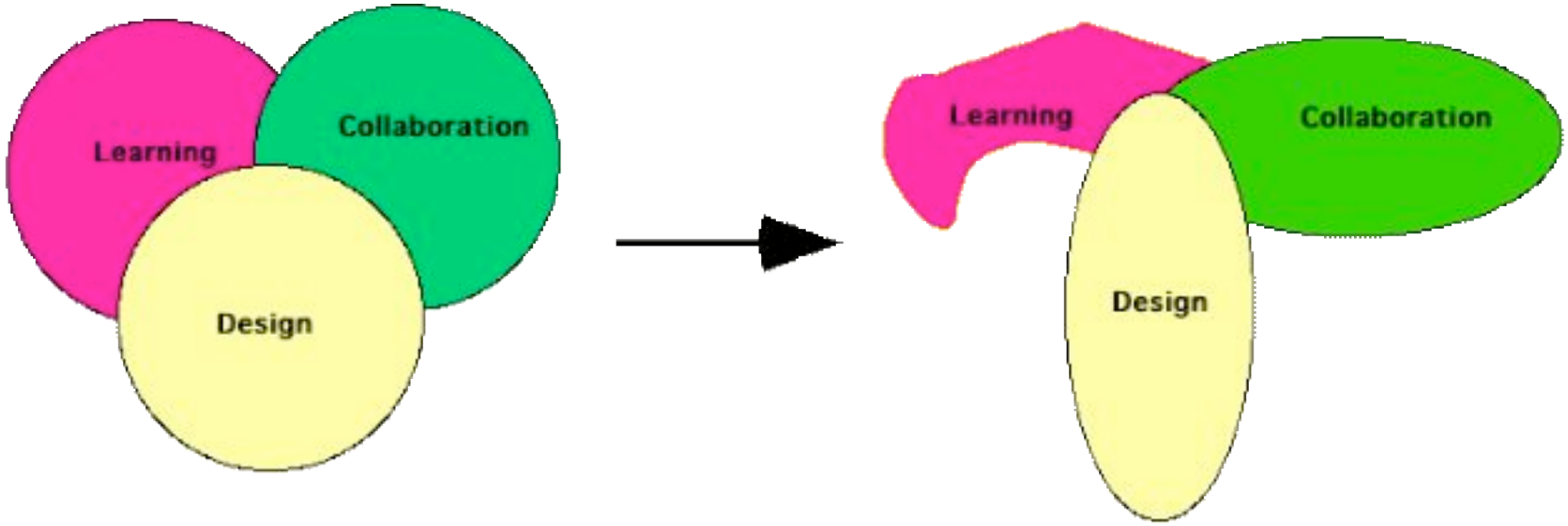
Wisdom is not the product of schooling but the lifelong attempt to acquire it.
- Albert Einstein

Overview of Design

Gerhard Fischer and Hal Eden
Spring Semester 2007

January 27, 2006

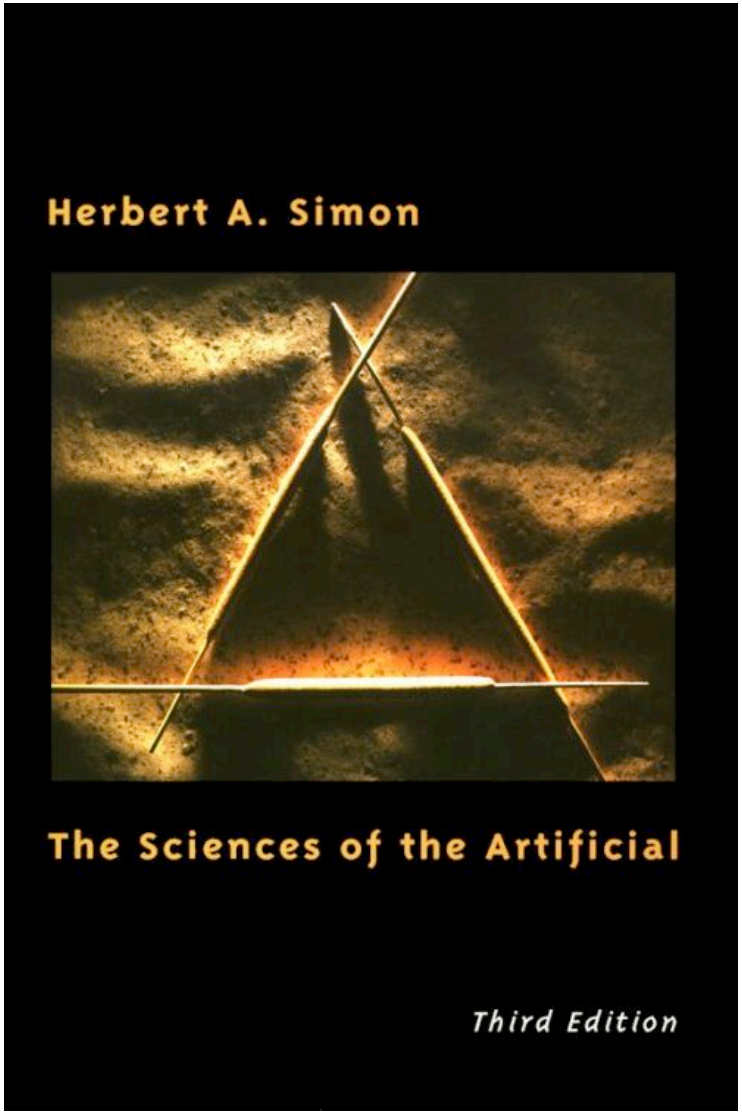
Interrelationships between Design, Learning, and Collaboration and Design, Learning, and Collaboration = f{Media}



Design

- **design to learn**
  - classroom
  - apprenticeship (e.g.: Undergraduate Research Apprenticeship Program)
  - Computer-Assisted Instruction
  - Intelligent Tutoring Systems
- **design to collaborate**
  - CSCW: computer-supported cooperative working
  - CSCL: computer-supported collaborative learning
  - Knowledge Management Systems
  - SWIKIs (e.g.: our course information environment for this course)
  - Collaborative Support for Writing (e.g.: in MS-Word)
- **design for designers → meta-design**
  - users are not passive consumers, but active contributors
  - systems are living entities
  - examples: open source, Wkipedia, 3D-Warehouse
  - Web 2.0 Technologies: Flickr, Facebook, ….

The Sciences of the Artificial



The Sciences of the Artificial

Simon, H. A. (1996) *The Sciences of the Artificial,* 3rd ed.,
The MIT Press, Cambridge, MA.
(1st ed: 1969, 2nd ed: 1981)

- **Definition of "artificial":** *human-made* as opposed to natural

- **questions:** where does mathematics / computer science / biology belong too?

- **claims by Herbert Simon:**
  - *"the world in which we live in today is much more a human-made, or artificial, world than it is a natural world"*
  - *"a plowed field is no more part of nature than an asphalted street — and no less"*

- **Alan Kay (Scientific America, Sept 84, p 57)**
  "molecular biology has the advantage of studying a system already put together and working; for the composer of software the computer is like a bottle of atoms waiting to be shaped by an architecture he must invent and then impress from the outside"

Science of Design

- **Definition:**

  Everyone designs who devise courses of action aimed at changing existing situations into preferred ones. The intellectual activity that produces material artifacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or a social welfare policy for a state (Simon, "Sciences of the Artificial", p 130)

- **generic design — does it exist?**
  - design as an activity has a distinct conceptual and cognitive realization from non-design activities
  - it can be abstracted away from the particulars of the knowledge base of a specific task or discipline and studied in its own right

- **a new major research program** of the Computer & Information Science & Engineering Directorate (CISE) of the National Science Foundation (NSF): **A Science of Design**

Brief Description of the "Science of Design" Program

by Peter Freeman, Director of CISE

"Efforts have been underway for many years to enable the creation of complex systems in a scientifically based manner. As we move forward into a world in which the number of devices, amount of software, and degree of connectivity in complex systems will all increase by orders of magnitude, it is essential that we have a 'science of design' on which to base our efforts at building such systems. CISE is engaged in spurring the innovation and scientific development necessary to achieving this goal."

A Success Example of Design in Architecture

Some Characteristics

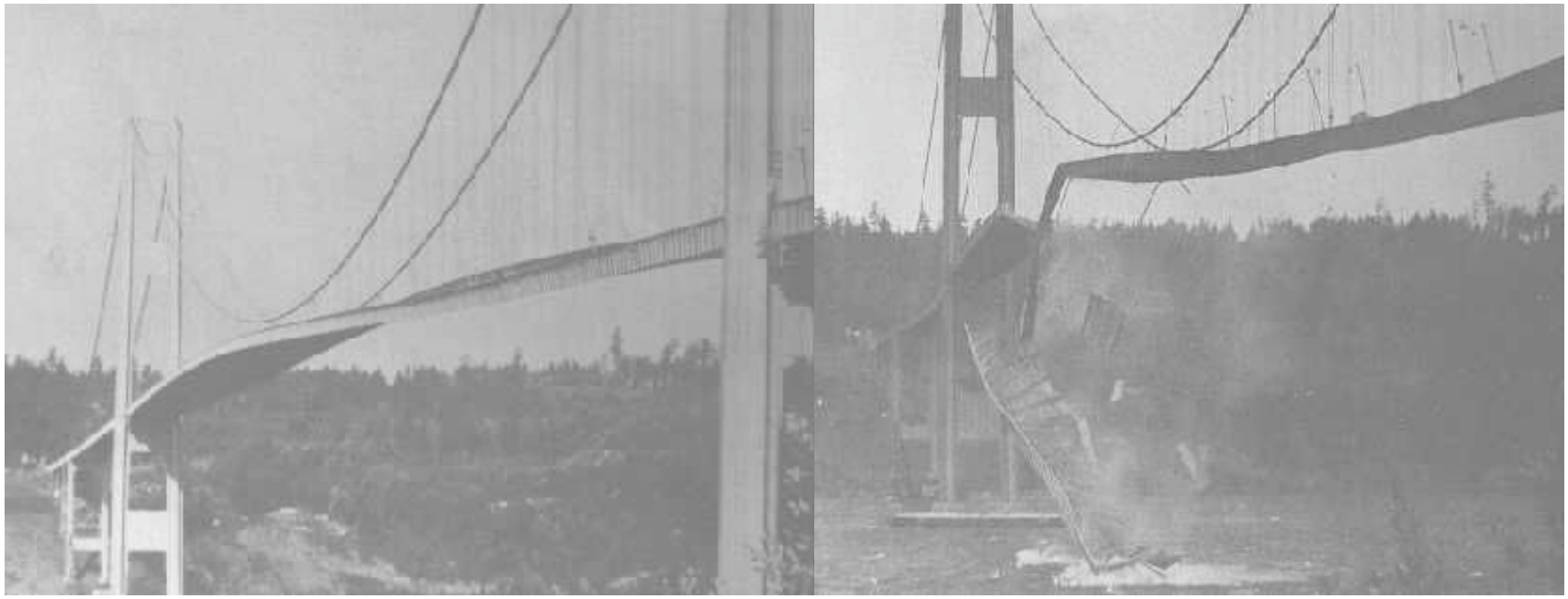
- Architect: Jorn Utzon
- Location: Sydney, Australia
- Date: 1957 to 1973
- Building Type: opera house
- Construction System: tile-clad concrete and precast concrete
- Climate: temperate
- Context: urban waterfront
- Style: Expressionist Modern
- Notes: Great stairway, family of forms in spherical section roofs, pure curving shapes that across the harbor in great heroic harmony

Another Success Example of Design in Architecture

Some Characteristics

- Architect: Frank Gehry
- Location: Bilbao, Spain
- Date: 1997
- Building Type: art museum
- Construction System: steel frame, titanium sheathing
- Climate: temperate
- Context: urban
- Style: Expressionist Modern
- Notes: A free sculpture of curvaceous metal-clad forms

To Engineer is Human



The Tacoma Narrows Bridge

- The original Tacoma Narrow Bridge, at all stages of its short life, was very active in the wind. Its nickname of *Galloping Gertie* was earned from its vertical motions in even very modest winds.

- Its collapse on November 7, 1940 attracted wide attention at the time and ever since, due in part to its capture on film.

- interesting book:
  Petroski, H. (1985) To Engineer Is Human: The Role of Failure in Successful Design, St. Martin's Press, New York.

Success Examples of Design in Computer Science?

- Fortran
- Subroutine
- Lisp
- Mouse
- SmallTalk (Dynabook)
- Lotus 1-2-3
- Microsoft Office: Word, Excel, Powerpoint
- World-Wide Web
- Google

Movie: “Starfire — A Vision of Future Computing”

an example of a genre of movies envisioning the future;
other example: “The Knowledge Navigator”

- made around 1995
- what is interesting about it?
- which part of the vision have become reality in 2007?
- what is still wishful thinking in 2007?

▪ Design Deals with Wicked or Ill-Defined Problems

- there is no **definitive formulation** of a wicked (ill-defined) problem. For any given tame (well-defined) problem, an exhaustive formulation can be stated containing all the information the problem-solver needs for understanding and solving the problem.

- Wicked problems have **no stopping rule**. In tame problems, problem solvers know when they have done the job. Problem solvers terminate work on a wicked problem, not for reasons inherent in the 'logic' of the problem.

- solutions to wicked problems are not “true-or-false”, but **“good-or-bad”**

- every wicked problem is essentially **unique**

- the aim of design is not to find the truth, but **to improve some characteristics of the world where people live**

Integration of Problem Framing and Problem Solving: An Example from McGuckin Hardware Store

Customer: I want to get a couple of heaters for a downstairs hallway.

Sales Agent: What are you doing? What are you trying to heat?

Customer: I'm trying to heat a downstairs hallway.

Sales Agent: How high are the ceilings?

Customer: Normal, about eight feet.

Sales Agent: Okay, how about these here?

(They proceed to agree on two heaters.)

Customer: Well, the reason it gets so cold is that there's a staircase at the end of the hallway.

Sales Agent: Where do the stairs lead?

Customer: They go up to a landing with a cathedral ceiling.

Sales Agent: OK, maybe you can just put a door across the stairs, or put a ceiling fan up to blow the hot air back down.

Complexity of Designs

from Dawkins, R. (1987) The Blind Watchmaker, W.W. Norton and Company, New York - London.

- **biology** is the study of complicated things that give the appearance of having been designed for a purpose
- **physics** is the study of simple things that do not tempt us to invoke design
- treat **complex human-made artifacts** (e.g., computers, airliners, cars, books) as biological objects
- the behavior of physical, non-biological objects is so **simple** that it is feasible to use existing mathematical language to describe it
- a complex thing is something whose constituent parts are arranged in a way that it is unlikely **to have arisen by chance** alone

The Shape of the Design: Hierarchy
—
The Problem of Modularity

- **claim**: to design a complex structure, one powerful technique is to discover viable ways of decomposing it into semi-independent components corresponding to its many functional parts. The design of each component can then be carried out with some degree of independence of the design of others, since each will affect the others largely through its function and independently of the details of the mechanisms that accomplish the function.

- **examples**:
  - functional programming
  - object-oriented programming
  - rule-based systems
  - nearly decomposable systems

Different Design Approaches

- **professionally-dominated design**
  - works best for people with the same interests and background knowledge
- **user-centered design:**
  - analyze the needs of the users
  - understand the conceptual worlds of the users
- **learner-centered design**
  - draws attention to the changing needs of users
  - combine HCI interaction principles with educational interaction support
- **participatory design**
  - involve users more deeply in the process as co-designers by empowering them to propose and generate design alternatives
  - focus on system development at design time by bringing developers and users together to envision the contexts of use
- **meta-design:**
  - create design opportunities at use time
  - requires co-creation

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