# Engineering Design

## **Engineering Design Process**

- Guides user from problem identification to design solution
- Used by all engineers in some way
- Reworking previous steps is common



# **Generating Criteria and Constraints**

#### Criteria

- Guidelines to follow to solve problem
- Take constraints into consideration
- Constraints
  - Limits on design
  - Challenges to overcome
  - Keeps design within limits

## **Researching Criteria and Constraints**

- Investigate projects with similar problems
- Verify appropriateness of criteria, constraints
- Ask questions
  - What do others see as constraints?
  - Are constraints under our control?
  - What external constraints must we consider?
  - Is criteria appropriate for design?

# Brainstorming

- Done alongside research
- Four principles
  - Generate as many ideas as possible
  - Do not criticize suggestions
  - Use imagination
  - Combine and modify ideas



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# **History: Brainstorming**

- Products created while trying to solve other problems
  - Post-it<sup>®</sup> Notes
  - Microwaves
  - Teflon<sup>™</sup>
  - Pacemakers



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#### **Solution Creation**

- Evaluate designs
- Select, refine best solutions
- Communicate solutions
  - Drawings
  - Computer-generated solutions

# **Test/Analysis**

- Engineers select best test to evaluate solution
  - Computer simulations
  - Prototypes
  - Rapid prototyping
- Solutions can fail testing
  - Return to appropriate design process step, work through

# **Final Solution or Output**

- Mechanical drawings
- Pictorial drawings
- Orthographic drawings (multiview drawings)
- Specifications sheets
- Models
- On completion, sent to management, client for approval



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## **Design Improvement**

- No perfect design
- Always room for improvement
- Keep up with technology, marketplace demands
- Use feedback to improve design

## **Reverse Engineering**

- Examine existing products, processes
- Disassemble for better understanding
- Has ethical implications
  - Illegal to use patented ideas



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#### **Physics of Pinball machines**



# **Plunger and Bumpers**

 The plunger that launches the ball is attached using a rubber band. Also, the bumpers are made of rubber bands.



## **Ramp and Tilt**

- The ramp must be elevated.
- Also, the entire pinball machine is set at an angle so energy forces the ball downwards towards the flippers.



#### **Flippers**

• Flippers must be powered by rubber bands and be able to push the ball



# **Pinball requirements**

	100 points
<ul> <li>Never jumps out (ball stays on board – 1 min)</li> </ul>	10 points
<ul> <li>Never Stuck (ball never gets stuck on board-1 min)</li> </ul>	10 points
<ul> <li>Flippers x 2 (must be elastic and easy to use)</li> </ul>	20 points
<ul> <li>Ramp (must be elevated and usable)</li> </ul>	10 points
<ul> <li>Plunger (ball is propelled onto board)</li> </ul>	10 points
<ul> <li>Ball Catcher (ball comes to stop after losing)</li> </ul>	10 points
<ul> <li>Themed (have some type of theme)</li> </ul>	10 points
<ul> <li>Bumpers x 2 (ball bounces off bumpers)</li> </ul>	10 points
<ul> <li>Elevated (ball rolls down on it's own)</li> </ul>	10 points

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