

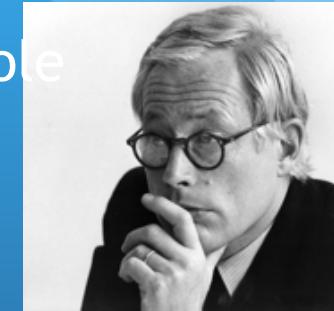
Rational design

Cameron Shelley
STV 202

The best solution

Dieter Rams describes design as a professional role

- Concerns good professional practice
- Entails a social mission



Not all designers are professionals, or work in the same profession

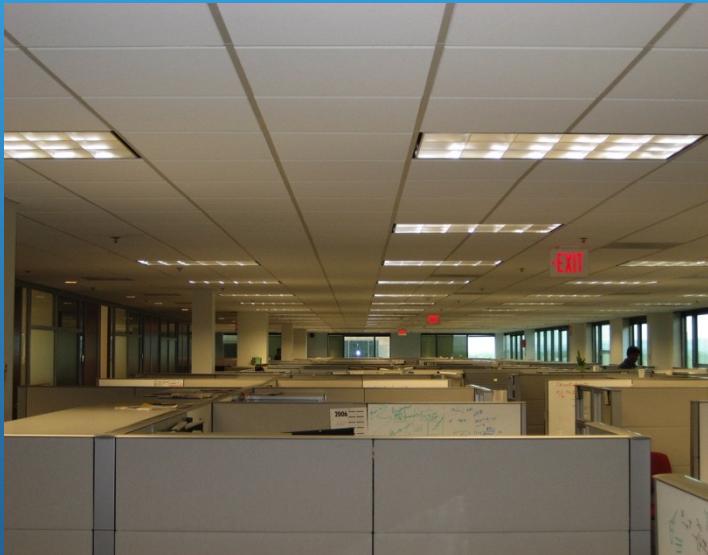
Herbert Simon describes design as problem solving

- Design involves solving a problem in the best possible way
- Good design is rational

This approach is more general and impersonal than Rams's

- However, it also requires God-like abilities

Case study: the open office...



Cubicles were introduced in the 1960s

- Provide privacy to “knowledge workers”
- Provide adaptability and cost-efficiency to managers

However, cubicles stifle interaction and facilitate loafing

The open office

The open office was introduced in the late 1990s

- Provides opportunities to interact among “knowledge workers”
- Allows managers and fellow employees to police loafing

However, open office designs can be distracting and stressful

Was the open office design a *rational* response to the problems of cubicles?



Herbert Simon (1916-2001)

Ph.D. in PoliSci from Chicago (1943)

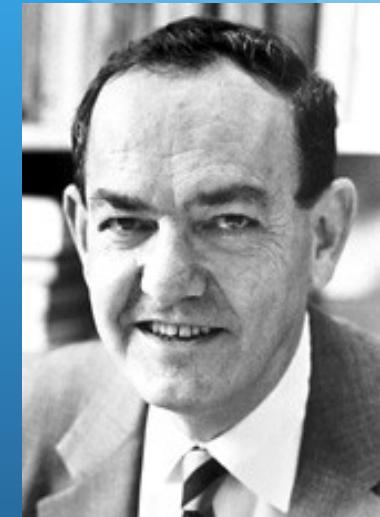
Moved to CMU (1949)

Studied human decision-making

- Staged in organizations
- Psychologically plausible models
- Computer simulations of human reasoning

Awards included:

- APA Award for distinguished contributions to Psychology (1969)
- ACM Turing Award for contributions to AI (1975)
- Nobel Memorial Prize in Economics (1978)



Herbert Simon

Design problems

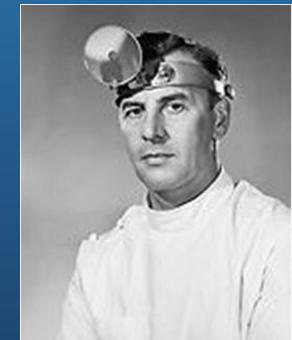
Science versus engineering

- Science concerns natural systems
- Engineering concerns artificial systems

On design:

- “Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. ... Schools of engineering, as well as schools of architecture, business, education, law, and medicine, are all centrally concerned with the process of design.”

How is a doctor a designer, on this view? A novelist?



The design environment

Inner environment:

- The set of plan alternatives

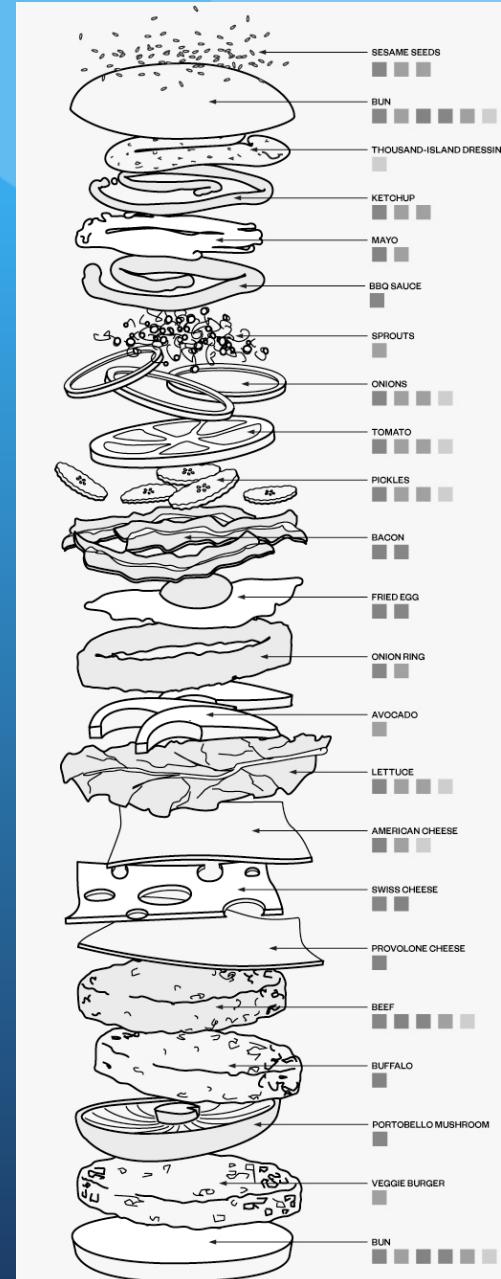
Outer environment:

- Parameters within which alternatives would operate

Finding the alternatives:

1. Simple list
2. Assemblies of more basic components

Situation 2 is the most typical



Rational design

Successful design involves relating three sorts of parameters

- The *means*: basic components and their quantities
- The *laws*: unalterable facts about the problem situation
- The *ends*: define what counts as a satisfactory solution, i.e.,
 - Constraints, e.g., thresholds, tolerances
 - Utility function, to evaluate alternative designs

Utility function typically amounts to *optimality*

The best solution to a design problem is the combination of means—the design—that obeys all relevant laws and satisfies all relevant ends in an optimal way.

A best solution is *rational* because it is optimal

- Any rational being would prefer optimal solutions to others



Case study: The diet problem

Means: a list of available foods and quantities

Laws: prices of foods, their nutritional values

Ends:

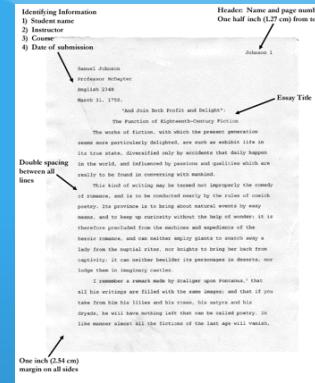
- Nutritional requirements, e.g., < 2000 cal./day,
> 10 mg vitamin C, no spinach (!) ...
- Utility: lowest cost



Summary

Types	Terms	Example: Diet problem
Means	Command variables	List of foods and quantities
Laws	Fixed parameters	Prices of foods Nutritional contents
Ends	Constraints Utility function	Nutritional requirements Cost of diet

Exercise



Terms	Designs		
	<i>Clock</i>	<i>Essay</i>	<i>Game</i>
<i>Means</i>			
<i>Laws</i>			
<i>Ends:</i> <ul style="list-style-type: none"> • <i>Constraints</i> • <i>Utility function</i> 			

Obstacles to rational design

There are several obstacles to rational design

1. Our *knowledge* of inner and outer environments is not perfect, e.g., a highway planning model



Obstacles: Computing power

2. We lack the *computing capacity* to make accurate predictions, even with perfect knowledge, e.g., the travelling salesman problem



Obstacles: Differences

3. Reasonable people may differ in
 - a) Their *methods* for finding solutions to a problem
 - b) Their *representations* of a problem and its solutions



Arctic sea ice

Bounded rationality

We lack the ability to solve non-trivial problems rationally

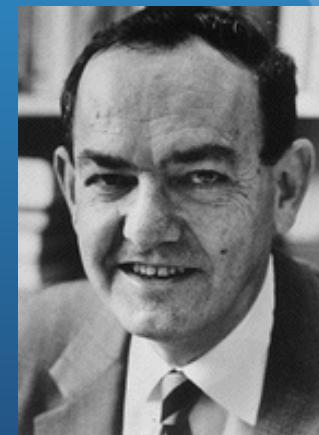


We can exercise *bounded rationality*:

- Solve problems as well as we know how

Good design applies bounded rationality

- No other design is known to be more optimal
- All assumptions have worked well before
- All assumptions are widely-accepted, e.g., best practices or industry standards



To improve designs, knowledge must increase

Unintended consequences

In 2013, Toyota recalled cars due to airbag bugs

- Spiders built webs in air conditioning condensers, causing water to condense and drip onto air bag controllers

Car designers are not expert in entomology

Can you think of other instances of unintended consequences in design?

