Engineering Design *An Introduction*

Chapter 4

Generating and Developing Ideas

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Introduction

- Ideas
  - Incredibly important to business
  - Generate new or improved products
  - Cornerstone of innovation
- "The best way to have a good idea is to have lots of ideas"–Linus Pauling

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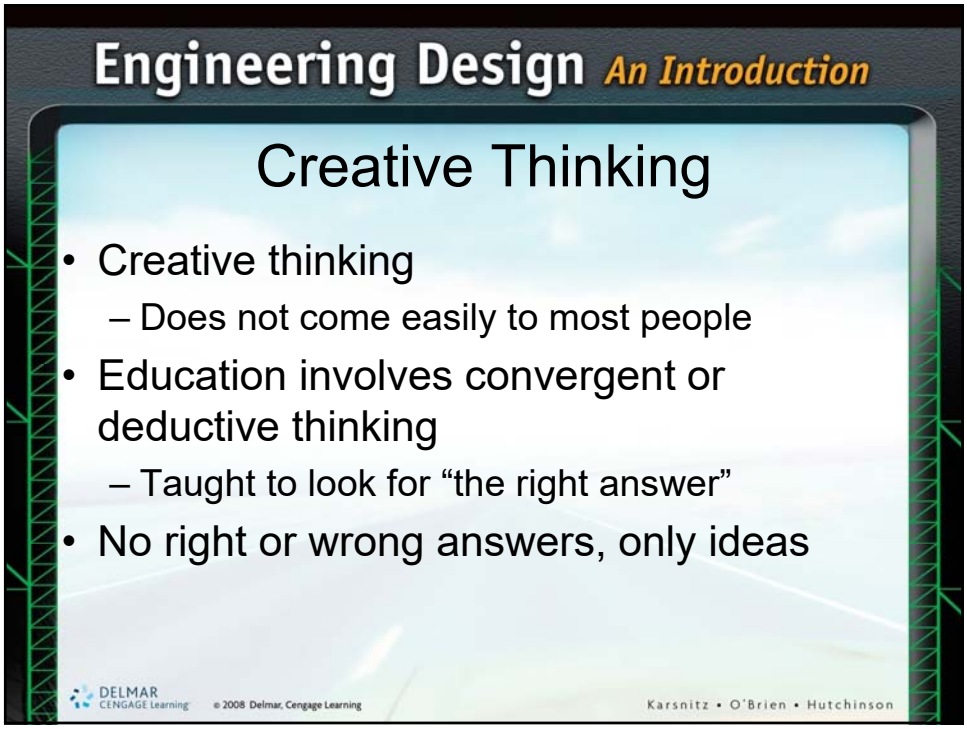
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Creative Thinking
• Creative thinking
– Does not come easily to most people
• Education involves convergent or deductive thinking
– Taught to look for "the right answer"
• No right or wrong answers, only ideas
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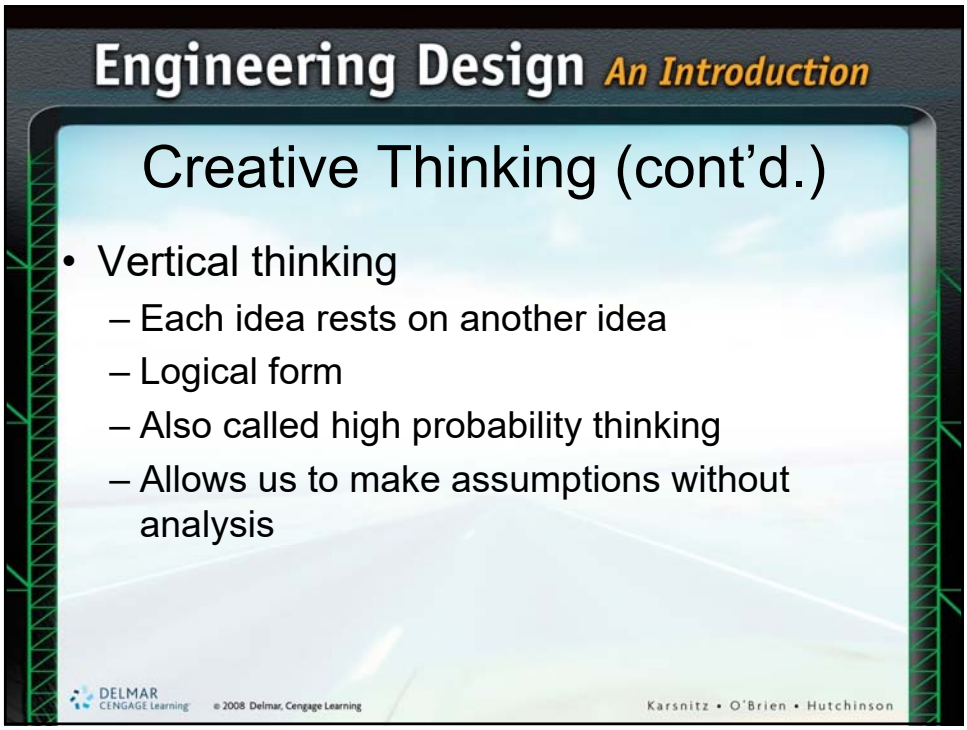
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Creative Thinking (cont'd.)
• Vertical thinking
– Each idea rests on another idea
– Logical form
– Also called high probability thinking
– Allows us to make assumptions without analysis
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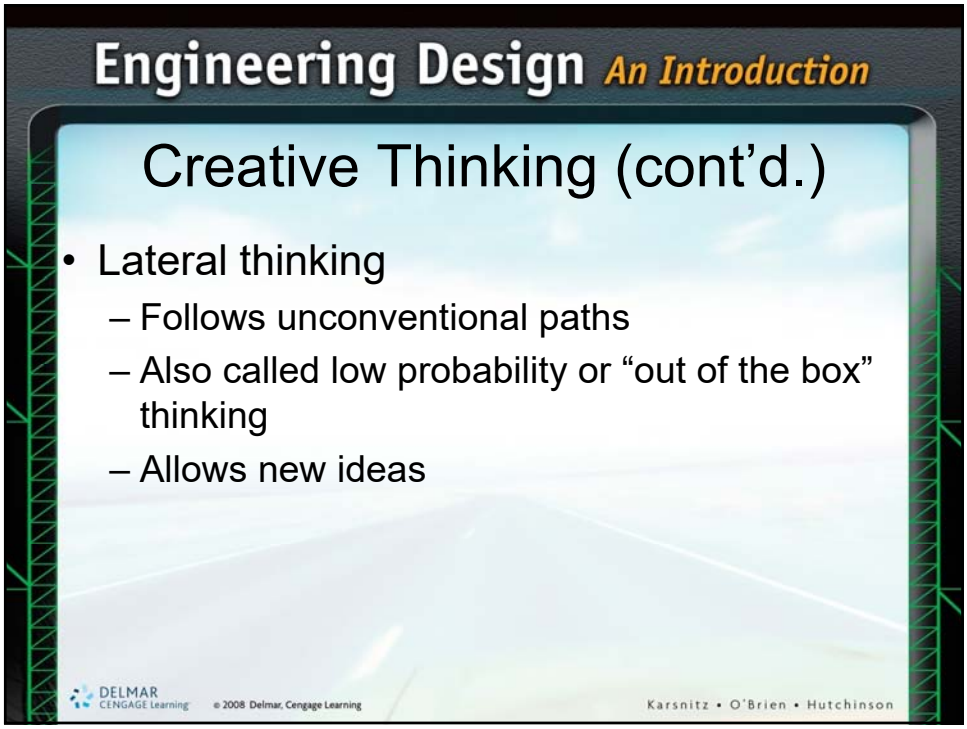
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Creative Thinking (cont'd.)
• Lateral thinking
– Follows unconventional paths
– Also called low probability or "out of the box" thinking
– Allows new ideas
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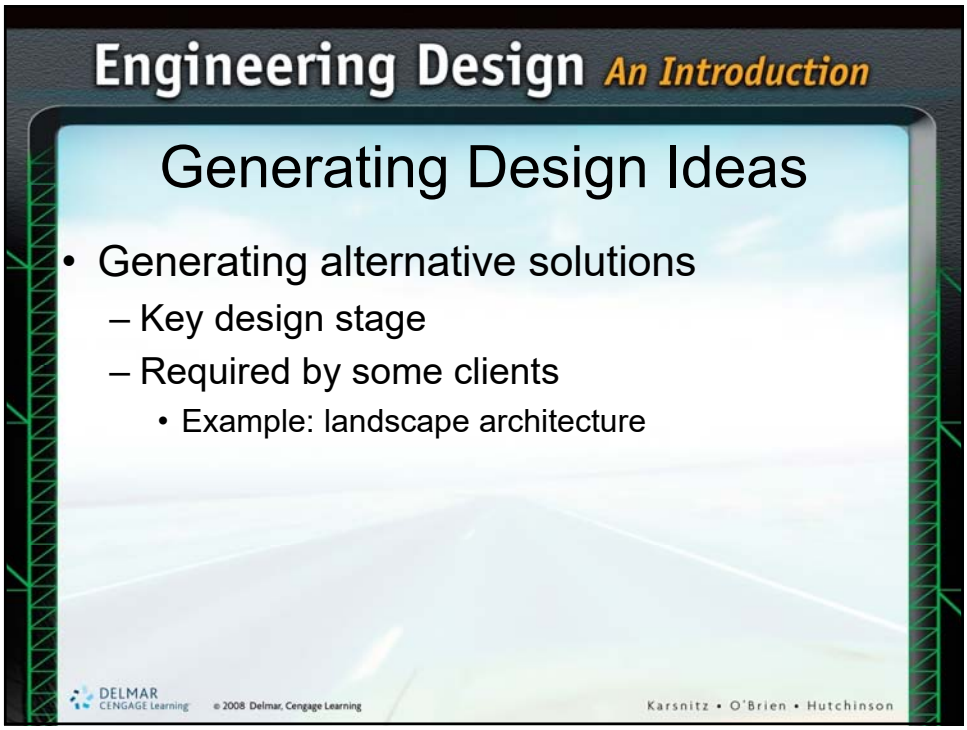
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Generating Design Ideas
• Generating alternative solutions
– Key design stage
– Required by some clients
• Example: landscape architecture
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Lateral Thinking

- Lateral thinking techniques
  - Pioneered by Edward de Bono
- Identify the dominant idea
  - Entrenched, or widely accepted idea
- Find different ways of looking at the problem
  - Uncover other viewpoints

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Analogies

- Similarities between two unlike things
- Example: Gutenberg's invention of the printing press
  - Coin punch and wine press
- Look for similarities to other problems
  - May present design possibilities

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Brainstorming

- Exchange of ideas in a group
  - Ideas used to stimulate more ideas
- Attempt to get away from conventional solutions
- Friendly environment where new ideas are welcome
- Limited time frame

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Figure 4-4: *Organization of a brainstorming session.*

Organizing a Brainstorming Session

Brainstorming can be an effective strategy for generating a lot of ideas for solving a problem. Here are some important rules for brainstorming.

1. Work in a group of at least three or four people.
2. One person must take notes; recording of emerging ideas is critical for allowing revisiting of earlier inspirations.
3. Define the problem well, and make sure that each person understands it.
4. Set relatively short time limits on each problem (30-60 min.).
5. Be spontaneous, be outrageous, be imaginative.
6. Listen carefully to other people's ideas, and build on them.
7. Do not criticize, evaluate, or even elaborate. [Important!]
8. Go for quantity to ensure quality.
9. Evaluate only after your idea creation ("ideation") session has ended.

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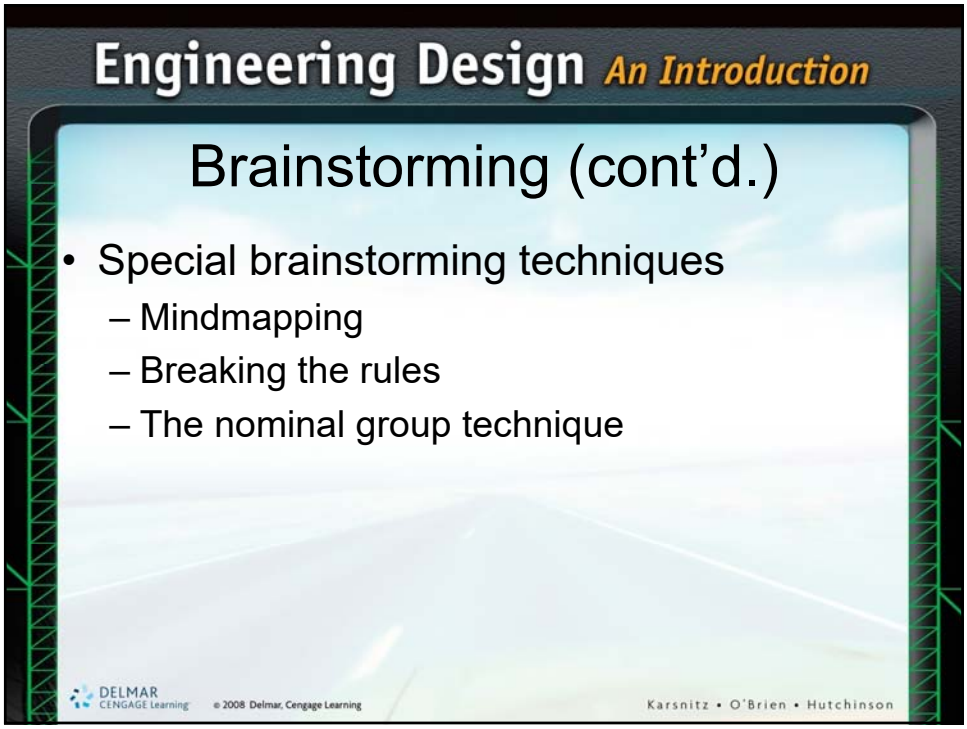
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Brainstorming (cont'd.)
• Special brainstorming techniques
– Mindmapping
– Breaking the rules
– The nominal group technique
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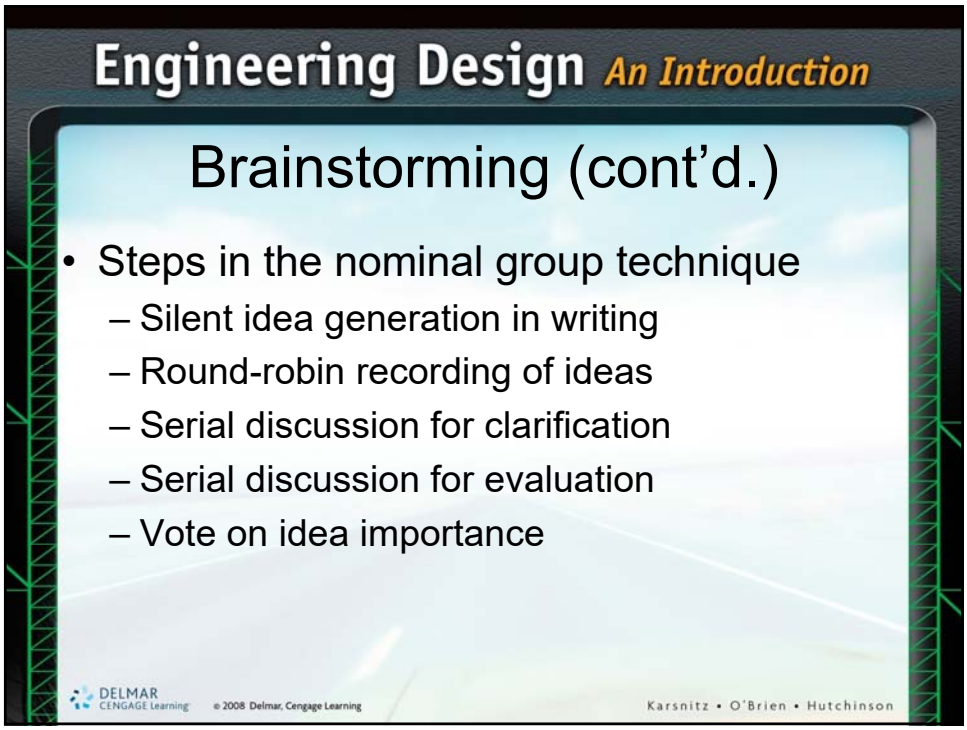
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Brainstorming (cont'd.)
• Steps in the nominal group technique
– Silent idea generation in writing
– Round-robin recording of ideas
– Serial discussion for clarification
– Serial discussion for evaluation
– Vote on idea importance
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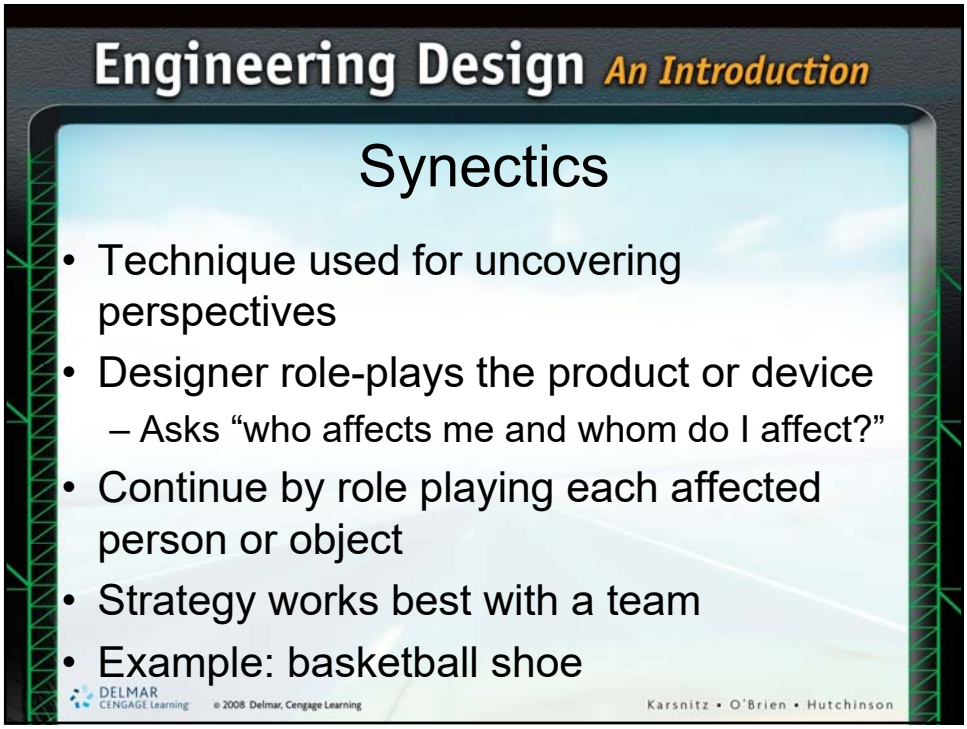
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Synectics
• Technique used for uncovering perspectives
• Designer role-plays the product or device
– Asks "who affects me and whom do I affect?"
• Continue by role playing each affected person or object
• Strategy works best with a team
• Example: basketball shoe
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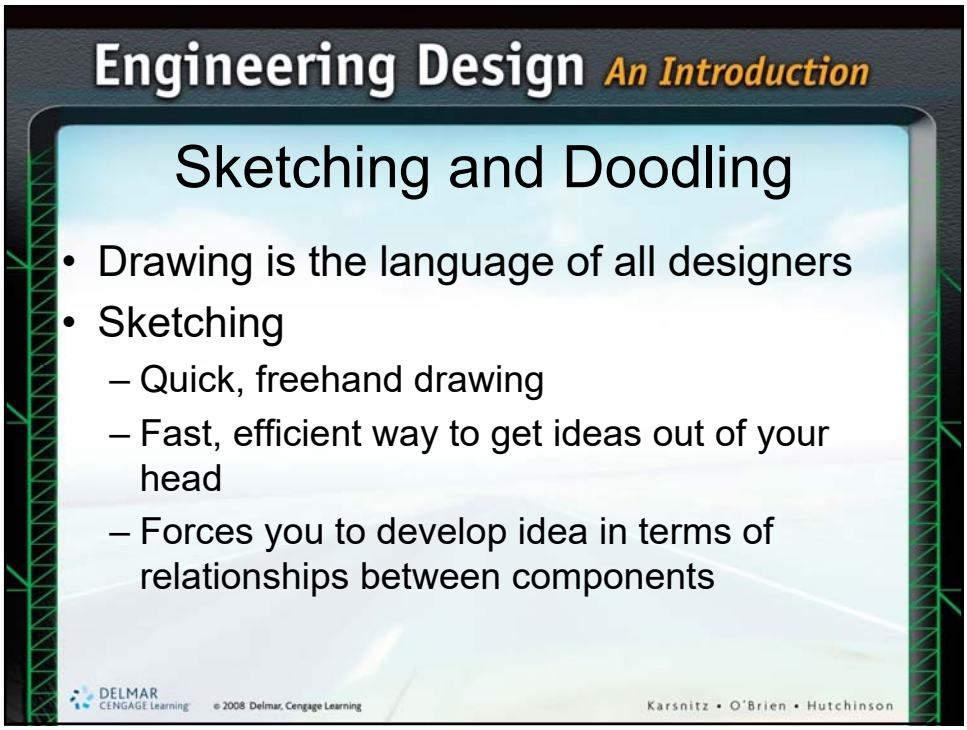
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Sketching and Doodling
• Drawing is the language of all designers
• Sketching
– Quick, freehand drawing
– Fast, efficient way to get ideas out of your head
– Forces you to develop idea in terms of relationships between components
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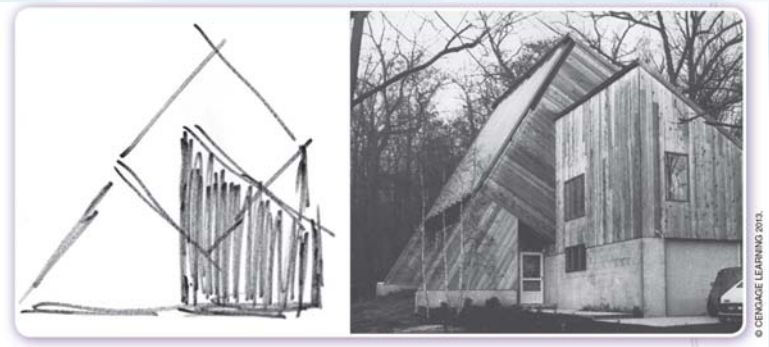

Figure 4-6: A sketch for a solar home, and its realization.

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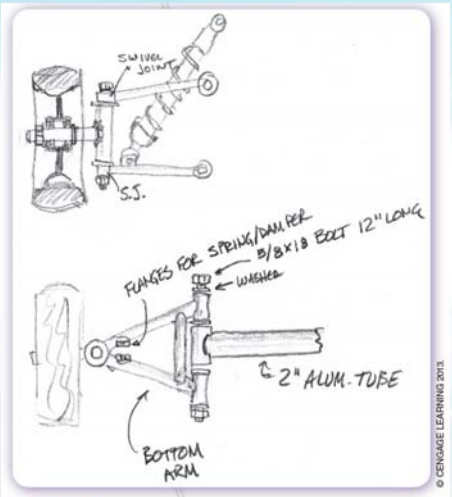
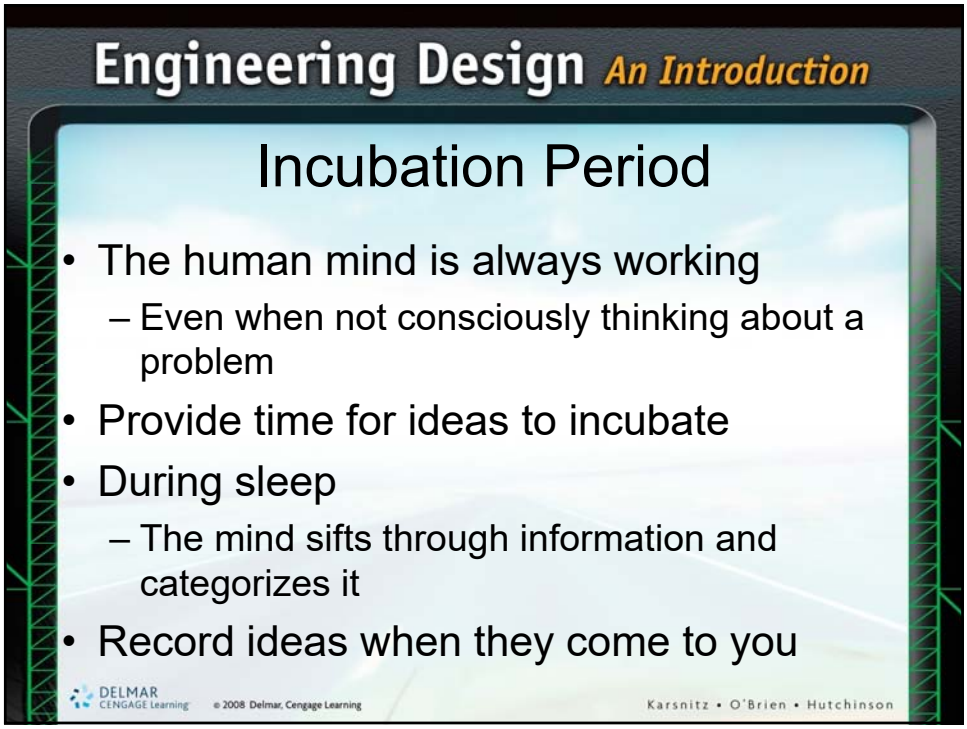


Figure 4-7: An example of an effective technical sketch.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Incubation Period
• The human mind is always working
– Even when not consciously thinking about a problem
• Provide time for ideas to incubate
• During sleep
– The mind sifts through information and categorizes it
• Record ideas when they come to you
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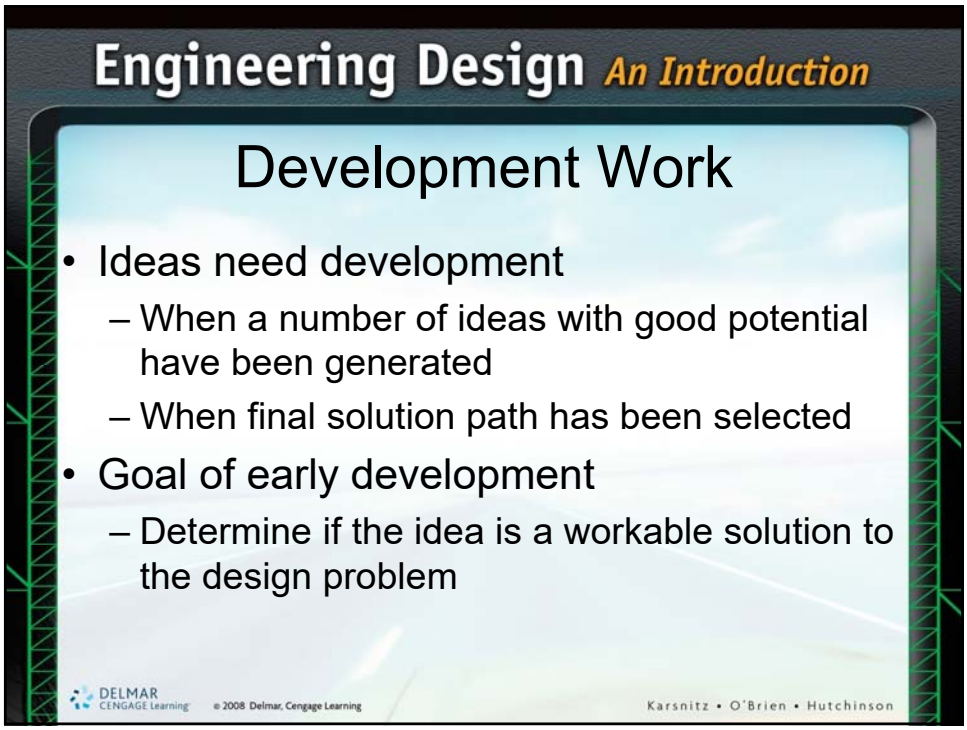
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Development Work
• Ideas need development
– When a number of ideas with good potential have been generated
– When final solution path has been selected
• Goal of early development
– Determine if the idea is a workable solution to the design problem
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Construction Kits

- Useful strategy
  - Use construction kits to make a model of the mechanism
    - Examples: Lego, K'NEX, Meccano, etc.
  - Allows working out details in three dimensions

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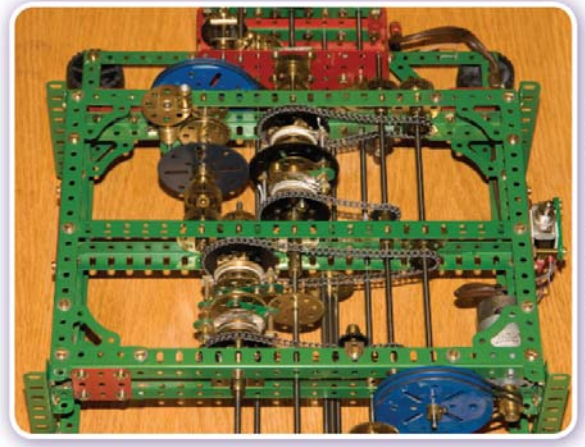

COURTESY OF TIM ROBINSON, WWW.MECCANO.US.

Figure 4-9: A "torque amplifier" for an analog computer constructed from Meccano.

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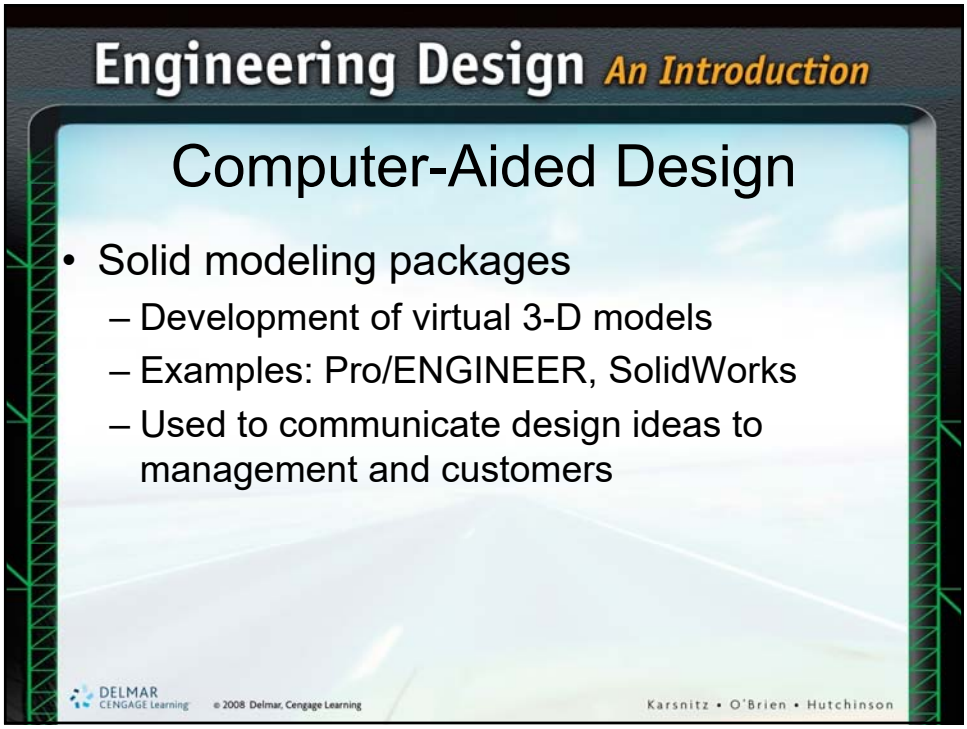
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Computer-Aided Design
• Solid modeling packages
– Development of virtual 3-D models
– Examples: Pro/ENGINEER, SolidWorks
– Used to communicate design ideas to management and customers
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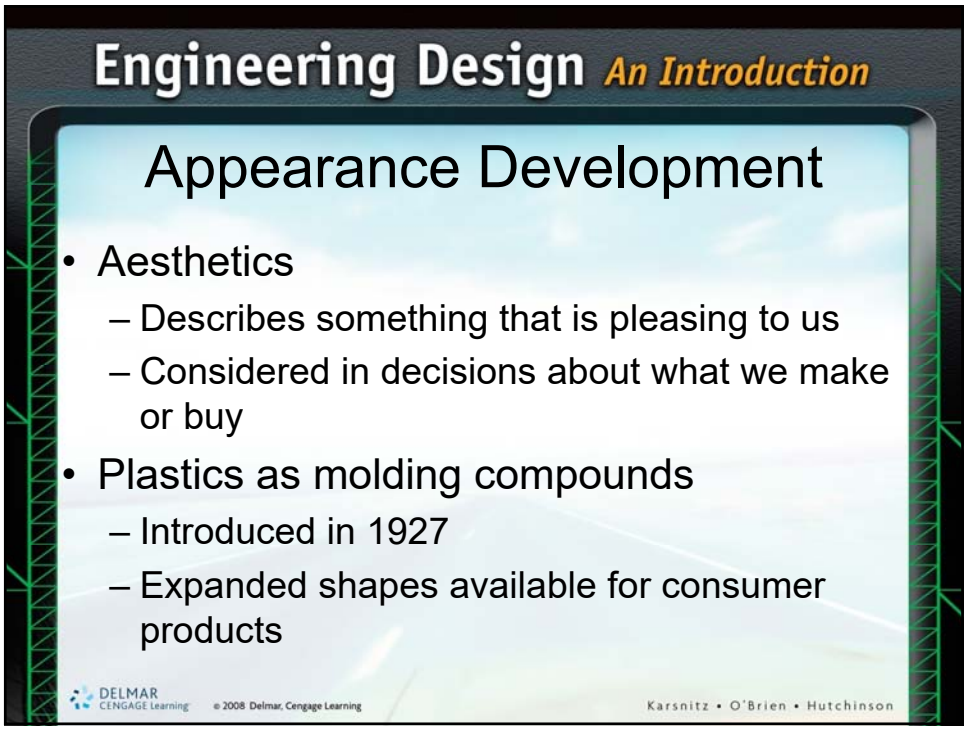
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Appearance Development
• Aesthetics
– Describes something that is pleasing to us
– Considered in decisions about what we make or buy
• Plastics as molding compounds
– Introduced in 1927
– Expanded shapes available for consumer products
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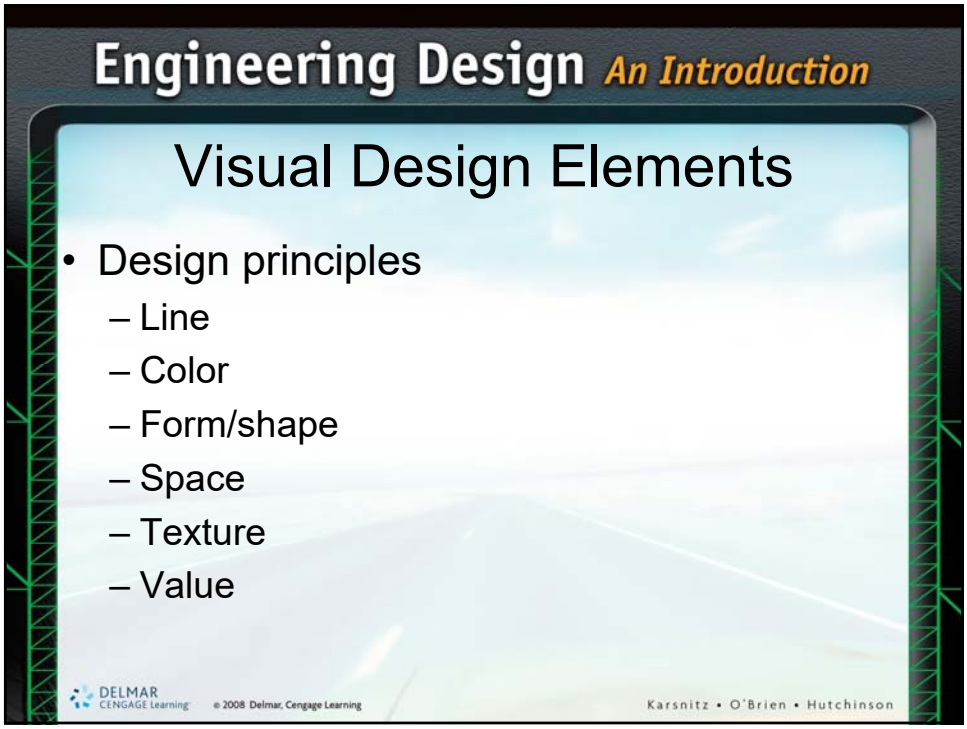
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Visual Design Elements
• Design principles
– Line
– Color
– Form/shape
– Space
– Texture
– Value
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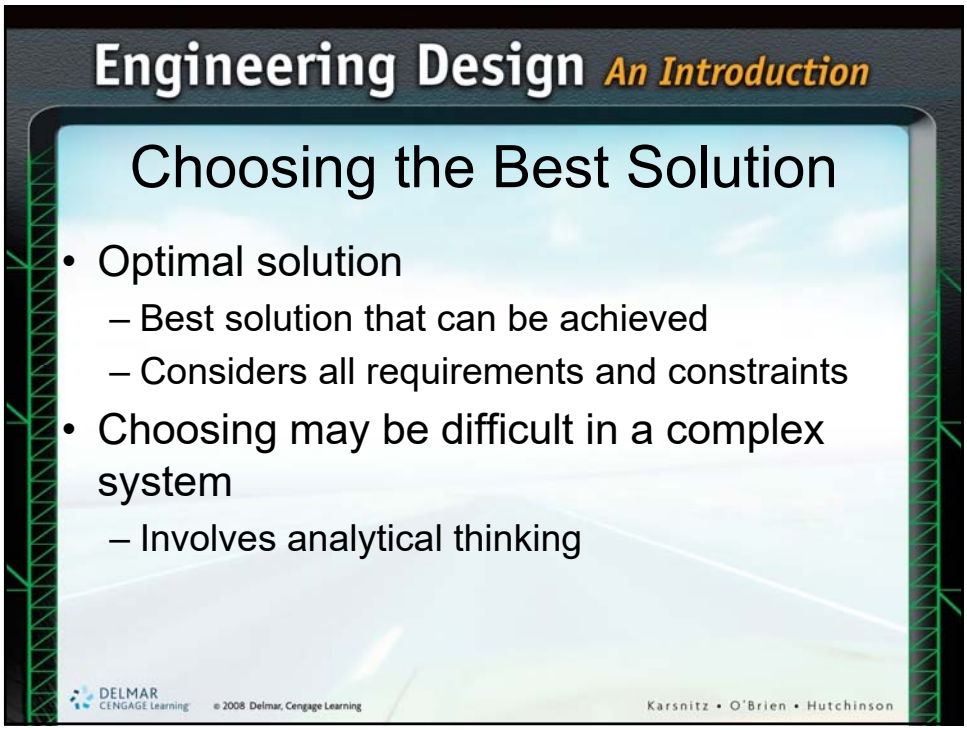
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Choosing the Best Solution
• Optimal solution
– Best solution that can be achieved
– Considers all requirements and constraints
• Choosing may be difficult in a complex system
– Involves analytical thinking
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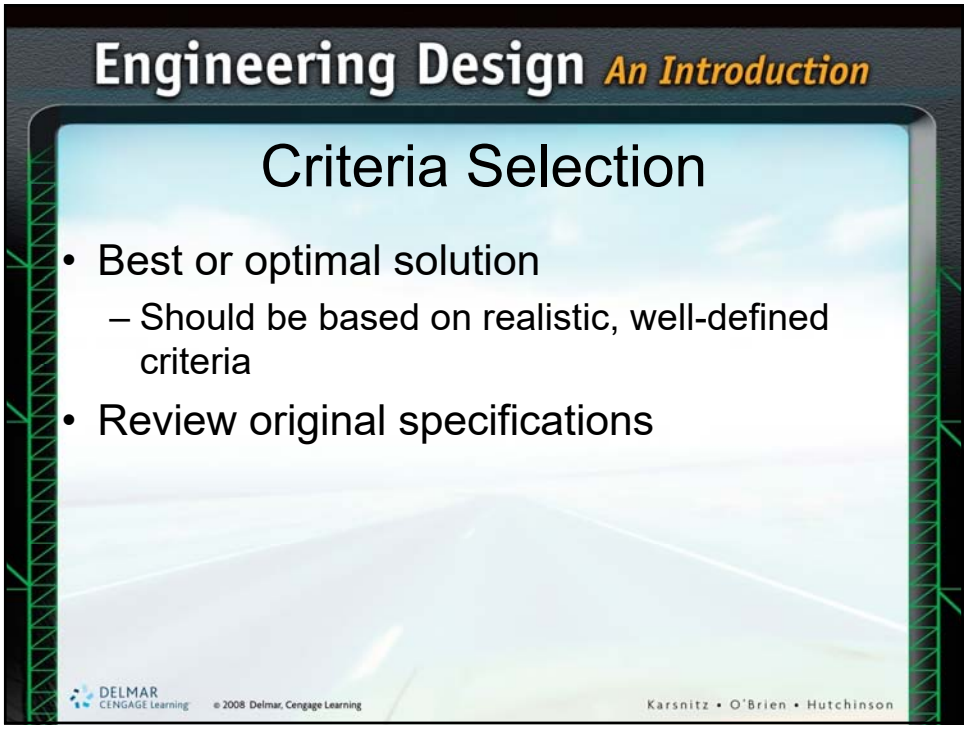
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Criteria Selection
• Best or optimal solution
– Should be based on realistic, well-defined criteria
• Review original specifications
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