

# EGR 107 Introduction to Engineering Design

Project Specification, Design Criteria,  
& DESIGN SELECTION

# The Knack



# Design Criteria include both Feasibility and Merit

- Developed from specifications to
  - Ensure compliance with client's requirements
  - Discriminate between designs
  - Identify a 'best' design
- Two Types
  - Feasibility Criteria
    - Eliminate infeasible designs
  - Merit Criteria
    - Identify characteristics of 'best' designs

# Feasibility Criteria provide design constraints

- Factors that limit the scope of a project
- Normally expressed as constraints
  - Unit must weigh less than 100 lbs.
  - Unit must accelerate to a velocity of 60 mph in less than 10 seconds.
- Go/No-Go Criteria
  - Feasible/Not-Feasible
- Project Specification are a primary source

# Merit Criteria used for discriminating between design ideas

- Factors that promote discrimination between  
FEASIBLE design alternatives
- Provide a logical method for selecting the  
“best” design
- Should be presented in a form that will  
facilitate the decision making process

# Merit Criteria are...

- Specific while still providing a basis for choosing between alternatives
- Examples include:
  - low unit production cost, low shipping cost, low storage cost, etc.
  - high acceleration, high velocity, high efficiency, etc.
- Project Specification are a good starting point
- Ask: What is the overall project goal?

# Design Criteria for the Toothpick Bridge Project

- Design Specification (handout)
- Feasibility Criteria (engineer)
- Merit Criteria (engineer)

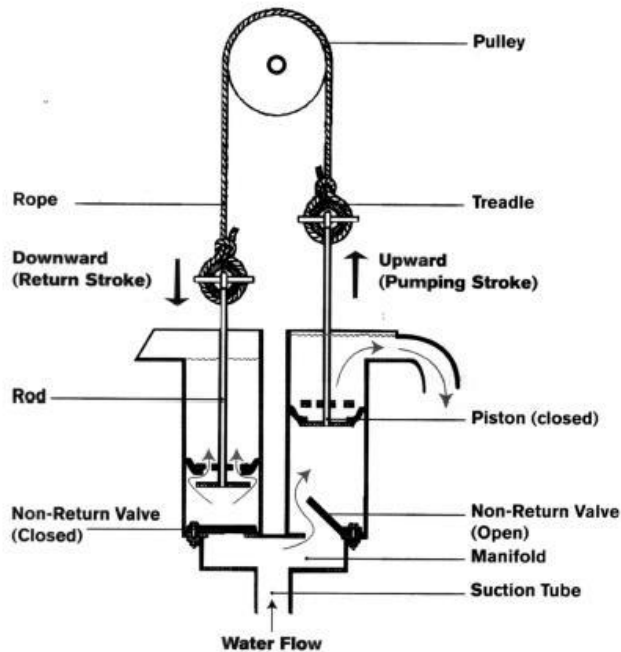
# Feasibility Analysis

- Eliminate some of the design concepts
- Reveal ways that other alternatives may overcome their limitations
- Produces at least two feasible alternatives
  - *In practice, this will not always occur*
  - *In this class, it must!!*
    - *Your project grade depends on it.*
- A single table comparing each design to the feasibility criteria with pass/fail (✓ or X) notation is a common approach
  - Good visual of why designs are succeeding or failing



# Treadle Pump Design Example

A treadle pump is defined as a foot operated single action double cylinder piston pump for low lift irrigation.



# Design Specifications for Treadle Pump Design Project

- Pump must provide suction-lift (S) and pressure delivery (P)
- Must produce at least 3 m<sup>3</sup>/hr
- Must cost less than US\$70

# Specifications for Treadle Pumps found in Africa

Pump Name	Type	Volume (m <sup>3</sup> /hr)	Price (US\$)
Swiss “concrete”	Suction-lift (S)	1.7	120 - 160
Bangladesh	Pressure delivery (P) and S	3.8 – 5.8	78
Deep well pump	S	1.6	156
Compact	S & P	2.6 – 3.1	45 – 52
Masvingo	P	5	100
Shoroma	P	2.5	60 – 145
Chova	S & P	1.7	86 (S), 97 (P)

Source: [http://www.appropedia.org/Treadle\\_pump\\_design\\_optimization](http://www.appropedia.org/Treadle_pump_design_optimization)

# Feasibility Analysis on a Treadle Pump Design Project

Pump Name	Type	Volume (m <sup>3</sup> /hr)	Price (US\$)
Swiss “concrete”	X	X	X
Bangladesh	✓	✓	X (but close \$78)
Deep well pump	X	X	X
Compact	✓	✓	✓
Masvingo	X	✓	X
Shoroma	X	X	✓
Chova	✓	X	X

Likely explore using Compact pump; may also consider Bangladesh

# Merit Analysis provides...

- A Structured way to make a logical, documentable decision concerning the ‘best’ design alternative
- It is not a ‘foolproof’ way of selecting the best design
- Also applies to problem solution, manufacturing process, product supplier, etc.

# Merit Analysis provides...continued...

- Provides a point of departure for engaging in intelligent debate over design decisions
- Shows why one of the alternatives was selected over the others
- Provides basis for retracing the steps that led to the decision
- Better than simply declaring victory based on some sort of “gut feeling”

# Weighted Average Merit Analysis – the process

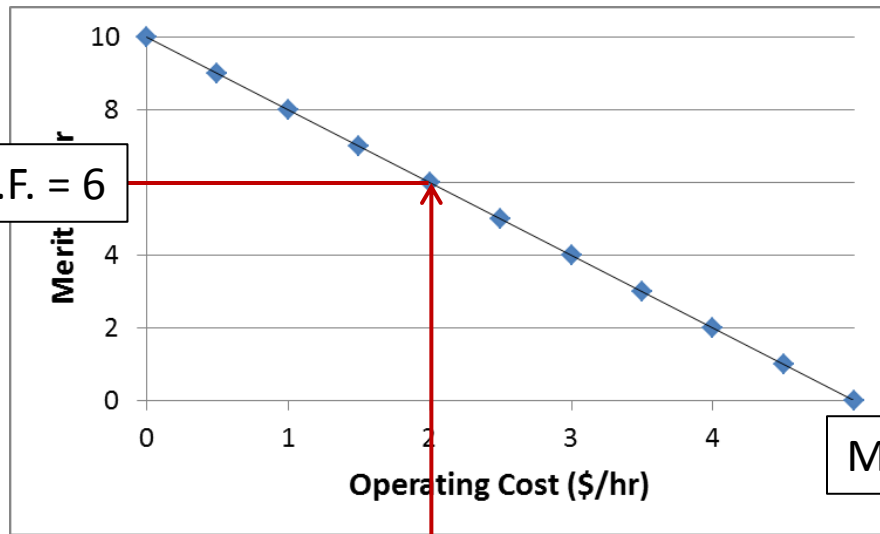
1. Criteria Importance
  2. Develop Merit Curves
  3. Merit Factor Assignment
  4. Calculation Step One
  5. Calculation Step Two
- Consider Results

# 1. Criteria Importance

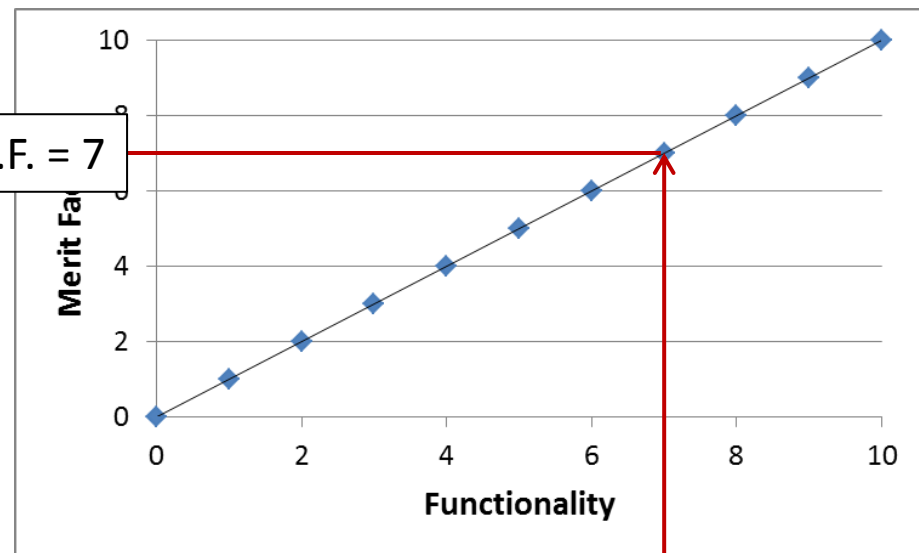
Criterion	Points
Functionality	40
Production cost	30
Operating cost	15
System weight	10
Aesthetics	5
<b>Total</b>	<b>100</b>



# 2. Develop Merit Curves – Examples for Operating Cost and Functionality



Feature Attribute = \$2/hr



Feature Attribute = 7

## 4. Calculation Step One

- Calculate merit associated with each criterion for each design
- Criterion merit = (weight) × (merit factor)

# 5. Calculation Step Two

- Calculate total merit associated with each design

$$\text{Total merit} = \sum_{\text{all criteria}} (\text{criterion merit})$$

# Example Merit Analysis Table – for Design Alternative #1

	Weight (%)	Feature Attribute	Merit Factor	Total Merit
Functionality	40	7	7	280
Production cost	30	\$1000/unit	6	180
Operating cost	15	\$2.00/hr	6	90
System weight	10	60 lbs	6	60
Aesthetics	5	10	3	15
Total	100			625

Recall we had example merit curves for Functionality and Operating Cost

# Making a Design Decision from weighted average merit analysis

- Discuss the scoring of the designs and consider:
  - What would a ‘perfect’ design score?
  - How different are the score numbers?
  - Which merit criterion are making the biggest difference?
  - Is one merit criterion driving the decision?
  - Can the merit criterion, weighting, curves, etc. be improved?

# Example Merit Analysis

Merit Criteria	Weight (%)
Functionality	40
Production cost	30
Operating cost	15
System weight	10
Aesthetics	5
Total	100

Alternative Design #1		
Feature Attribute	Merit Factor	Total Merit
7	7	280
\$1000/unit	6	180
\$2.00/hr	6	90
60 lbs	6	60
10	3	15
		<b>625</b>

Alternative Design #2		
Feature Attribute	Merit Factor	Total Merit
9	9	360
\$500/unit	8	240
\$4.00/hr	2	30
70 lbs	2	20
50	7	35
		<b>685</b>

Alternative Design #3		
Feature Attribute	Merit Factor	Total Merit
8	8	320
\$750/unit	7	210
\$3.00/hr	4	60
50 lbs	10	100
25	5	25
		<b>715</b>