

Modeling Multiple Attribute Decisions



Abstract

In some cases, complex decisions can have several, competing, important decision criteria. This presentation highlights a technique that a member of Conoco's Core Team learned while attending an advanced ADA Class in 1997. He has introduced the use of modeling multiple decision attributes to members of the team. This presentation will show two examples of how to use the tools in decision making.

While most teams have a laundry list of decision criteria, every effort must be made to reduce the amount of competing objectives prior to beginning the project evaluation. In the case that several decision criteria have "equal" importance to the Decision Makers, efforts must be made to build an easily understandable evaluation/selection tool. An example will be reviewed using the standard framing tools followed by an evaluation performed using the multi-attribute analysis technique. The example covered is: How to select the correct station wagon for long term family usage. In addition to the covered example, the presentation will cover actual project usage of selecting a process.

◆ Multi-attribute D&RA

What is a multi-attribute problem?

- ◆ Multiple decision criteria are relevant
- ◆ There are no commonly agreed upon measures for evaluating criteria (ie. NPV)
- ◆ Three or more alternatives must be evaluated
- ◆ Difficult value tradeoffs need to be made

Multi-attribute D&RA

Multi-attribute Analysis should be the last resort because:

- ♦ **This analysis is not easy**
- ♦ **Decision makers may be uncomfortable with the discussion on trade-offs. Often they may have differing opinions about the multiple decision criteria as well.**
- ♦ **Will probably not represent all of each decision makers' preferences**
- ♦ **May lack buy-in from those familiar with EMV**

Multi-attribute D&RA

How can Decision Makers help the team?

- ♦ Be open to describing the tradeoffs you would make between various criteria
- ♦ Don't worry that tradeoffs will be taken as absolutes
- ♦ Minimize the number of decisions you want to make in your head

Multi-attribute D&RA

How can the team help the Decision Makers?

- ♦ Be sensitive to the fact that some tradeoffs are best kept with the team (tight) due to economic/legal considerations
- ♦ Don't take tradeoffs as absolutes. Go back to the decision makers when the calls are close
- ♦ Be sensitive when different Decision Makers have trouble reaching consensus on some decision criteria-it is possible that they have differing goals and experiences

Multi-attribute D&RA

Steps in the Process:

1. **Identify decision criteria and put in a hierarchy**
2. Define performance measures for each objective
3. Decide how to combine the objectives into a single overall performance measure
4. Determine a scale for each objective
5. Determine weighting factors for each objective

Station Wagon - Policies

- ♦ **Vehicle must be Station Wagon in medium range (small not acceptable)**
- ♦ **The vehicle must be low enough to ground (or at least 3" below Jeep Cherokee)**
- ♦ **The vehicle must be new or used but not older than a 1996 model**
- ♦ **The vehicle must still be under some type of warranty**
- ♦ **Dealer location must be within 10 miles of home in Houston**
- ♦ **Need easy access to back seat**
- ♦ **This must be a real 4 passenger vehicle with adequate room for baggage**

Station Wagon - Strategic Decisions

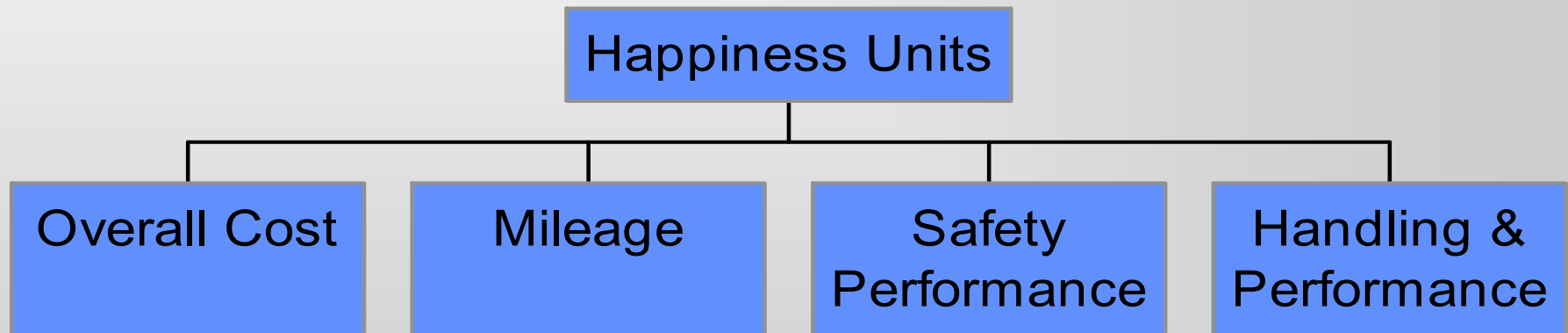
- ◆ **Make & Model of Car**
- ◆ **Color of Vehicle**
- ◆ **What type of options to include**
 - ☠ **Type of seats - Leather vs. Cloth**
 - ☠ **Stereo vs. CD player**
 - ☠ **Cover for baggage area**

Station Wagon -Decision Criteria

- ◆ **Cost of Vehicle**
- ◆ **In town mileage/On the road mileage**
- ◆ **Safety Performance**
- ◆ **Performance of Vehicle**

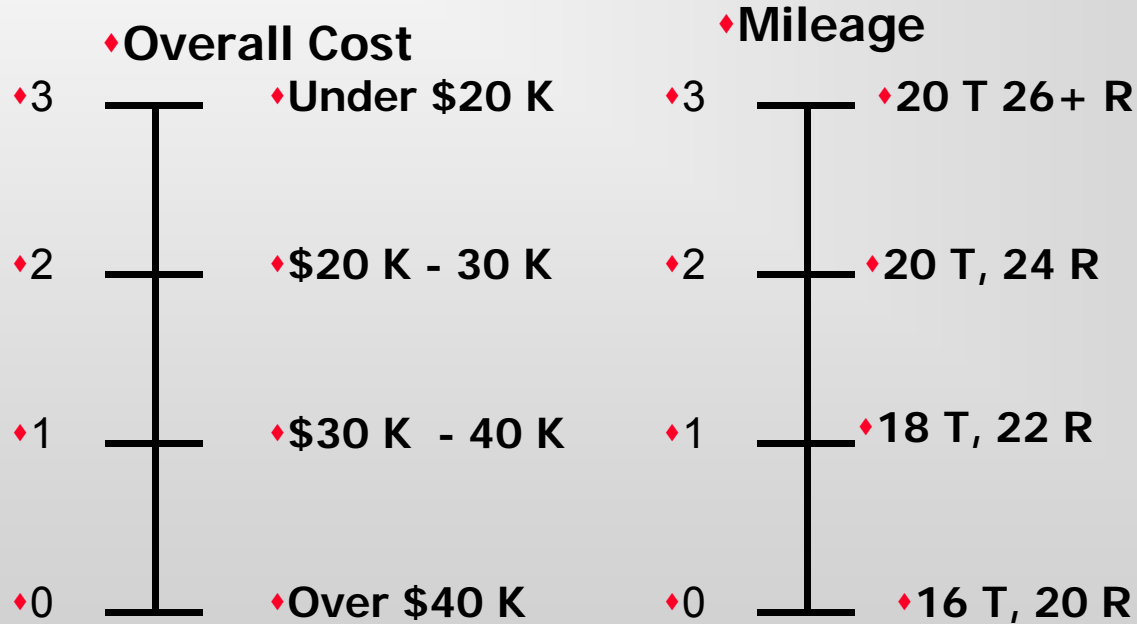
Station Wagon -Step 1

Station Wagon Decision Model



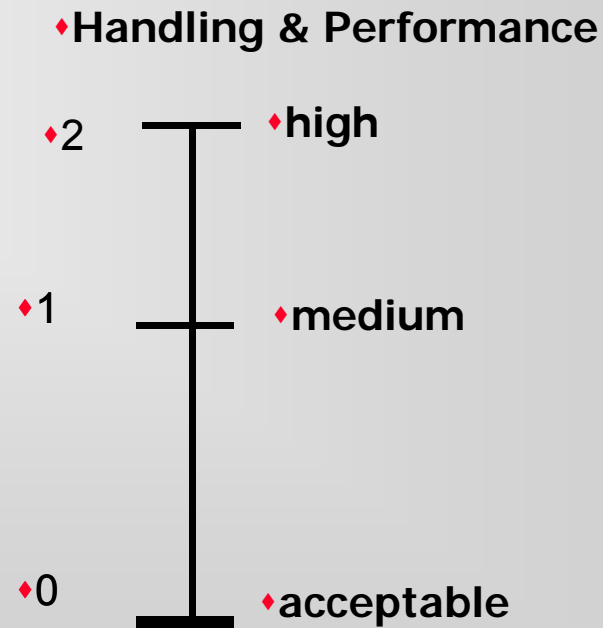
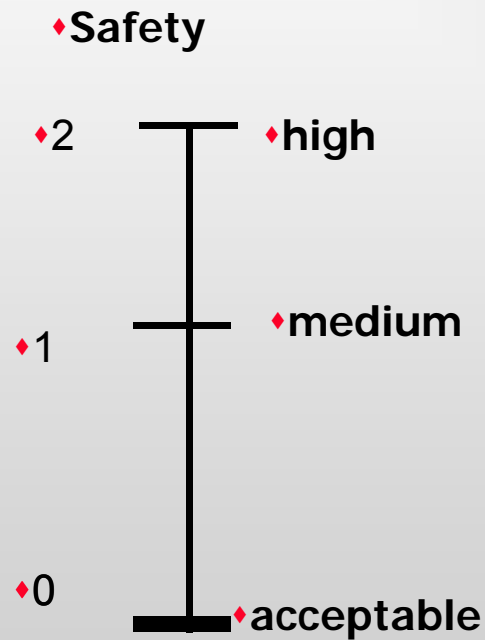
Station Wagon -Step 2

Define performance measures for each objective



Station Wagon -Step 2

Define performance measures for each objective



Station Wagon -Step 3

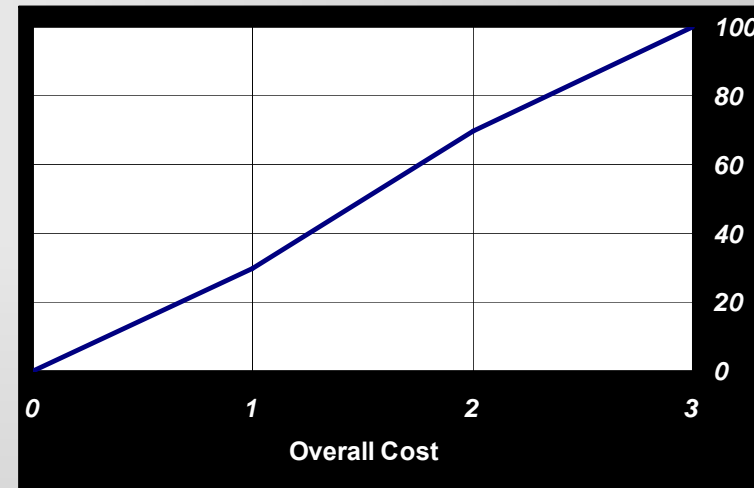
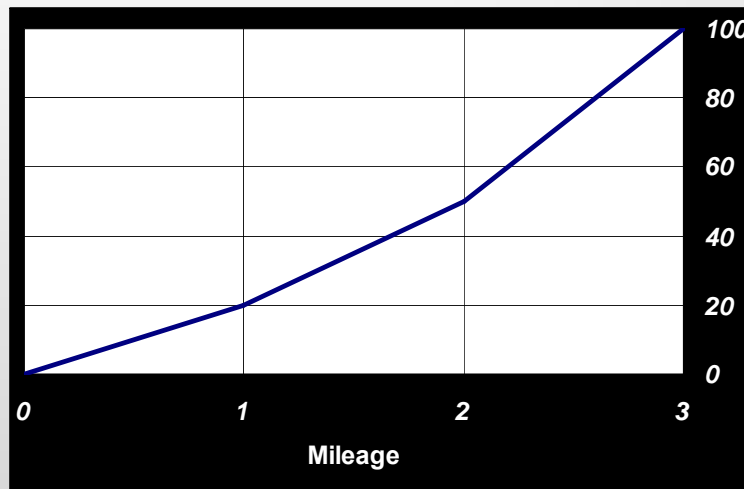
- 3. Decide how to combine the objectives into a single overall performance measure**

In this example: Value of Station Wagon = $W1 * \text{Overall Cost} + W2 * \text{Mileage} + W3 * \text{Safety Performance} + W4 * \text{Handling \& Performance}$

This happens to be a linear performance measure where all four are independent but important.

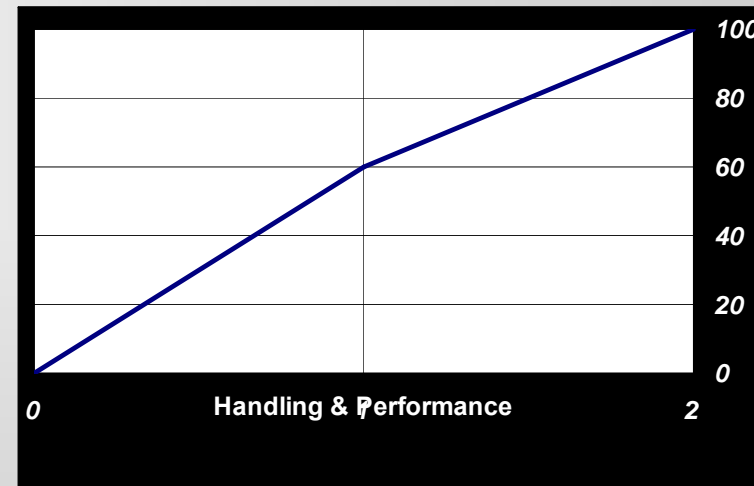
Station Wagon -Step 4

4. Determine a scale for each objective



Station Wagon -Step 4

4. Determine a scale for each objective



Station Wagon -Step 5

♦5. Determine weighting factors for each objective

Step-by-Step:

1. Assume you're at the worst level of everything
2. Which would be the first objective you'd improve, if you could go from the worst level to the best?
3. Assign this objective a weight of 1.0, then using discussion and judgment assign relative weights to the others (can use the "how much would you pay..." approach)

Station Wagon -Step 5

♦5. **Determine weighting factors for each objective**

If all were at the worst - then Overall Cost would be 1.0

Based on family judgment, the following values were assigned:

Mileage .7

Safety Performance .5

Handling and Performance .3

Station Wagon -Wrap-Up

To use the tools, compare values of two alternatives:

- 1) Volvo StationWagon**
Total cost is \$36,000
Mileage - 20 in town and 26 on road
Safety Performance - Medium
Handling & Performance - Medium

- 2) Saturn StationWagon**
Total cost is \$18,000
Mileage - 20 town and 28 on road
Safety Performance - Acceptable
Handling & Performance - Acceptable

Station Wagon - Wrap-Up

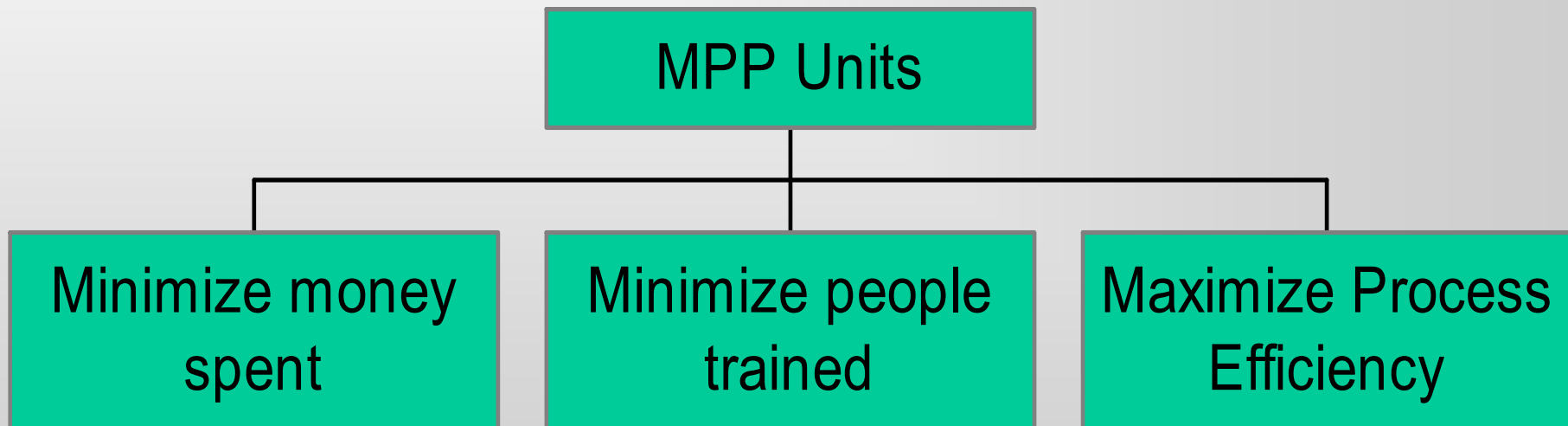
Volvo Evaluation				
	Cost	Mileage	Safety Performance	Handling & Performance
Indicators	1	3	1	1
Values	30	100	80	60
Weights	1	0.7	0.5	0.3
Weighted Values	30	70	40	18
Total Score	158			
Saturn Evaluation				
	Cost	Mileage	Safety Performance	Handling & Performance
Indicators	3	3	0	0
Values	100	100	0	0
Weights	1	0.7	0.5	0.3
Weighted Values	100	70	0	0
Total Score	170			

Process Work Example

Problem Statement - Generate and evaluate 3 different themes to build a Process to be Utilized by the Entire Company

Process Work Example

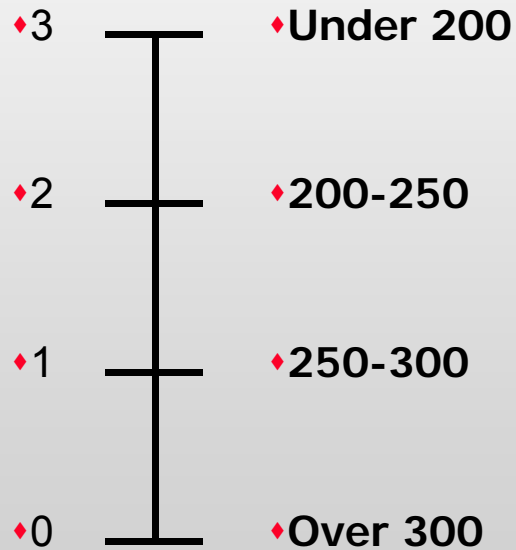
Process Evaluation



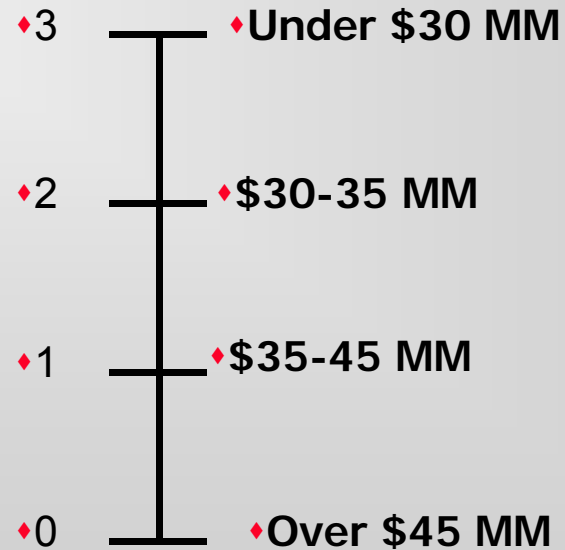
Process Work Example

◆ Define performance measures for each objective

◆ Minimize people



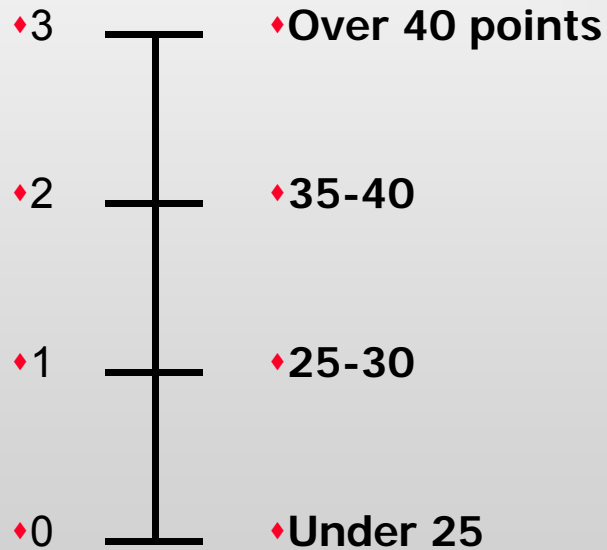
◆ Minimize investment



Process Work Example

◆ Define performance measures for each objective

◆ Maximize Process Efficiency



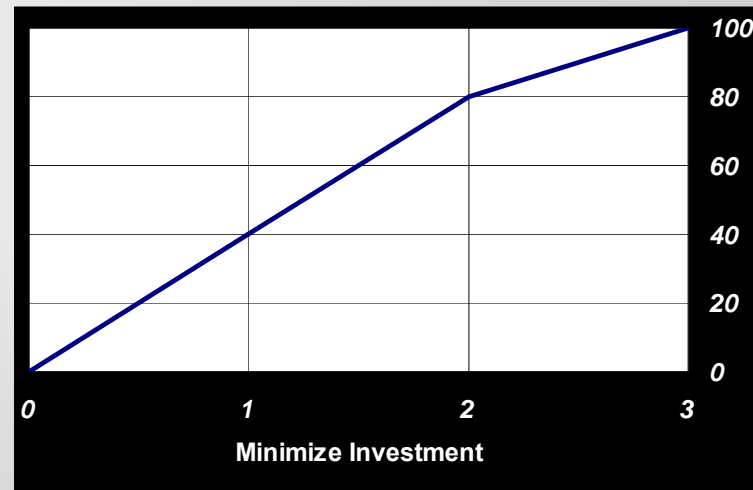
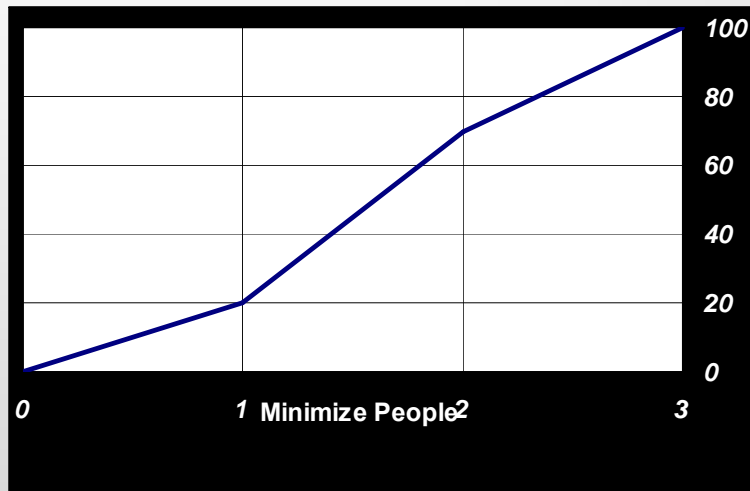
Process Work Example

- ♦ Decide how to combine the objectives into a single overall performance measure

In this example: Value of Process = $W1 * \text{Process Efficiency} + W2 * \text{Minimize Number of People Trained} + W3 * \text{Minimize Cost}$

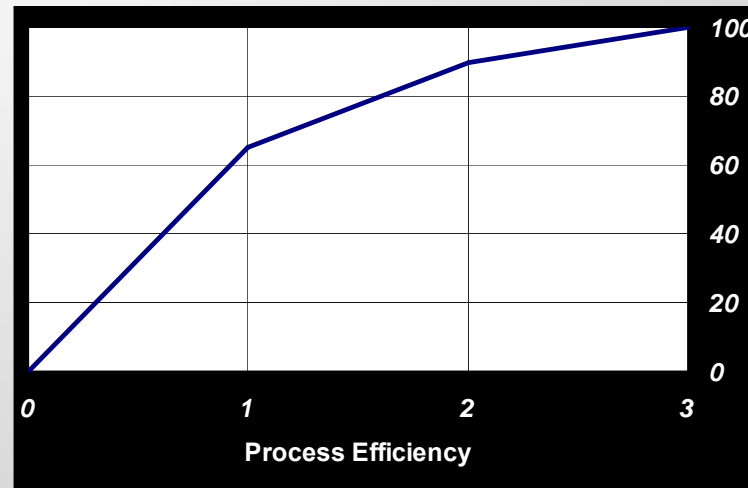
Process Work Example

◆ Determine a scale for each objective



Process Work Example

- ◆ Determine a scale for each objective



Process Work Example

◆ Determine weighting factors for each objective

Based on the judgement of experts in this field area:

Process Efficiency is 1.0

Minimize Cost is .5

Minimize People is .5

Process Work Example

Evaluation of Three Alternatives:

Alternative A - Process Efficiency is 25 points

People Count is 387 and Total Cost is \$36 MM

Alternative B - Process Efficiency is 38

People Count is 190 and Total Cost is \$30 MM

Alternative C - Process Efficiency is 22

People Count is 260 and Total Cost is \$47 MM

Process Work Example

Alternative A			
	Money	People	Process
Indicators	1	0	1
Values	40	0	65
Weights	0.5	0.5	1
Weighted Values	0.2	0	0.65
Total Score	0.85		

Alternative B			
	Money	People	Process
Indicators	2	3	2
Values	80	100	90
Weights	0.5	0.5	1
Weighted Values	0.4	0.5	0.9
Total Score	1.8		

Alternative C			
	Money	People	Process
Indicators	0	1	0
Values	0	20	0
Weights	0.5	0.5	1
Weighted Values	0	0.1	0
Total Score	0.1		