DESIGN PROCESS (ENGINEERING)

Creativity

Design

Problem solving

ERG Design

CREATIVITY

CREATIVITY

Creativity is looking at the same thing as everyone else and thinking something different (A. Szent-Gyorgyi)

CREATIVITY

Select a figure that is different from all the others. Explain the reason for your choice.

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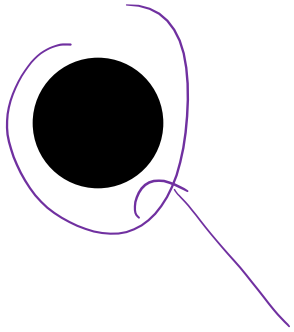
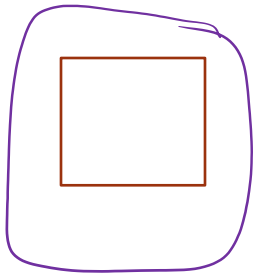
b. 

c. 

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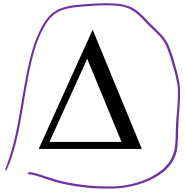
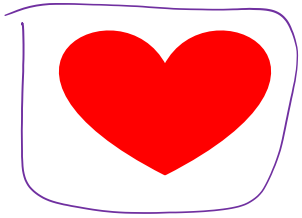
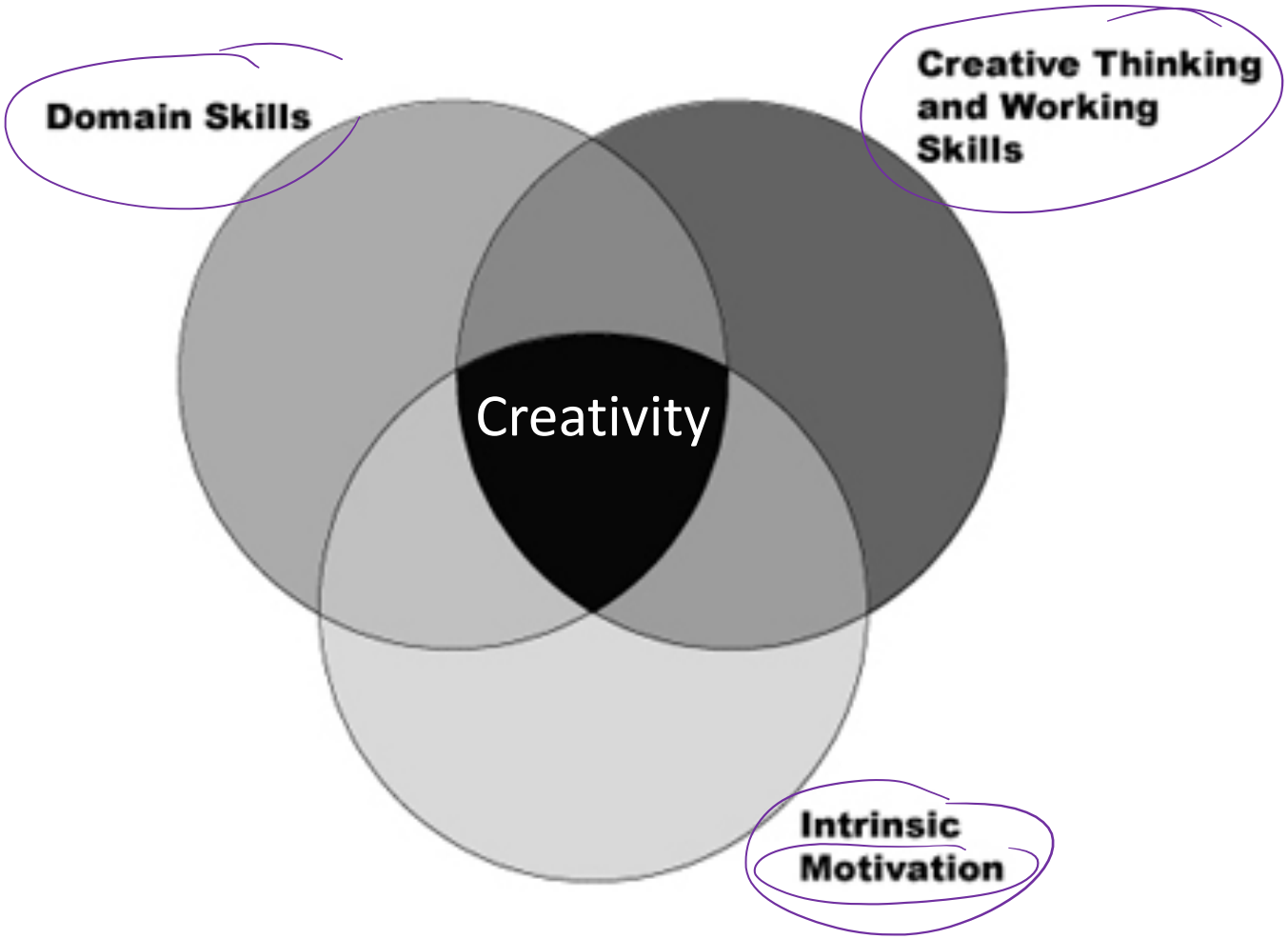
e. 

f. 

Adapted from: Creative problem solving and Engineering Design, Lumsdaine et al 1999

CREATIVITY

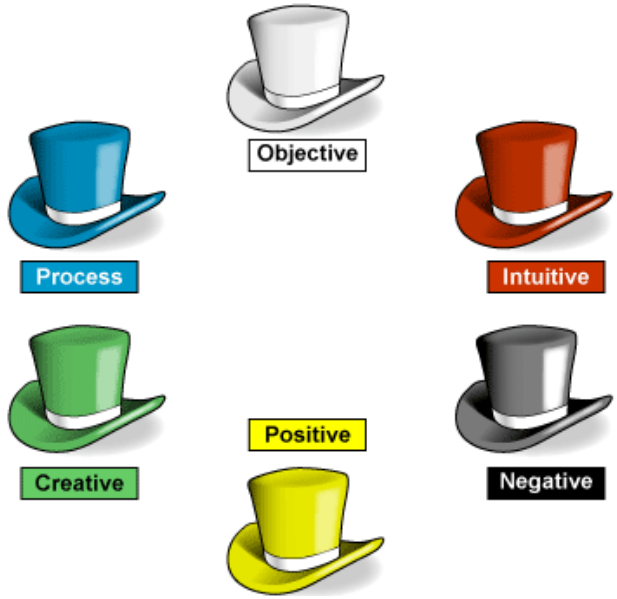


Amabile HBR 1998

CREATIVE THINKING

Becoming more creative

- Removing habit barriers
  - There is only one right answer
  - Looking at a problem in isolation
  - Following the rules
- Remove attitude barriers
  - Discomfort with ambiguity
  - Negative pessimistic thinking
  - Risk-avoidance or fear of failure



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DESIGN

WHAT IS DESIGN?

" 1) to create, fashion, execute, or construct according to plan; 2) to conceive and plan out in the mind" – Webster's

"Good design keeps the user happy, the manufacturer in the black and the aesthete un-offended" – Raymond Loewy

"When you're a carpenter making a beautiful chest of drawers, you're not going to use a piece of plywood on the back, even though it faces the wall and nobody will ever see it. You'll know it's there, so you're going to use a beautiful piece of wood on the back." --???

WHO DESIGNS?

Answer the following: *how many job/domain titles can you think of that end in "design"?*

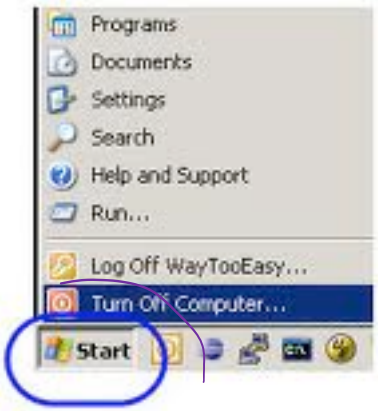
- Examples: Interior *design*, Game *design*

DESIGN FAILURES

De la Concorde overpass Canada

Experience Music Project Seattle

BER airport Berlin



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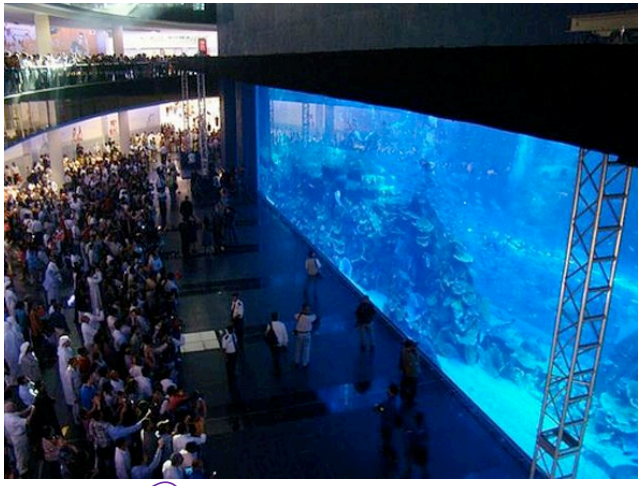


Dubai Aquarium

The Lotus Riverside Complex, Shanghai

DESIGN EXERCISE

List one item from your everyday life that you consider to be a good design, and one that is bad. Briefly describe the qualities of the design.

GOOD:

BAD:

FOLLOW-UP

- When describing how the things you listed demonstrate good design, did you consider Loewy's attributes? Does it…
  - keep the user happy? (functional)
  - keep the manufacturer in the black (feasible)
  - keep the aesthete un-offended (elegance)
- Were there other things that influenced your opinion on what makes good design?

PROBLEM SOLVING

WHAT IS NEEDED?

- Creativity and Intelligence
  - Creative thinking
  - Abstract thinking
  - Logical thinking
  - Analyzing
- Decision making
  - See dependencies
  - Realize what is important and what is not
  - Flexibility
  - Handling of failure

BASIC APPROACH

- Define goal:
  - Overall goal
  - Part goals
    - ➔ Motivation to find goal: knowing when goal is reached
- Set up boundaries and pre conditions
- Get rid of prejudice
  - Think outside the box
  - Do not think of everything already known and done
    - ➔ Allows for broad search of solutions, new solutions
- Evaluate
  - Does it meet the goal
- Decide
  - Is the goal met, is another iteration needed?

ERG DESIGN

THE ENGINEERING DESIGN PROCESS

Define the problem: "*It is important that the problem being addressed is actually the problem that is important to customers*"

Techniques:

- Gather info from customers and stakeholders (*elicitation*)
- Expert information
- Root cause analysis

- A huge problem in SE
  - You will spend a lot of time here in SER415

THE ENGINEERING DESIGN PROCESS

Criteria & Constraints: *Establish up-front decision-making conditions to be used in later stages*

Criterion: "A standard or attribute of a design that can be measured"

Constraint: "A limitation or condition that must be satisfied by a design"

THE ENGINEERING DESIGN PROCESS

Generate Ideas: *This is the 'black magic art' of the process!*

Techniques: (just a sample)

- Decompose problems
- Metaphors and Analogies
- External inspiration
- Brainstorming
- Work in Parallel vs. GroupThink

- Idea Reduction
  - Your goal is to generate a lot of ideas
  - Can you quickly prune the space?

THE ENGINEERING DESIGN PROCESS

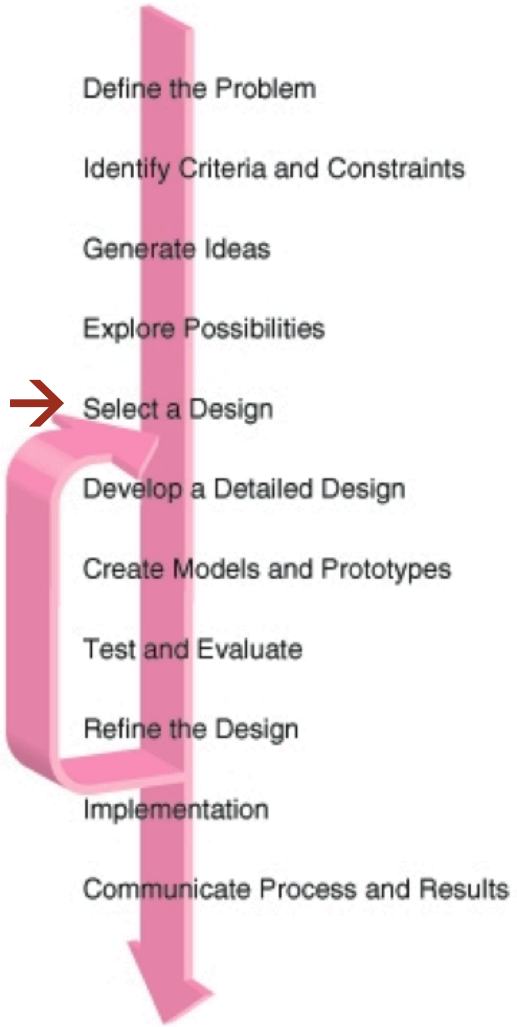
Explore Possibilities: *reading says do this with a structured process*

Idea Reduction Techniques:

- Combine ideas
- Voting methods
- Map idea to root cause analysis
- Explore others' approaches
- Prototype (rapid and light)

- A difficult problem - how much time you devote to exploring solutions has a big impact on your project outcome!
  - Too much: "analysis paralysis"
  - Too little: "married to an idea"

THE ENGINEERING DESIGN PROCESS



Select a Design: *How do you pick?*

Techniques:

- Voting
- Concept combination tables (score)
- Senior engineers decide
- Team lead /architect decides
- External business stakeholder decides

- Risks
  - This can get emotional and personal!
  - It is nice to say "use a structured process" but not always easy

THE ENGINEERING DESIGN PROCESS

Develop a Detailed Design: *Detailed designs usually get into some language, template, or model for specification*

Techniques (some examples from SE):

- Interaction design model
- UML component & class diagrams

- Detailed design (or BUFD) is both *in* and *out of vogue* in SE
  - UX development does a lot of BUFD
  - Agile shops do hardly any

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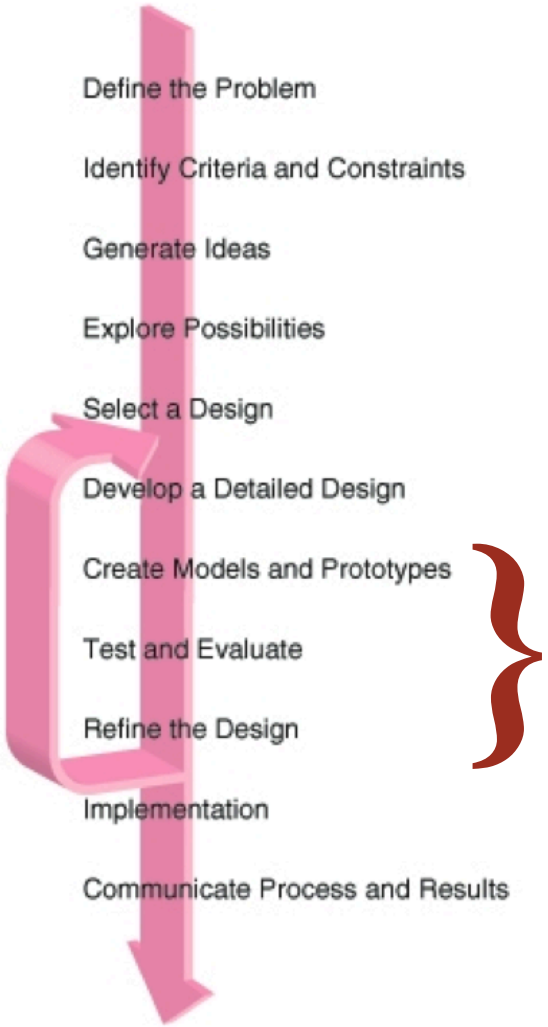
THE ENGINEERING DESIGN PROCESS



Prototype, Test, Refine:
"…provide additional understanding of the design and its performance."

Prototyping exists for UX and system design in SE:

- On UX side, rapid development and simulation tools enable users to "see" the app before it is developed
- On the system side, prototyping is an incredibly valuable tool for seeing if system constraints can be met

- *The extent to which you test and refine depends on the continuing possibility of adopting the design*

THE ENGINEERING DESIGN PROCESS

Implement and Communicate:

"If the design is a product that is manufactured, then a manufacturing system must be developed."

Well, we know that is not software!

- Design and implementation blend
- Many shops avoid design altogether
- Better shops have the ability to understand when implementation deviates from the desired design.
  - We will talk architecture soon enough!
- Some shops require full traceability from requirements to design to implementation however!

Summary: The EGR Design Process

- Key Points:
  - Idea generation
  - Selection and iteration among alternatives
  - Prototyping as a means of gaining information
- Key differences to SE
  - BUFD is not in style for much of SE nowadays
  - SE processes tend to be much more concurrent
    - And the lines blur!
- To Remember (Loewey):
  - It needs to have *function*, *feasibility*, and *elegance*