Presented at the 2011 ISPA/SCEA Joint Annual Conference and Training Workshop - www.iceaaonline.com

cobec CONSULTING

QUANTIFYING THE FUTURE

Objective System Acquisition Decision Making Utilizing the Analytic Hierarchy Process

Society of Cost Estimating and Analysis

June 2011

Hisham Jalil, CCEA, MBA
Vice President, Cobec Consulting

hjalil@cobecconsulting.com
703-963-3903

Topics

- Introduction
- Presentation Goal
- Background
  - Today's decision making challenges
  - The typical decision making steps and challenge areas
- Analytic Hierarchy Process (AHP) description, background, and uses
- Interactive AHP Example
- AHP application success story
- AHP uses at Cobec
- Conclusion

Introduction

- Hisham Jalil, Vice President & Co-Founder of Cobec Consulting
  - B.S. in Finance
  - MBA
  - Certified Cost Estimator / Analyst
  - Over 9 years experience in cost estimation, investment analysis, and program management consulting
  - Currently responsible for analyzing and estimating $5B+ in government mission-critical systems
  - Project Management Institute (PMI) Project Management Professional (PMP) certification expected in 2011

Presentation Goal

- To gain a better understanding of AHP
- How AHP can be applied to complex government decision making.

Today's Decision Making Challenges

- Uncertain Environment
  - Budget Cuts & Economic Uncertainty
  - Continual technological advancement
  - Rapid increase in vendor capability specialization
  - Increasing systems interdependency

- Decision Makers must make for
  - Increasingly complex decisions
  - Significantly impactful decisions

- Complex Multi-Criteria Decision Making (MCDM)
  - Requires thorough analysis
  - Decisions must be objective, defensible

The typical decision making process

- Recognize a Problem or Decision Point
- Define a Goal
- Identification of Feasible Alternatives
- Selection of Criteria for evaluating Alternatives
- Assembly of Relevant Data
- Modeling the Interrelationships
- Choosing the Best Alternative

Key Steps in the Decision Making Process present Problem Areas that greatly influence Choosing the Best Alternative. AHP modeling addresses these key problem areas.

Analytic Hierarchy Process (AHP)

- The Analytic Hierarchy Process (AHP) is a structured (mathematical and psychological based) technique for dealing with complex decisions. AHP helps decision makers find a solution that best suits their goal and their understanding of the problem.

Source: http://en.wikipedia.org/wiki/Analytic_Hierarchy_Process

Analytic Hierarchy Process (AHP)

- Structured technique for dealing with complex decisions
- Decomposes decision problem into a hierarchy of sub-problems
  - Can be analyzed independently
- Uses pairwise comparisons
  - Simplifies criteria weighting
  - More focused comparison between criteria
  - Results of pairwise comparisons generate criteria priorities (weightings)
- Widely used and accepted
- Allows for both objective and subjective input
  - Subjective input is not always bad!
- **Works particularly well in group decision making**
- Well suited for decisions that involve a great deal of perception and judgment

Analytic Hierarchy Process (AHP)

- AHP History
  - Developed and Pioneered by Thomas Saaty
  - One of the pioneers of Ops Research
    - Wrote first Mathematical Methods of Operations Research textbook and the first queuing textbook
  - Directed research projects for the Arms Control and Disarmament Agency at the U.S. Department of State
    - Communication difficulties and lack of practical systematic approach to priority setting and decisions making made weapon trade-off analysis nearly impossible.
  - While teaching at Wharton School of the University of Pennsylvania, he developed AHP.

Source: http://www.johnsaunders.com/papers/ahpexpo.pdf

Analytic Hierarchy Process (AHP)

- Can be used for
  - Choice
  - Rating
  - Ranking
  - Prioritization
  - Resource allocation
  - Benchmarking
  - Quality management
- Recent Applications
  - Systems Engineering - Design alternatives selection
  - Acquisition - Organic vs. Service decisions, Vendor Selection
  - Strategic Planning - Mission and strategy selection/tradeoff

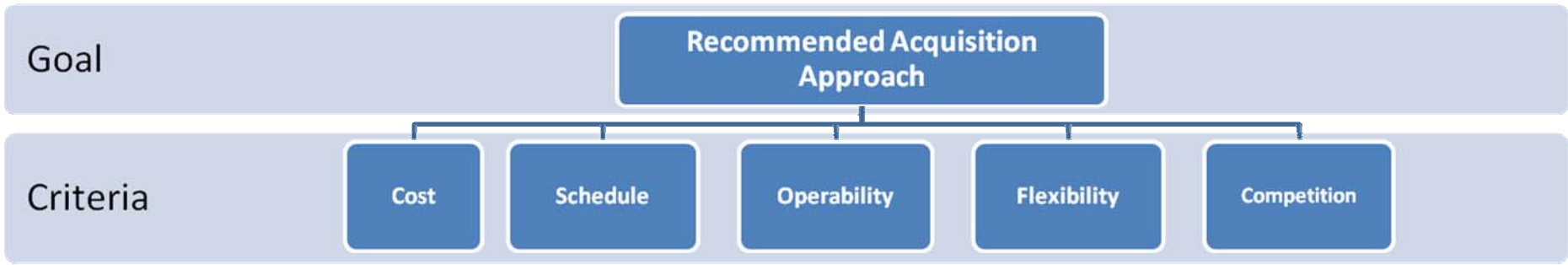
AHP Example: Conference Lunch

- Excel Model Demo….

Analytic Hierarchy Process (AHP): Success Story

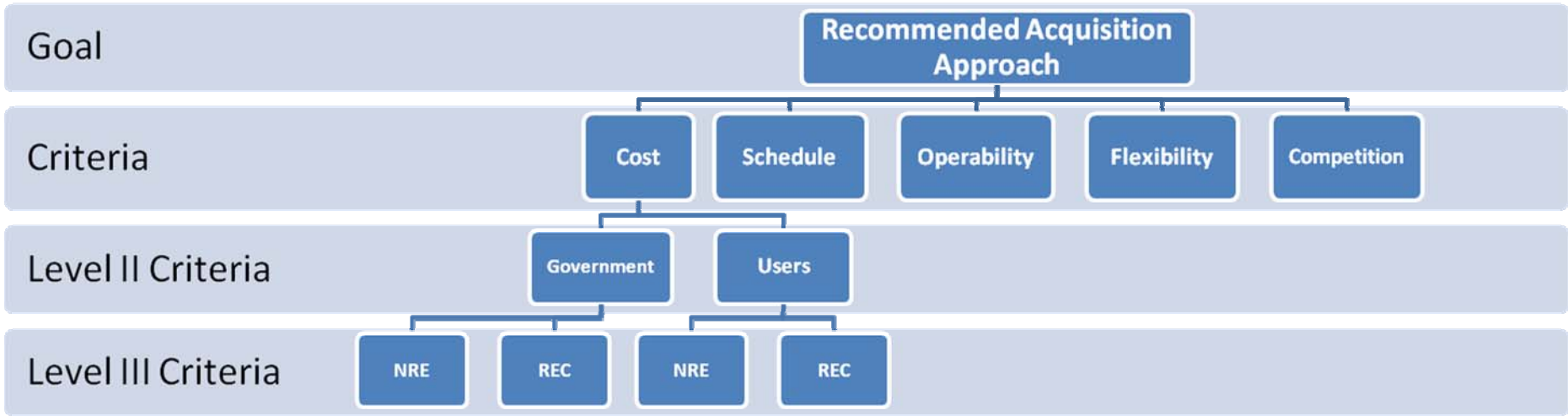
- Problem: Determine best acquisition approach decision for a Government mission-critical system
  - Fundamentally, there are two alternatives
    - Alternative 1: Organic (built/implemented by vendor, turned over to Government for operations and maintenance)
    - Alternative 2: Service (built/implemented/operated & maintained by vendor)
- Multiple complicating factors depending on alternative:
  - Technical – Varying technical implications
  - Business – Varying competitive environment
  - Political – Union and workforce impacts

Analytic Hierarchy Process (AHP) Success Story : Hierarchy View



Criteria derived from established program goals/values

Analytic Hierarchy Process (AHP) Success Story : Hierarchy View



Multiple levels of criteria can be created to further decompose decision complexity

Analytic Hierarchy Process (AHP) Success Story : Criteria Pairwise Comparisons

Established priorities (weighting) of the top level criteria set:

Performed pairwise comparisons:

a. Each criterion was individually compared to every other criteria.

b. One criterion was chosen as being more important.

c. Choices can be made in group format (i.e. program management, SMEs, etc)

d. Choices made in accordance with established program values.

e. Voting system utilized to reach final consensus selection. Helps to minimize group think.

High Level Criteria		
Criteria		More Important
A	B	
Cost	Schedule	A
Cost	Operability	B
Cost	Competition	A
Cost	Flexibility	B
Schedule	Operability	B
Schedule	Competition	A
Schedule	Flexibility	B
Operability	Competition	A
Operability	Flexibility	A
Competition	Flexibility	B

Analytic Hierarchy Process (AHP) Success Story : Criteria Intensities

Assigned degree of importance (Intensity) of each criterion selected as being more important in each pairwise comparison.

Intensities based on the following scale:

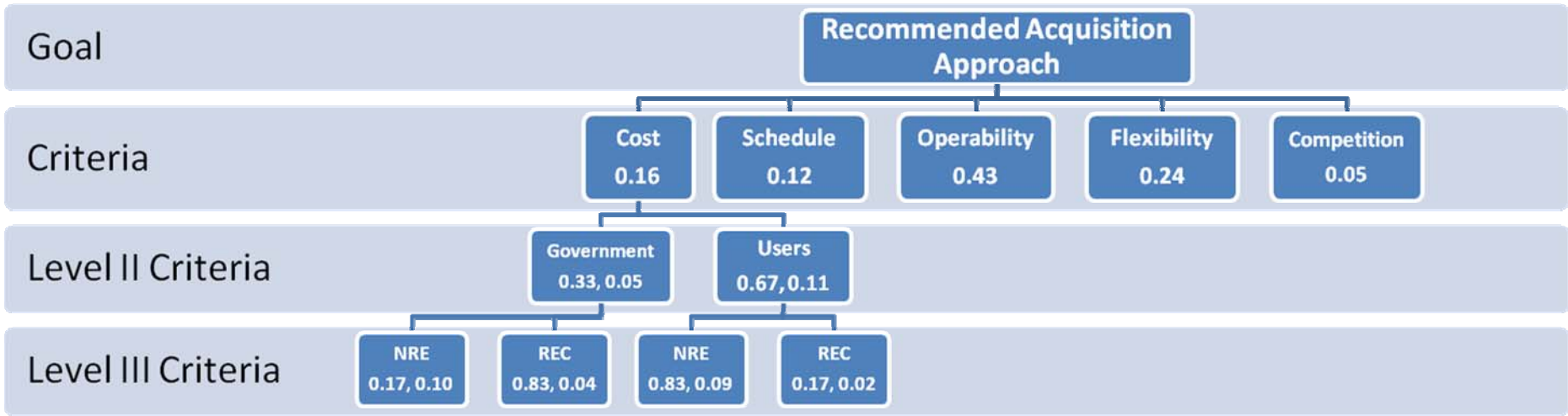
The Fundamental Scale for Pairwise Comparisons		
Intensity of Importance	**Definition**	**Explanation**
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance.		

Utilized voting system

Consensus Intensity numbers were based on mathematical average of intensities

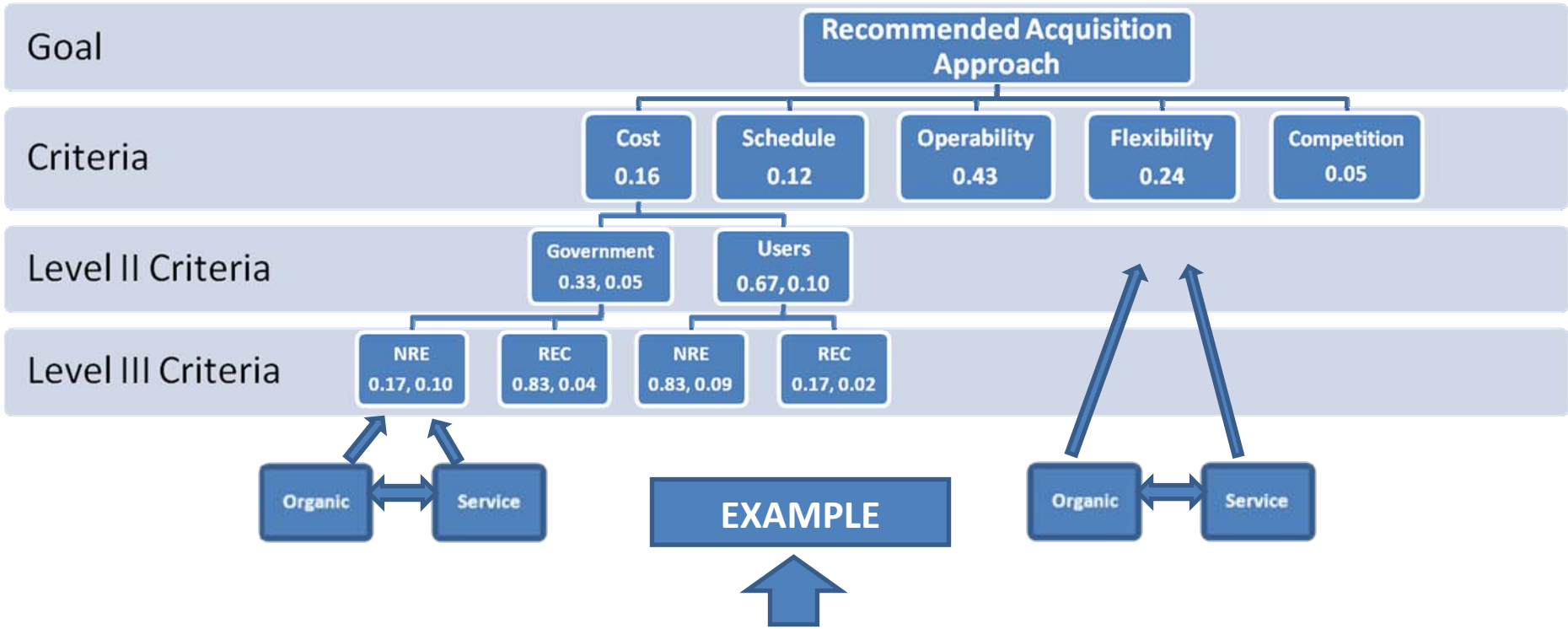
High Level Criteria			
Criteria		**More Important**	**Intensity**
A	**B**		
Cost	Schedule	A	3.30
Cost	Operability	B	0.23
Cost	Competition	A	4.10
Cost	Flexibility	B	0.34
Schedule	Operability	B	0.29
Schedule	Competition	A	5.60
Schedule	Flexibility	B	0.32
Operability	Competition	A	5.50
Operability	Flexibility	A	3.00
Competition	Flexibility	B	0.25

Analytic Hierarchy Process (AHP) Success Story : Priority Results



Perform paired comparison for all criteria at each level to establish priorities (weightings).

Analytic Hierarchy Process (AHP) Success Story : Alternative Inputs and Prioritization



Alternative Inputs for Pairwise Comparisons								
Alternative	Government		Users		Schedule	Operability	Flexibility	Competition
					# Sites to Implement	Risk Rating	Adaptability Rating	Number of Intersted Vendors
	NRE	REC	NRE	REC				
Organic	$800	$1,200	$300	$1,000	50	13	17	7
Service	$400	$1,800	$100	$700	25	6	11	3

Analytic Hierarchy Process (AHP) Success Story : Results

Alternative Inputs for Pairwise Comparisons									
Alternative	Government		Users		Schedule	Operability	Flexibility	Competition	
					# Sites to Implement	Risk Rating	Adaptability Rating	Number of Intersted Vendors	
	NRE	REC	NRE	REC					
Organic	$800	$1,200	$300	$1,000	50	13	17	7	
Service	$400	$1,800	$100	$700	25	6	11	3	
Global Priority Results									**Total**
Organic	0.003	0.018	0.022	0.007	0.041	0.129	0.143	0.033	0.40
Service	0.006	0.027	0.067	0.010	0.082	0.306	0.093	0.014	0.60

- Recommended Acquisition Approach: Service

AHP Applications at Cobec

- We utilize AHP at the Federal Aviation Administration (FAA):
- For complex decisions, including determining acquisition approaches and developing prioritized deployment schedules for major Air Traffic Control programs/systems.

Conclusions

- AHP can be utilized to provide more objective solutions to complex problems in the government environment.
- Provides documented, traceable, technical methodology
- Allows for input from various stakeholders, team members, SMEs

Questions

Hisham Jalil
hjalil@cobecconsulting.com