Nejhad’s SSADLLIE Rules of Design (Each 0.1 Bonus Point)

S = Safe
S = Simple
A = Aesthetically Pleasing
D = Durable
L = Low Cost
L = Light Weight
I = Innovation
E = Efficient

DRAWING QUIZZ

1% Bonus Point

Top View

Front View

Left View
• **Designing a System:**
  • System ----→ Subsystem ----→ Components ----→ Parts

  **Example:**
  • Automobile ----→ Engine ----→ Pistons Assembly ----→ Piston, Rings, Pins, etc.

**Finalize the Design Teams with the following Officers**

• Project Manager: PM (Managerial)
• System Integrator: SI (Technical)
• Fiscal Manager: FM
• Marketing Manager: PM
• Competition Manager: CM

**Subsystem Groups with the following Officers**

• Subsystem Lead
• Subsystem Co-Lead
I. Rules of Brainstorming:

a) Criticism is ruled out
b) The wilder the idea, the better the outcome
c) Quantity is needed
d) Participants should seek ways to improve the proposed ideas

II. Organization of a Brainstorming Session:

a) A one-page outline of information about the session should be given to panel members a few days before the session
b) The problem to be brainstormed should be defined
c) A moderator (not a leader) should be selected to be in charge of the session
d) The moderator should not permit long responses that would slow down the flow of ideas
e) Each team member should generate at least three ideas
f) A recorder should produce the list of ideas gathered during the session for distribution among the participants

Select best ideas from the ideas generated during the brainstorming session. Use the selected ideas or the modification and/or combination of the ideas
Design Process

1. Define the Problem
2. Do Background Research
3. Specify Requirements
4. Brainstorm, Evaluate, and Choose Solution
5. Develop and Prototype Solution
6. Test Solution
   - Solution Meets Requirements
   - Solution Meets Requirements Partially or Not at All
7. Communicate Results

Based on results and data, make design changes, prototype, test again, and review new data.
Design Process

FOS: Factor of Safety = Strength/Max Stress = I > 1

Design Process

1) Problem Identification: Needs, effects, causes, data, background, economics
2) Preliminary Ideas: Brainstorming, sketches/notes
3) Problem Refinement: Shapes/forms, angles/lengths, weight/volumes, properties, scale drawings
4) Analysis: Science, engineering, graphics, logic, experience
5) Decision: Evaluating the Alternatives against the Objectives
   & Constraints and selecting the Best Design/Design Features
6) Implementation: Details, specifications, working drawings, communications
Design Process

1. Identify
   - Background
   - Economics
   - Data
   - Problem Identification
   - Needs
   - Causes
   - Effects

2. Ideate
   - List Ideas
   - New Approach
   - Sketches
   - Preliminary Ideas
   - Notes
   - Ideate
   - Brainstorm

3. Refine
   - Angles and Lengths
   - Weights and Volumes
   - Scale Drawings
   - Refinement
   - Intersections Developments
   - Physical Properties
   - Shapes and Forms

4. Decide
   - Mathematics
   - Science
   - Graphics
   - Analysis
   - Logic
   - Engineering
   - Experience

5. Decide
   - Accept
   - Reject
   - Combine
   - Decision
   - Restudy
   - Continue
   - Stop

6. Recycle as Needed
   - Working Drawings
   - Specifications
   - Models
   - Implementation
   - Details
   - Finished Solution
   - Marketing
PROBLEM IDENTIFICATION

1. Project title
   SWING SET ANCHOR

2. Problem statement
   SWING SETS (SEE SKETCH TEND TO OVERTURN WHEN IN USE WHICH CAUSES AN UNSAFE CONDITION.

3. Requirements and limitations
   A. SEE SKETCH FOR DIMENSIONS. 3 SWINGS ATTACHED.
   B. SALES PRICE: $5 - $10 RANGE
   C. EASY TO ATTACH BY HOUSEWIFE
   D. ALLOWS SWING SET TO BE MOVED
   E. SAFE FOR CHILDREN
4. Needed Information

A. Number of Swing Sets Sold
   - Write manufacturers
   - Write retailers

B. Sizes of Various Swing Sets
   - Write manufacturers

C. Are there competing products
   - Review product catalogs

5. Market Considerations

A. Sales Prices of Swing Sets
   - Survey catalogs & local retailers

B. Would an anchor sell?
   Survey families with swing sets

C. Effects of geography within USA on swing set sales
   - Write manufacturers of sets

D. Where are swing sets sold?
   - Check Yellow Pages
   - Visit stores
PRELIMINARY IDEAS

I. Brainstorming ideas
   A. SAND BAGS
   B. STAKE IN GROUND - METAL OR WOOD
   C. SET IN CONCRETE
   D. WIDEN BASE
   E. FOOT ATTACHED TO LEGS
   F. WEIGHTS ON LEGS
   G. REDesign SWING SET A-Frame
   H. STAKE WITH NYLON CORD
   I. STAKE WITH CHAIN
   J. STAKE WITH ROPE
   K. SUCTION CUPS ON PATIO
   L. WATER-FILLED WEIGHTS
   M. BRICKS AT BASE
2. Description of best ideas
   A. Stake ideas seem to be best suited for development
   B. Extension feet OK

PRELIMINARY IDEAS

IDEA 1
EXTENSION

IDEA 2
PIN JOINT

IDEA 3
FOOT

IDEA 4
DRIVE-IN STAKE

IDEA 5
NYLON

IDEA 6
STAKE
REFINEMENT
1. Description of design
   A. Stake
      1. Metal or wood stake - 6 in-10 in
      2. Attached with chain, coro, or
cable - about 10 in long
      3. Attach to A-frame with collar
      4. Need 4

   B. Extension Foot
      1. Attach to A-frame legs
      2. Must determine length of foot
         necessary to prevent tilting
      3. Must be easy to attach to A-frame
      4. Need 4 feet
      5. No heavier than 1 pound each

   2. Attach scale drawings
6. Production procedures
A. USE 15 GAGE GALVANIZED IRON PIPE
   (Ø 40 CD) FOR STAKE. CUT ON DIAGONAL TO CRIMP & POINT STAKE
B. 15 GAGE METAL COLLAR TO BE
   FORMED INTO U-SHAPE & DRILLED
   FOR Ø 5 BOLT
C. STAKE DRILLED Ø 8 FOR Ø 5 BOLT
   FOR ATTACHING CHAIN

7. Economic analysis
A. COSTS
   1. CHAIN $0.30
   2. STAKE .20
   3. COLLAR .20
   4. EYE BOLT & NUT .10
   5. COLLAR BOLT .10
   TOTAL .90
B. LABOR .60
C. PACKAGING .30
D. PROFIT 1.15
E. WHOLESALE PRICE 2.95
F. RETAIL PRICE $4.95
ANALYSIS

1. Function
   A. ANCHORS SWING SET
   B. ATTACHES TO GROUND - NOT CONC. SLAB
   C. PREVENTS OVERTUNING

2. Human engineering
   A. EASY TO INSTALL
   B. REQUIRES NO SPECIAL TOOLS
   C. PROVIDES SAFETY FOR CHILDREN

3. Market & consumer acceptance
   A. KEEP PRICE UNDER $15 FOR SWING SET
   B. SHOULD BE SOLD WITH SWING SET
   C. CAN BE SOLD AS AN ACCESSORY TO THE SWING SET.
   D. NEED ESTIMATE OF SWING SETS SOLD PER YEAR

4. Physical description
   A. STAKE: 14" LONG - CRIMPED AT ONE END FOR EASE OF DRIVING
   B. CHAIN ATTACHED TO STAKE WITH EYE-BOLT THROUGH HOLE IN STAKE
   C. WEIGHT - ABOUT 8 OUNCES
   D. METAL COLLAR WITH NUT & BOLT TO FIT AROUND SWING SET LEG

5. Strength
   A. WITHSTANDS A TENSION AT EACH LEG OF 70 LBS.
DECISION

1. Decision table for evaluation

<table>
<thead>
<tr>
<th>Maximum value</th>
<th>Factors for analysis</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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</table>

CONCLUSIONS

Implement the Stake & Chain. This is the best design with the best market potential. Market with swing sets.

SALES PRICE $4.95
SHIPPING EXPENSES $.50
NUMBER TO SELL TO TO BREAK EVEN 1000
MANUFACTURED BY CONTRACTOR
ESTIMATED PROFIT PER SET OF 4 $1.15
6) Implementation

Diagram:
- Collar
- Holes
- Bolt & Nut
- Chain - Double Loop 155 m
- Test - 180 Long

Cut & Crimp Tubular Stake

Dimensions:
- R: 20
- 78
- 32
- 30
- 360
- 2
- 52
- 20
- 20
- 12
Decision Making

The basic ingredients in every decision are:

<table>
<thead>
<tr>
<th>Basic Ingredients</th>
<th>Substitute for basics</th>
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<tbody>
<tr>
<td>Facts</td>
<td>Information</td>
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<tr>
<td>Knowledge</td>
<td>Advice</td>
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<tr>
<td>Experience</td>
<td>Experimentation</td>
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<tr>
<td>Analysis</td>
<td>Intuition (Educated guess)</td>
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<tr>
<td>Judgement</td>
<td>None</td>
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</table>

Use of a substitution does not necessarily mean that a bad decision will be made; however, it does mean that the foundation for the decision is weakened.

- Ask the right questions.
- Avoid giving the right answer to the wrong question.
- Be selective in information you get from subordinates. (Subordinate bears disapproval if superior worries about loss of face)
- It is the decision maker who bears the ultimate responsibility, although he/she may seek advice from other people.
**Evaluating Designs**

**TABLE 3-5**

<table>
<thead>
<tr>
<th>11 point scale</th>
<th>Description</th>
<th>5 point scale</th>
<th>Description</th>
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<tr>
<td>0</td>
<td>Totally useless solution</td>
<td>0</td>
<td>Inadequate</td>
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<tr>
<td>1</td>
<td>Very inadequate solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Weak solution</td>
<td>1</td>
<td>Weak</td>
</tr>
<tr>
<td>3</td>
<td>Poor solution</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>Tolerable solution</td>
<td>2</td>
<td>Satisfactory</td>
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<td>5</td>
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<tr>
<td>6</td>
<td>Good solution with a few drawbacks</td>
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<tr>
<td>7</td>
<td>Good solution</td>
<td>3</td>
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<tr>
<td>8</td>
<td>Very good solution</td>
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<tr>
<td>9</td>
<td>Excellent solution (exceeds the requirement)</td>
<td>4</td>
<td>Excellent</td>
</tr>
<tr>
<td>10</td>
<td>Ideal solution</td>
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</table>
Design of a Crane Hook for a Ladle

FOS = Strength/Stress Max

Stress = Force/Area
**Decision Making Matrix (DMM)**

\[
\Sigma w_r = 1.0 \text{ (Sub-objects)} \quad \Sigma w_t = 1.0 \text{ (level)}
\]

Score: is based on Approach II (i.e., rank order, 0-10)

Value = Weight factor x score

<table>
<thead>
<tr>
<th>Objective</th>
<th>Weight factor</th>
<th>Parameter</th>
<th>Magnitude</th>
<th>Score</th>
<th>Value</th>
<th>Magnitude</th>
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<td>0.9</td>
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<td>Manufacturing cost</td>
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<td>1200</td>
<td>9</td>
<td>1.8</td>
<td>2000</td>
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<td>hours</td>
<td>40</td>
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<td>0.3</td>
<td>25</td>
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<td>Durability</td>
<td>0.15</td>
<td>experience</td>
<td>high</td>
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<td>1.2</td>
<td>high</td>
<td>8</td>
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<td>good</td>
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<td>Reliability</td>
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<td>experience</td>
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<td>Repairability</td>
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**FIGURE 3-15**
Decision matrix for the crane hook design.
Gantt Chart/Project Scheduling

Heat Exchanger
FIGURE 10-1
Bar chart for prototype testing a heat exchanger (Gantt Chart)
Due next class:

(1) Title, Affiliation, Team Members

(2) Needs Assessment/Functional Requirement

(3) Budget
# Budget

<table>
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<th>System</th>
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<th>Est. Cost</th>
<th>Actual Cost</th>
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<td>-------------</td>
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<tr>
<td>etc.</td>
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Subtotals

Margin (10%)

Total