ECEN 478: Senior Design

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Outline

Engineer Defination

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Engineer

One versed in the design, construction, and use of machines. **American College Dictionary**

Engineer

One who employs the innovative and methodical application of scientific knowledge and technology to produce a device, system, or process, which is inteded to satisfy the human needs. **American College Dictionary**

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- What is the difference between engineering design and other types of designs that are associated with creativity (Fashion, Web, Interior design)
- Are Innovation and Methodical Application contradictory terms?

Learning Objectives

By the end of this chapter, the student should:

- Understand what is meant by engineering design.
- Understand the phases of the engineering design process.
- Be familiar with the attributes of successful engineers.
- Understand the objectives of this book.

Outline

What is engineering Design

Engineering design

The process of devising a system, component, or process to meet desired needs.

- It is a decision-making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective.
- Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation.

Example

- You are hungry and need to eat dinner before you can go to see a movie that starts in one hour. constraints? possible solutions?

What is product realization?

- It is broader in scope than engineering design process.
- Add aspects such as entrepreneurship, market research, financial planning, product pricing, and market strategy.

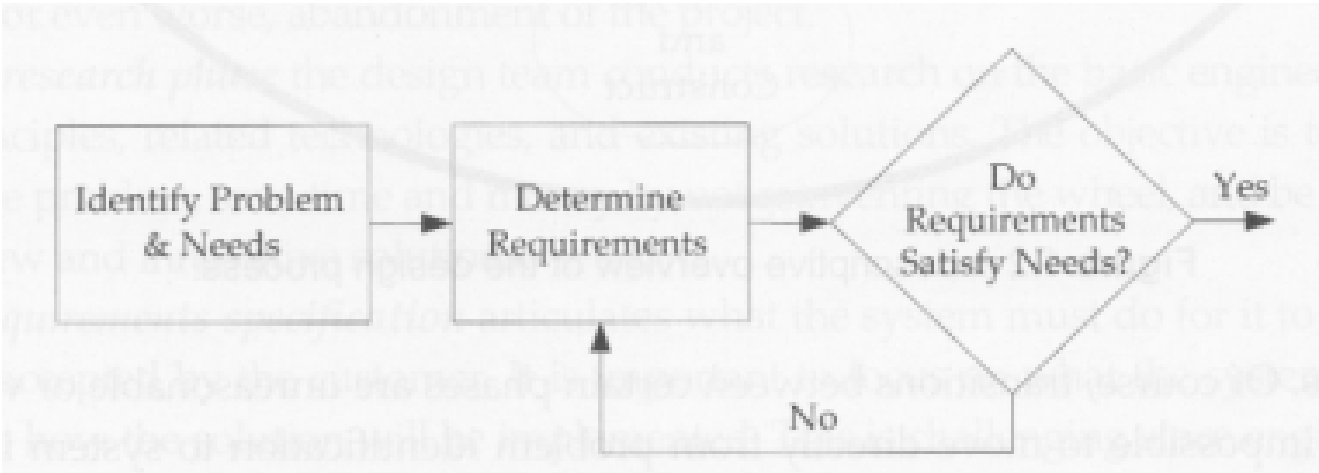
Example

- Realize a smart watch.

Design Processes Types

Prescriptive design processes

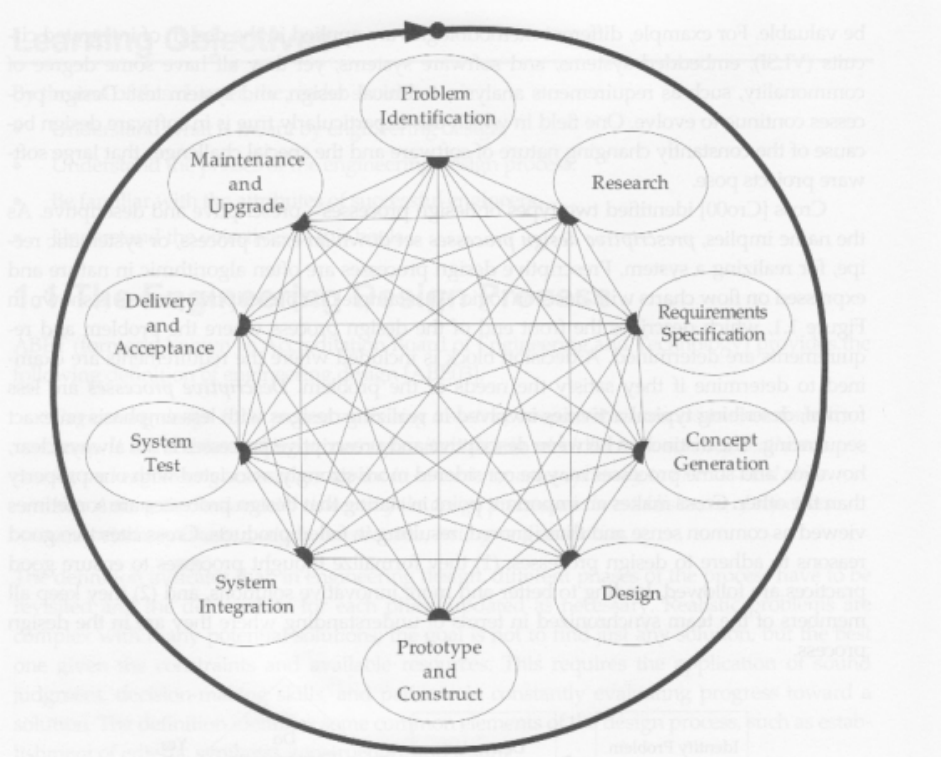
- Set down an exact process, or systematic recipe, for realizing a system.
- Often algorithmic in nature and expressed on flow charts with decision logic.
- Clear sequencing.



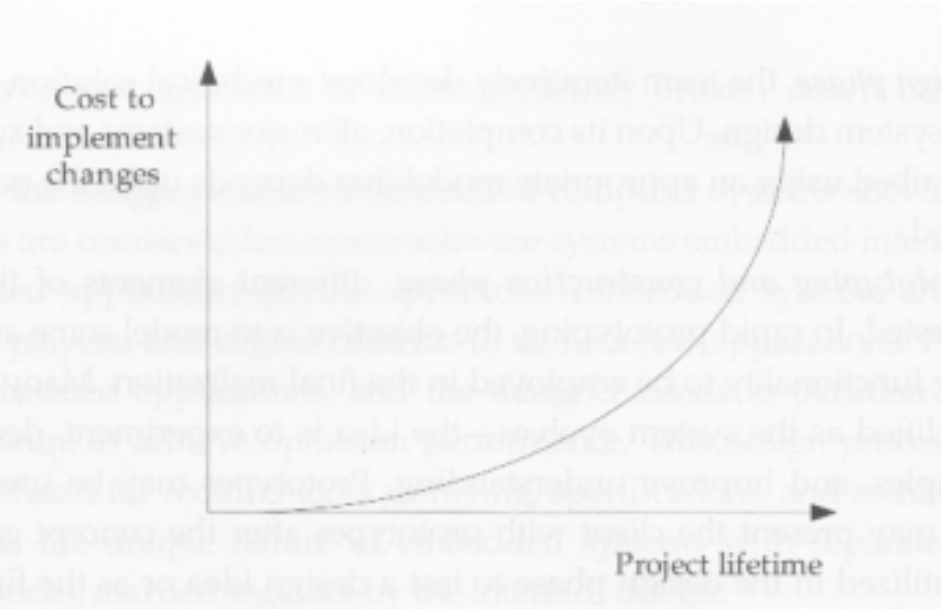
Design Processes Types

Descriptive design processes

- Are less formal, describing typical activities involved in realizing designs with less emphasis on exact sequencing.
- Transitions between certain phases are unreasonable or very costly.



Cost of Changes



- The customer's needs may change while in the design phase, necessitating reevaluation of the needs, correction of the requirements specification, and system redesign
- Studies have shown that the cost required to correct errors or make changes increases exponentially as the project lifetime increases.

Outline

1- Problem identification

The objective of the first phase, problem identification, is to identify the problem and customer needs.

- It is important to determine the true needs for the product, device, or system (terms that are used interchangeably and often referred to as systems)

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- It is important to determine the true needs for the product, device, or system (terms that are used interchangeably and often referred to as systems)
- Failure to correctly identify the needs has negative ramifications for the entire process, typically resulting in costly redesigns, or even worse, abandonment of the project.

2- Research phase

- In the research phase the design team conducts research on the basic engineering and scientific principles, related technologies, and existing solutions.
- The objective is to become experts on the problem, save time and money by not reinventing the wheel, and be positioned to develop new and innovative solutions.

3- Requirements Specification

- The requirements specification articulates what the system must do for it to be successful and to be accepted by the customer.
- It is important to focus on what the system must do, as opposed to how the solution will be implemented.
- **Challenge** Engineers tend to focus on solutions (problem solving).
- Requirements are guides the entire project, and if properly developed, provide flexibility for creativity and innovation in developing solutions.

4- Concept generation

- In concept generation, many possible solutions to the problem are developed.
- The objective is to develop the one that best meets the requirements and satisfies the constraints.
- Creativity is encouraged, but it is ultimately tempered with critical evaluation of the competing alternatives.

6- Design phase

- The team iteratively develops a technical solution, ultimately producing a detailed system design.
- Upon its completion, all major systems and subsystems are identified and described using an appropriate model that depends upon the particular technology being employed.

7- Prototyping and Construction phase

- Different elements of the system are constructed and tested.
- Objective is to model systems and subsystems, demonstrating functionality to be employed in the final realization.
- Prototypes may be used anywhere in the process—you may present the client with prototypes after the concept generation phase, or they may be utilized in the design phase to test a design idea

8- System integration

- During system integration, all of the subsystems are brought together to produce a complete working system.
- This phase is challenging and time-consuming since many different pieces of the design must be interfaced, and the team must work closely to make it all work.
- Care taken in the design phase to clearly communicate the functionality and interfaces between subsystems aids in system integration.
- System integration is closely tied to the test phase.

9- Test, Delivery, and Maintenance

- Device will be tested by a mutually (You and the Customer) agreed upon process.
- In the maintenance phase, device is maintained, upgraded to add new functionality, or design problems are corrected.

Outline

Technology-Specific Design Processes

- Some industuries have developed specialized processes for technology-specific design.
  - Very Large Scale Integrated Circuits
  - Embedded systems
  - Software Engineering

Very large-scale integration

- Very large-scale integration (VLSI) is the process of creating an integrated circuit (IC) by combining millions of MOS transistors onto a single chip.

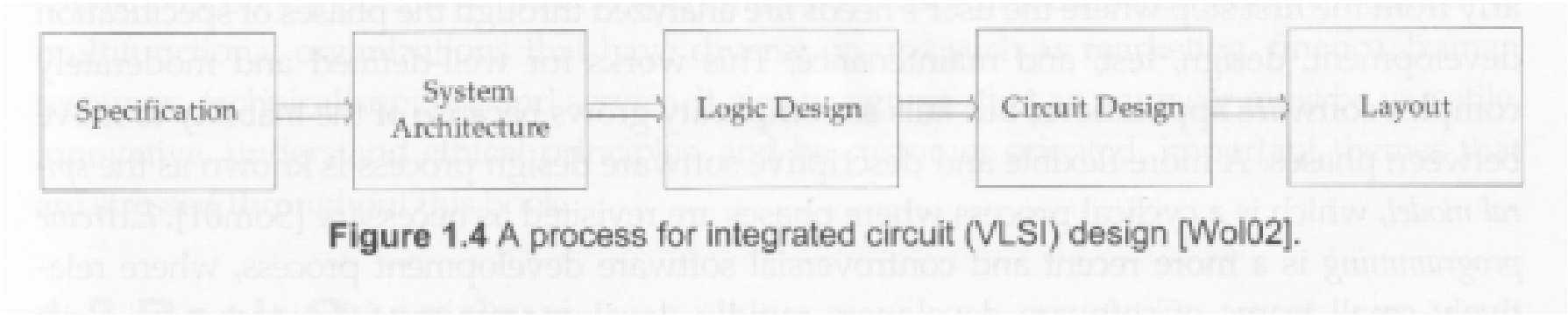


Figure 1.4 A process for integrated circuit (VLSI) design [Wol02].

- Each functional unit is then designed at the gate logic level, which is subsequently designed at the circuit (transistor) level, and finally the circuit elements are laid out on the silicon chip.

Embedded systems

- Embedded systems are combined hardware/software systems embedded into a larger system to perform dedicated application-specific operations.

- This design process is somewhat prescriptive, with phases for requirements gathering specifications, and architectural design.

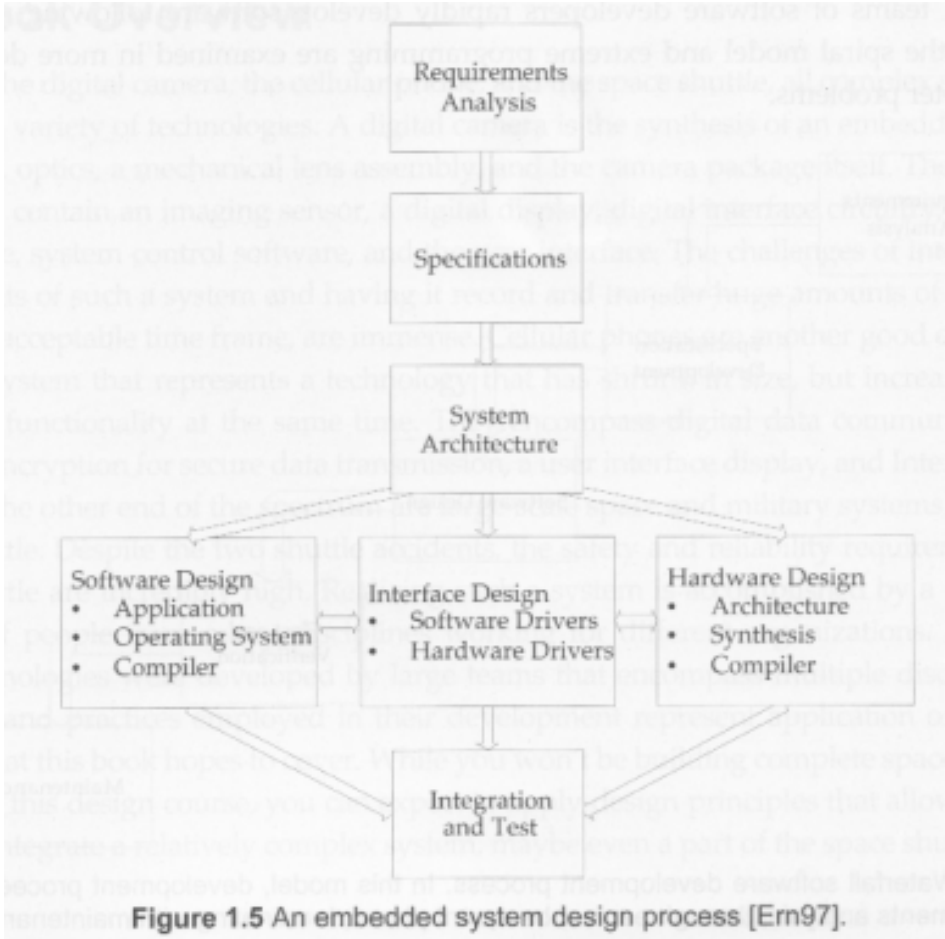


Figure 1.5 An embedded system design process [Ern97].

Software Engineering

- The estimated size of software programs may easily exceed one million lines of code written by many different software developers.
- Large software needs a systematic process for upgrade and reuse of software.
- Below is "Water fall model" = (Prescriptive)

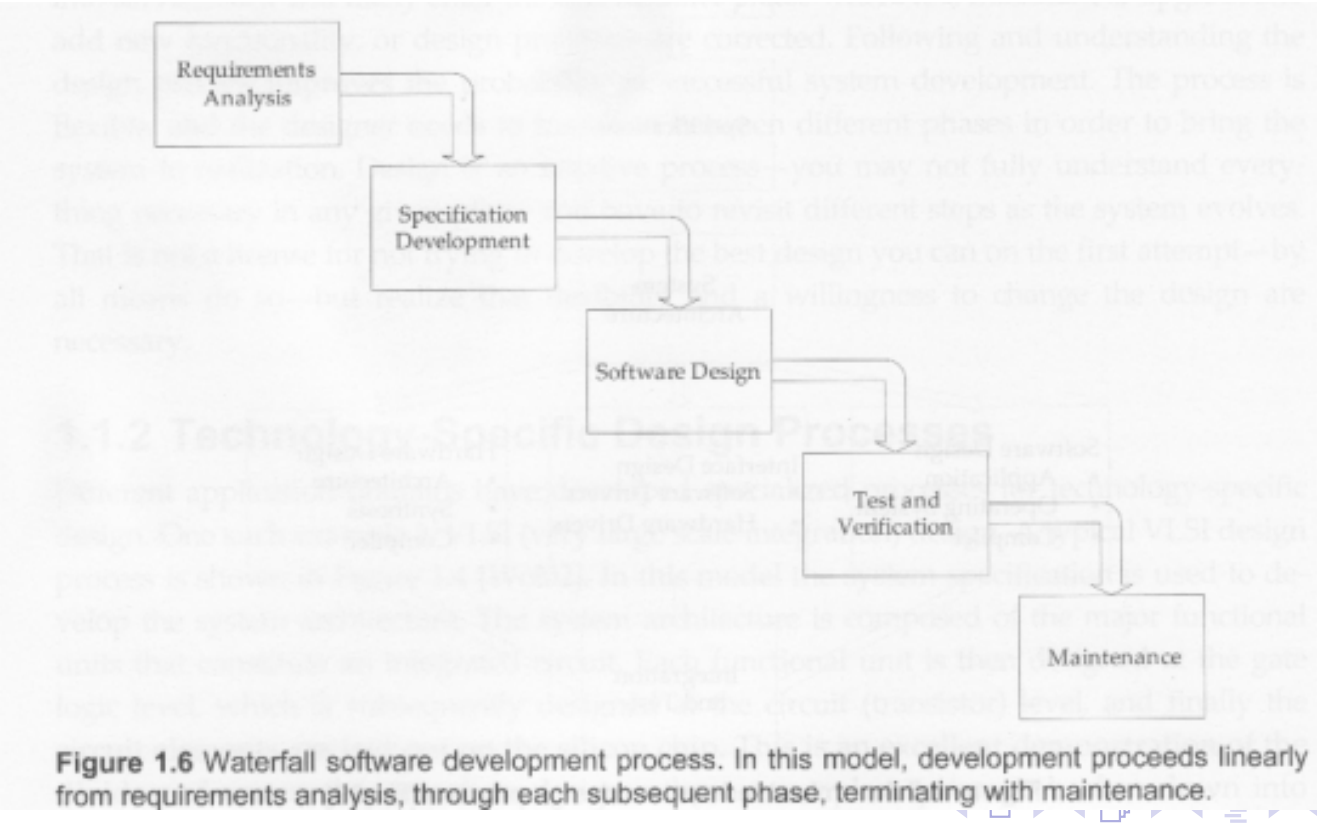
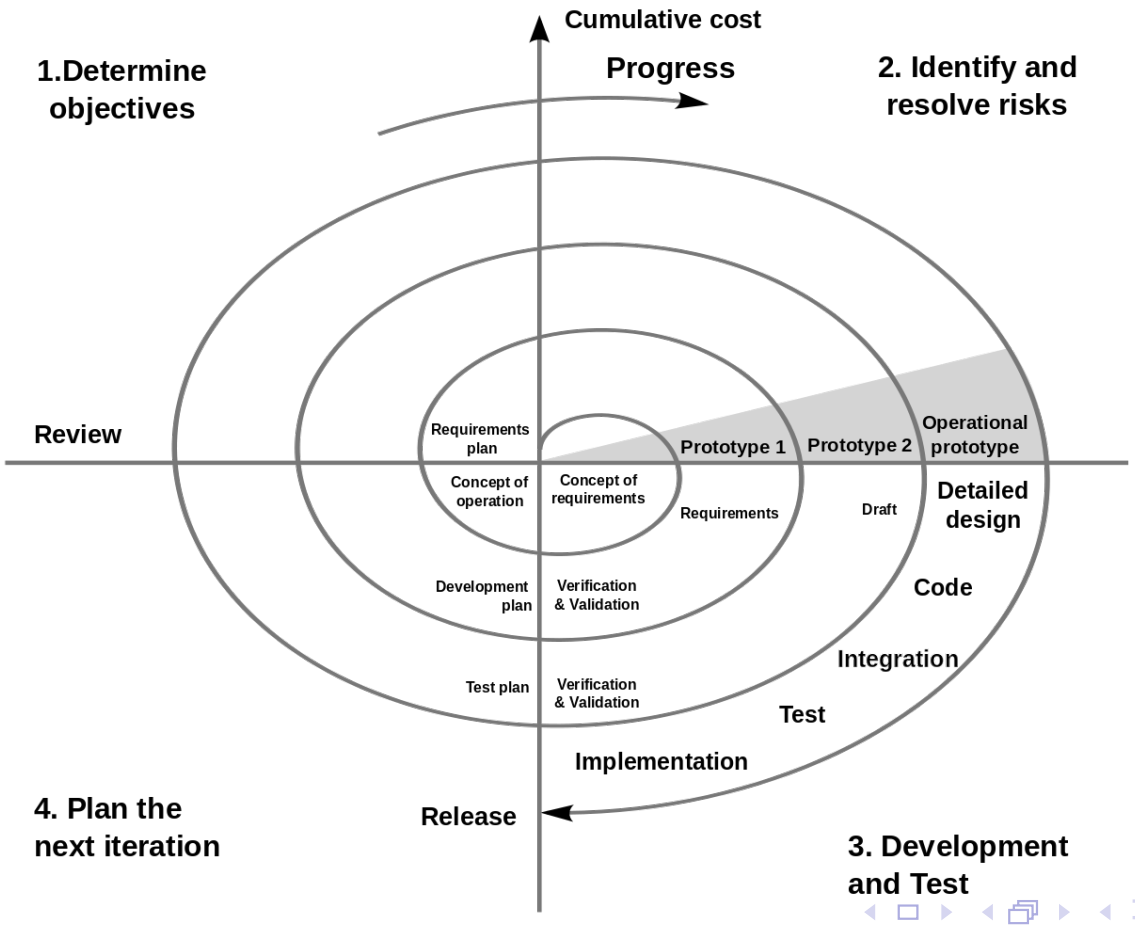


Figure 1.6 Waterfall software development process. In this model, development proceeds linearly from requirements analysis, through each subsequent phase, terminating with maintenance.

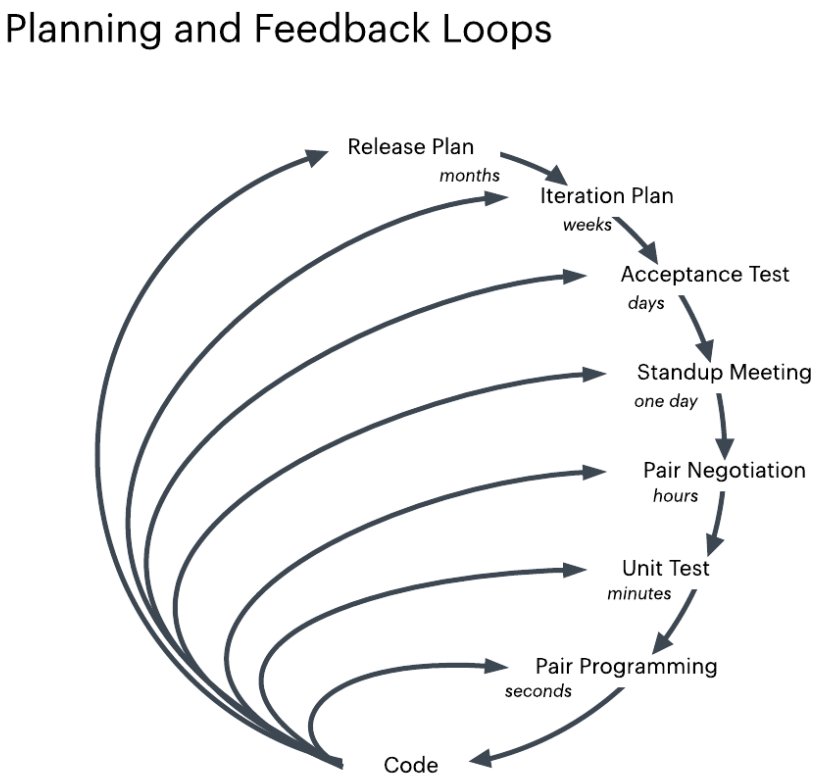
Software Engineering

- A more flexible and descriptive software design process is known as the "Spiral model" (Descriptive)
- It is a cyclical process where phases are revisited as necessary.



Software Engineering

- Extrerme programming is a more recent and controversial software development process, where relatively small teams of software developers rapidly develop software following some strict rules. (Descriptive)



Outline

Successful Engineer

The characteristics of successful engineers contains six major elements:

1. Aware of the World
2. Solidly Grounded
3. Technically Broad
4. Effective in Group Operations
5. Versatile
6. Customer Oriented.

1- Aware of the World

- Sensitive to cultural differences, environmental concerns, and ethical principles.
- Alert to market opportunities (both high and low tech).
- Aware of competitive talents, work ethic, and motivation.

2- Solidly Grounded

- Thoroughly trained in the fundamentals of a selected engineering discipline.
- Has a historical perspective and remains aware of advances in science that can impact engineering.
- Realizes that knowledge doubles at breakneck speed and is prepared to continue learning throughout a career.

3- Technically Broad

- Understands that real-life problems are multidisciplinary.
- Thinks broadly, seeing an issue in a rich context of various alternatives, probabilities, etc., rather than as a narrow quest to find a single answer.
- Aware of several disciplines.
- Is trained in systems modeling and the identification of critical elements.
- Is psychologically prepared to embrace any field necessary to solve the problem at hand.

4- Effective in Group Operations

- Cooperative in an organization of individuals working toward a common creative goal
- Effective in written and oral communication.
- Willing to seek and use expert advice.
- Being aware of the importance of time.
- Respectful of the many facets of business operation (general management, marketing, finance, law, human resources, manufacturing)

5- Versatile

- Innovative in the development of products and services.
- Sees engineering as applicable to problem solving in general.
- Considers applying engineering beyond the typical employment focus of engineering graduates.

6- Customer Oriented

- Very hard to satisfy customers.
- Realizes that finding and satisfying customers is the only guarantee of business success.
- Understands that products and services must excel in the test of cost-effectiveness in the global market place.

Outline

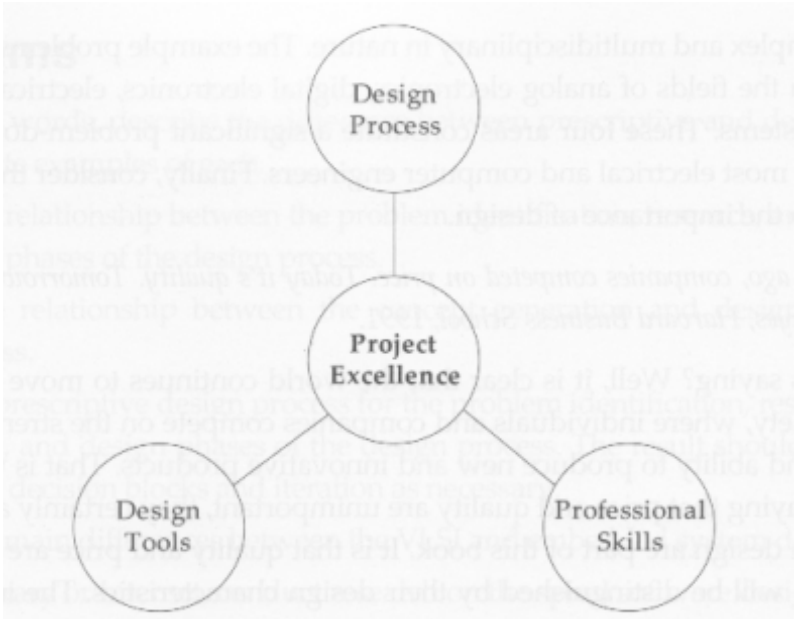
Course objective

- Consider the cellular phone components
  - Digital display
  - Flash memory
  - Operating system
  - Security Modules (NFC)
  - Imaging sensors
  - GPS sensor
  - ...
- The integration of such system requires awarness of variety of technologies.
- While we will not build a complete cellular phone, you can expect to apply design principles.

Book Philosophy

- The majority of engineering education is: math, science, and problem solving.
- However, there other important topics that are equally important for your success as an engineer
  - Innovation
  - Ethical Principles
  - Team work
  - Communiction skills
  - System Design

Book Organization



The guiding philosophy of this book. To achieve success in executing engineering and design projects. It takes an understanding of the design process, strong technical design tools and professional skills.

References

- Ford, Ralph Michael Coulston, Chris S - Design for electrical and computer engineers theory, concepts, and practice-McGraw-Hill (2008)

Questions