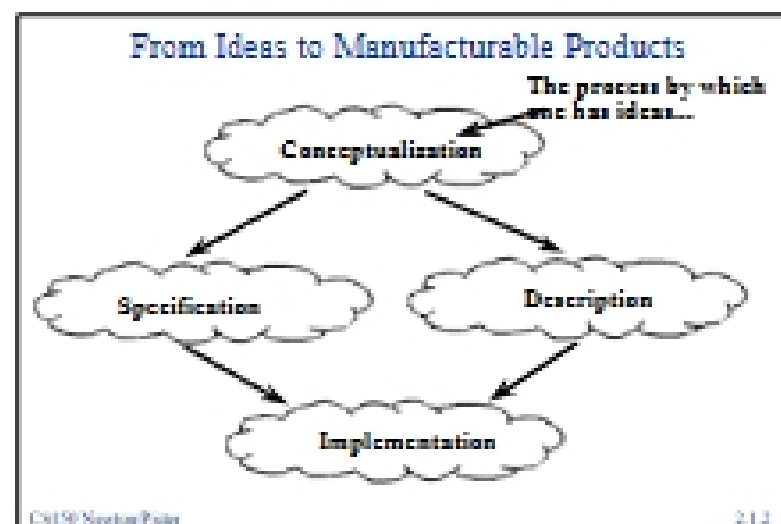


Outline

- Last time:
 - Design Example: Translating a word problem into a sequential design language
 - State Transition Graph
 - State Transition Table
 - Mealy and Moore Forms
- This lecture:
 - Design versus Implementation
 - Specification, Description, and Duplication
 - Conceptual Blocks & How to Overcome Them
 - Good Versus Bad Design
 - The Role of Language in Design
 - The CS150 Project

CS150 Newton/Pister 2.1.1



Specification vs. Description

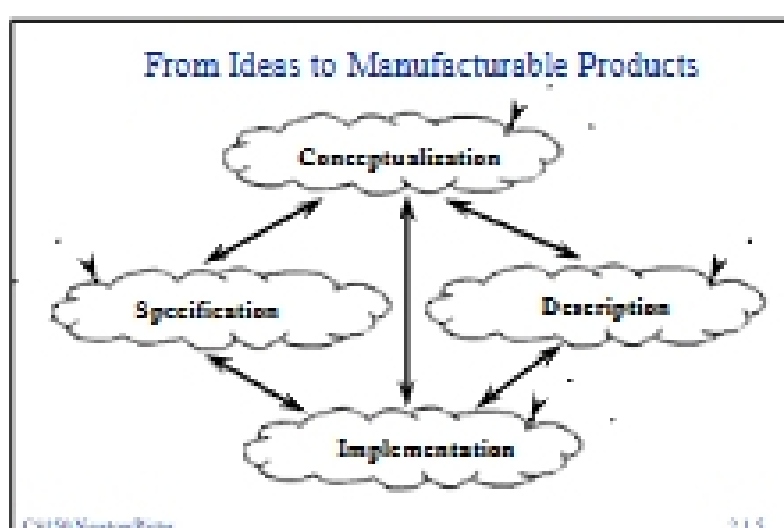
- **Specification:** Saying what I want; presents behavior in terms of results.
e.g. $\forall A \{ A[i,j] = 0 \}$
- **Description:** Saying how to do it; describes behavior in terms of procedure or process.
e.g. `for(i=0; i<N; i++)
 for(j=0; j<M; j++)
 A[i][j] = 0;`
- We do not have specification languages for general-purpose digital design. For some special-purpose applications (e.g. DSP) we do.

CS150 Newton/Pister 2.1.3

But Can We Really Specify or Even Describe Anything of Real Interest... ?

- It is not clear, in today's complex world, with complex interactions, that descriptive languages are particularly useful any more.
- "Any experience of reality is indescribable!" R. D. Laing
- "...conventional scientific language is descriptive, whereas a language used to share experience needs to be *descriptive*. It would be a language more akin to poetry, or even music, which would *depict an experience directly*, conveying, somehow, its qualitative character." Fritjof Capra

CS150 Newton/Pister 2.1.4



"Pure-Science" Problems

- Usually characterized by a *small number* of well-defined, relatively *independent*, first-order effects.
- Input and required output usually well defined.
- Measure of success usually well defined.
- Usually well-suited to algorithmic (or recipe-like) solution.
- Description or specification languages are, almost by definition, adequate!
(e.g. minimize the number of ANDs and ORs in a combinational logic function)

CS150 Newton/Pister 2.1.6

"Engineering-Science" Problems

- Characterized by a *large number of interacting second-order effects*.
- Often difficult to define inputs and outputs precisely.
- Measure of success often time-dependent and ill-defined.
- Require the use of good **experimental technique, modular design, and iteration**.

(e.g. Find the best multilevel combinational logic network that minimizes the area in an IC implementation using a particular library of logic gates while meeting the performance requirements and not using too much power.)

CS150 Newton/Pister 2.1.7

"Real Design" Problems

- Characterized by the *subtle, qualitative interaction of an uncountable number of effects*, integrated with a very small subset of quantitative, "designable" variables.
- **Controllable and measurable variables are usually misleading** if used to manipulate and evaluate the overall quality of a system.
- The *measure of success is more a "feeling,"* how much people "like" what you have done, than anything else - and that in itself is very time and context-dependent.
- The only viable approach is to use a **deceptive language** (build scenarios, build realistic models, build prototypes) and to "live" with it - to experience it directly in its real-world context.

CS150 Newton/Pister 2.1.8

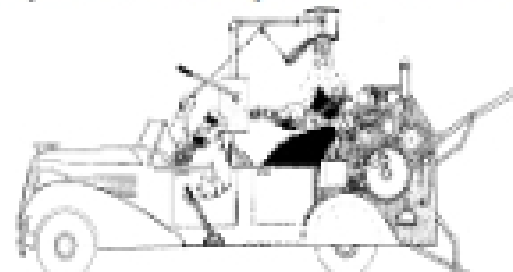
Classical Approaches to Design

- Design as a Refinement of Representations (Katz)
 - Design Specification
 - Design Constraints
 - Design as Representation
- Implementation and Assembly (Katz)
 - Top-Down Decomposition
 - Bottom-Up Assembly
- Other Common Approaches:
 - Mix-in-the-Middle Design
 - Waterfall Design Methodologies
 - Cooperative Design Methodology (e.g. Unix, X-Windows, Common Lisp)
 - Object-Oriented Design

CS150 Newton/Pister 2.1.9

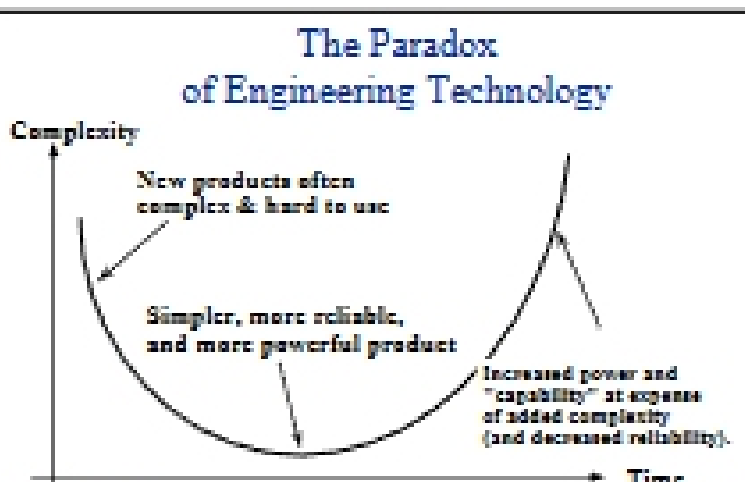
Bottom-Up or Top-Down?

- "In engineering one often finds the "Rube Goldberg" solution - the problem is solved by an inelegant and complicated collection of partial solutions."



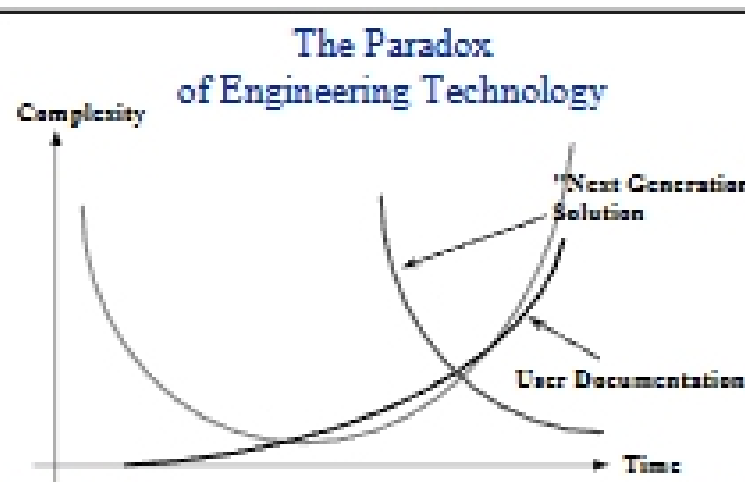
CS150 Newton/Pister 2.1.10

The Paradox of Engineering Technology



CS150 Newton/Pister 2.1.11

The Paradox of Engineering Technology



CS150 Newton/Pister 2.1.12

Conceptual Blocks

from "Conceptual Blockbusting," James L. Adams

- Perceptual Blocks
- Emotional Blocks
- Cultural & Environmental Blocks
- Intellectual & Expressive Blocks

CS150 Newton/Pister

2.1.13

Perceptual Blocks

- Seeing what you expect to see: Stereotyping
- Difficulty in Isolating the Problem
- Tendency to Delimit the Problem Area Too Closely
- Inability to See the Problem from Various Viewpoints
- Saturation
- Failure to Utilize All Sensory Inputs

CS150 Newton/Pister

2.1.14

Emotional Blocks

- Barnyard...
- Fear of Taking a Risk
 - Assess the possible negative consequences of an idea: What are your catastrophic expectations?
- No Appetite for Chaos
- Judging Rather than Generating Ideas
- Inability to Incubate: Sleep on it...

CS150 Newton/Pister

2.1.15

Cultural and Environmental Blocks

- Cultural Blocks
 - Taboos: Ping-pong & Pipe Example.
 - Fantasy & Reflection are a Waste of Time
 - Playfulness is only for Children
 - Design is too Serious for Humor!
 - Reason, Logic, Numbers, Utility, Practicality: GOOD; Feeling, intuition, qualitative judgments

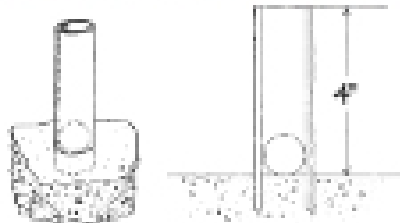
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2.1.16

A metal pipe is embedded in the concrete floor of a bare room, as shown below. The inside diameter is 0.007" larger than the diameter of the ping-pong ball (1.50") that is resting at the bottom of the pipe. You are one of a group of six people in the room, along with the following objects:

100 feet of clothesline	A light bulb
A carpenter's hammer	A chisel
A box of M&M's	A file
A wire coat hanger	A monkey wrench

Use as many ways as you can think of (in five minutes) to get the ball out of the pipe without damaging the ball, the tube, or the floor.



CS150 Newton/Pister

2.1.17

Cultural and Environmental Blocks

- Environmental Blocks
 - Lack of Cooperation & Trust among Colleagues
 - Autocratic Boss who Values only His/Her Own Ideas; Does not Reward Others.
 - Distractions: Telephone, Easy Intrusions.
 - Lack of Support to Bring Ideas into Action

CS150 Newton/Pister

2.1.18