, executive VP, business development.

The conversation:

Joe: Okay, Lee, what's this I hear about your folks developing a what? A generic universal wireless box?

Lee: It's pretty cool, about the size of a small matchbook. We can attach it to sensors of all kinds, a digital camera, just about anything. Using the 802.11b wireless protocol it allows us to access the device's output without wires.

We think it'll lead to a whole new generation of products.

Joe: You agree, Mal?

Mal: I do. In fact, with sales as flat as they've been this year, we need something new. Lisa and I have been doing a little market research, and we think we've got a line of products that could be big.

Joe: How big, . . . , bottom-line big?

Mal: (avoiding a direct commitment): Tell him about our idea, Lisa.

Lisa: It's a whole new generation of what we call "home management products." We call 'em *SafeHome*. They use the new wireless interface, provide homeowners or small business people with a system that's controlled by their PC—home security, home surveillance, appliance and device control. You know, turn down the home air conditioner while you're driving home, that sort of thing.

Lee: (jumping in) Engineering's done a technical feasibility study of this idea, Joe. It's doable at low manufacturing cost. Most hardware is off the shelf. Software is an issue, but it's nothing that we can't do.

Joe: Interesting. Now, I asked about the bottom line.

Mal: PCs have penetrated 60 percent of all households in the USA. If we could price this thing right, it could be a killer-App. Nobody else has our wireless box—it's proprietary. We'll have a two-year jump on the competition. Revenue? Maybe as much as \$30–40 million in the second year.

Joe (smiling): Let's take this to the next level. I'm interested.

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SafeHome Summary From Initial Meeting

- High-level Customer Product Description:
 - The SafeHome company has developed an innovative **hardware box that implements wireless Internet (802.11) connectivity** in a very small form factor (the size of a matchbook).
 - The idea is to use this technology to develop and market a comprehensive **home automation product line**.

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SafeHome Summary From Initial Meeting II

- High-level Customer Product Description:
 - This would ultimately provide not only **security functions**, but also would enable control over telephone answering machines, lights, heating, air conditioning, and home entertainment devices.
 - The first generation of the system, described here, will **only focus on home security** since that is a market the public readily understands.

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Which System Application Pattern Does this system match?

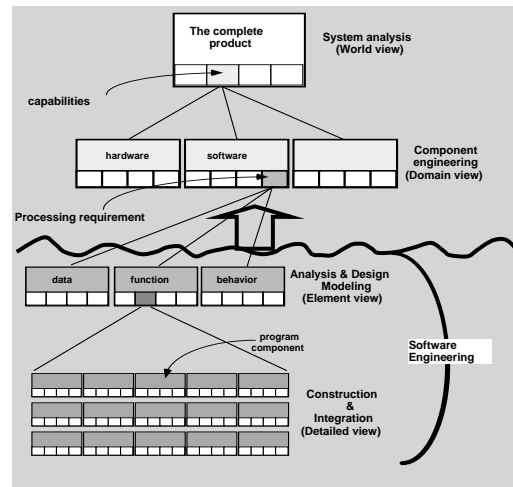
- Two key application patterns that define the majority of the systems:

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We Must Define the Elements of the System Hierarchy



For the System Engineering we will focus above this line, and below it once we partition the application across HW/SW

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System-level Requirements for SafeHome

Preliminary notes of the structure/functionality of SafeHome:

- The system will make use of one or more PCs, various wall-mounted and/or handheld control panels, various sensors, and appliance/device controllers.
- All will communicate via wireless protocols (e.g., 802.11b) and will be designed for new-home construction and for application within existing homes.
- All hardware with the exception of our new wireless box will be off the shelf.

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System-level Requirements for SafeHome II

Recall only going to focus on home security first

Home security functions:

- Standard window/door/motion sensor monitoring for unauthorized access (break-ins).
- Monitoring for fire, smoke, and CO levels.
- Monitoring for water levels in basement (e.g., flood or broken water heater).
- Monitoring for outside movement. This requirement needs some expanding, video, doppler, etc?
- Change security setting via the Internet.

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System-level Requirements for SafeHome III

Use the desired surveillance functionality to expand motion sensor requirement

Provides needed details on motion sensor

Device Controller requirement

Additional PC requirements

Home surveillance functions:

- Connect to one or more video cameras placed inside/outside house.
- Control pan/zoom for cameras.
- Define camera monitoring zones.
- Display camera views on PC.
- Access camera views via the Internet.
- Selectively record camera output digitally.
- Replay camera output.

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These System Requirements Imply Hardware Elements for SafeHome I

A. Processors:

- 1. Central processor:**
- 2. Corporate site processors:**
- 3. Remote processors for internet access:**

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These System Requirements Imply Hardware Elements for SafeHome II

A. Processors:

- 1. Central processor:** There is a central processor (CP) located on the customer's premises.
 - The CP uses a broadband Internet connection and/or modem to communicate with:
 - SafeHome corporate site,
 - Emergency call monitoring company.
 - Home owner via a remote PC
 - The CP is a wireless base station for communication with the sensor/actuator devices.
 - The CP must record and replay camera video data (display remote)
 - The CP would be a dedicated computer.
 - The CP would have an uninterruptible power supply.

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These System Requirements Imply Hardware Elements for SafeHome III

A. Processors:

- 2. Corporate site processors:** What can or do we need to say here?
- 3. Remote processors for internet access:** What can or do we need to we say here?

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These System Requirements Imply Hardware Elements for SafeHome IV

B. Special Control Panels: These are hardware devices that provide a simple user interface to the system.

- They communicate with the CP wirelessly.
- They allow for such basic functions as arming and disarming the system.
- Normally there would be one in the home near the front door, but there could be others (e.g. at other exterior doors or in a bedroom).

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These System Requirements Imply Hardware Elements for SafeHome V

C. Sensor and actuator devices: There are a variety of devices that communicate with the CP.

- Some of these are **sensors** (e.g. **motion** sensors placed internally and externally, sensors that detect whether a door or window is open, fire detectors, **smoke** detectors, **CO** detectors, basement **water** detectors, etc.).
- Some are **alarm signalers** (siren, flashing light, etc.).
- Some are **cameras** that can send digital pictures to the CP, and can be panned or zoomed.

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These System Requirements Imply Hardware Elements for SafeHome VI

C. Sensor and actuator devices: There are a variety of devices that communicate with the CP.

- It is the intent of the company that the line of devices would be expanded in the future.
- A significant number of devices can be purchased, installed physically and then **configured with the software system** so that the software system can communicate with them.

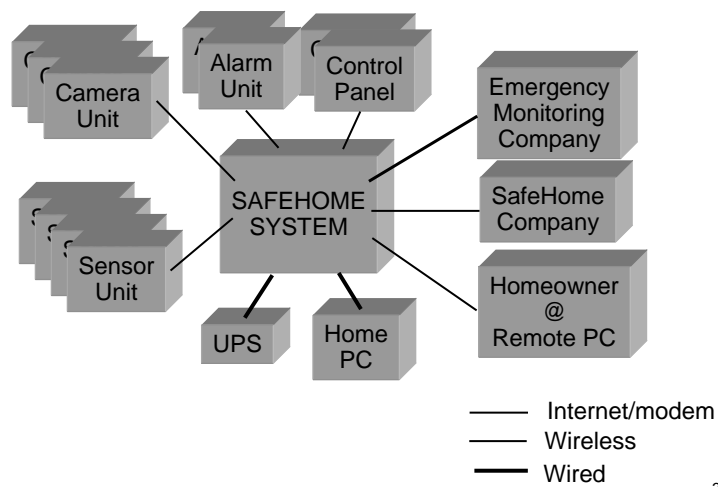
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Definition of Hardware Elements for SafeHome

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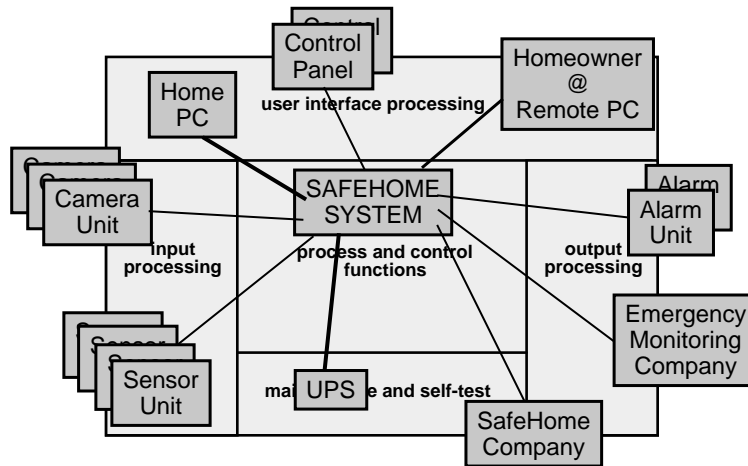
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Definition of System Hardware Elements for SafeHome



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Mapping of System Hardware Elements for SafeHome to System Functions



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For Next Class

- Read Chapter 7 (Requirements Engineering)
 - The systems engineering defined the hardware architecture and the top level functional and performance specifications.
 - Next stage is to derive additional requirements for **only the software**

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