

Command Post Agility Capstone Research Project

**Creating a Hierarchical Value Model to
Evaluate a System of Systems**

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The Team



Agenda

- The Team
- Stakeholders
- Background (Command Post Context and History)
- Problem Statement and Answer
- Value Modeling with Example
- The Hierarchical Value Model
- Concept of the Model
- Base Level Analysis
- Intermediate Level Analysis
- Whole System Analysis
- Conclusion
- Recommendation
- Tool Demo
- Questions

Stakeholders

- Primary Customer
 - TRAC-WSMR is in charge on planning, organizing, and conducting bi-annual Network Integration Exercises (NIE) in order to put together reports which entail the effects of different incremental enhancements on the different command post
- Other Stakeholders
 - **Brigade Modernization Command**

The Modernization Brigade at Ft. Bliss has a TRAC-WSMR detach element in charge of testing and evaluating technology enhancements for Command Post systems
 - **US Combined Arms Center and Mission Command Center of Excellence**

Focused on providing the vision and direction of how Command Posts shall be in the future. They are in charge of researching and analyzing technological enhancements which will accomplish a set of goals in making command post more agile, effective, and efficient

CP Context

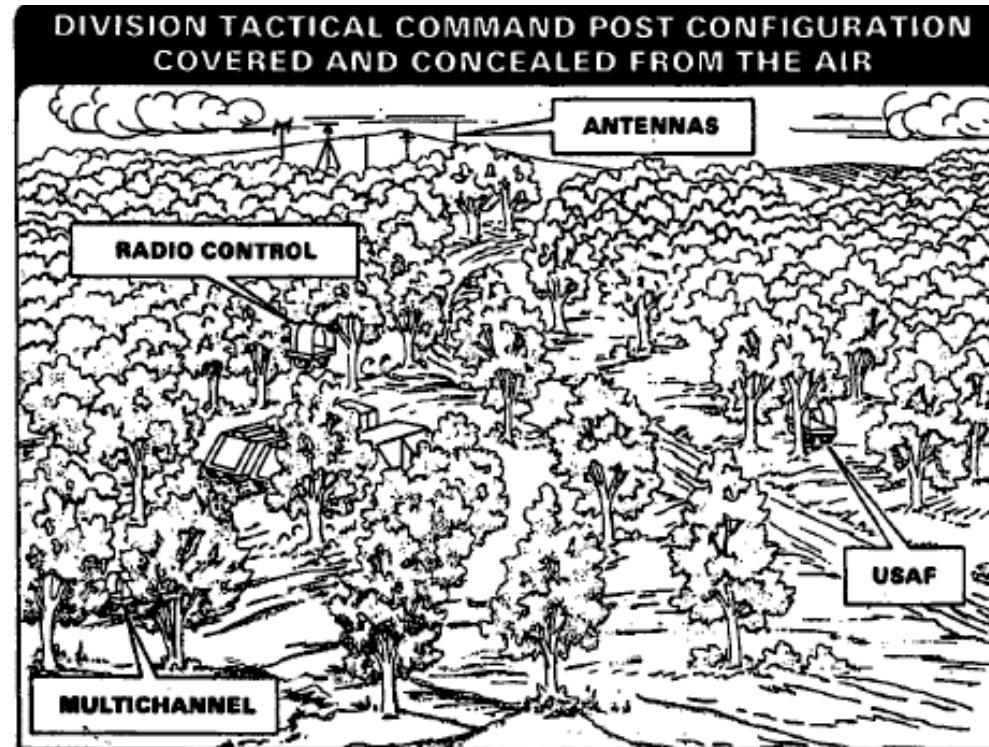
“As the size, complexity, mobility, and dispersion of military forces increased, the challenges of obtaining and disseminating information and of maintaining control increased as well. Expanded staffs, improved organization and procedures, and new technology...could alleviate some of these difficulties, but they created new problems for commanders to solve.”

--David W. Hogan, Jr. “*A Command Post at War*”

History

"There will always be a tendency to expand the functions and, so, the size of any command post. This particularly so in the case of the tactical command post since the commander normally takes station there. Therefore, it is necessary to guard against expansion lest the command post becomes cumbersome, less mobile, and more identifiable by enemy information-gathering agencies. Four or five armored command control vehicles should be sufficient for operational needs."

FM 71-100, p. 7-11 (1978)



Background (cont.)



Problem Statement

Provide a systems engineering framework to be able to evaluate the whole system (Command Post) and its many subsystems (e.g., structures, visual information, power, etc.) while maintaining flexibility for the many stakeholders

Answer to Problem Statement

- We have constructed a hierarchical value model (in MS Excel) to evaluate focus area (or subsystem) improvements of a CP and CP configurations
- The hierarchical value model provides a ranking of CP improvements, sensitivity analyses, and Pareto charts to further aid in making informed decisions

Value Modeling

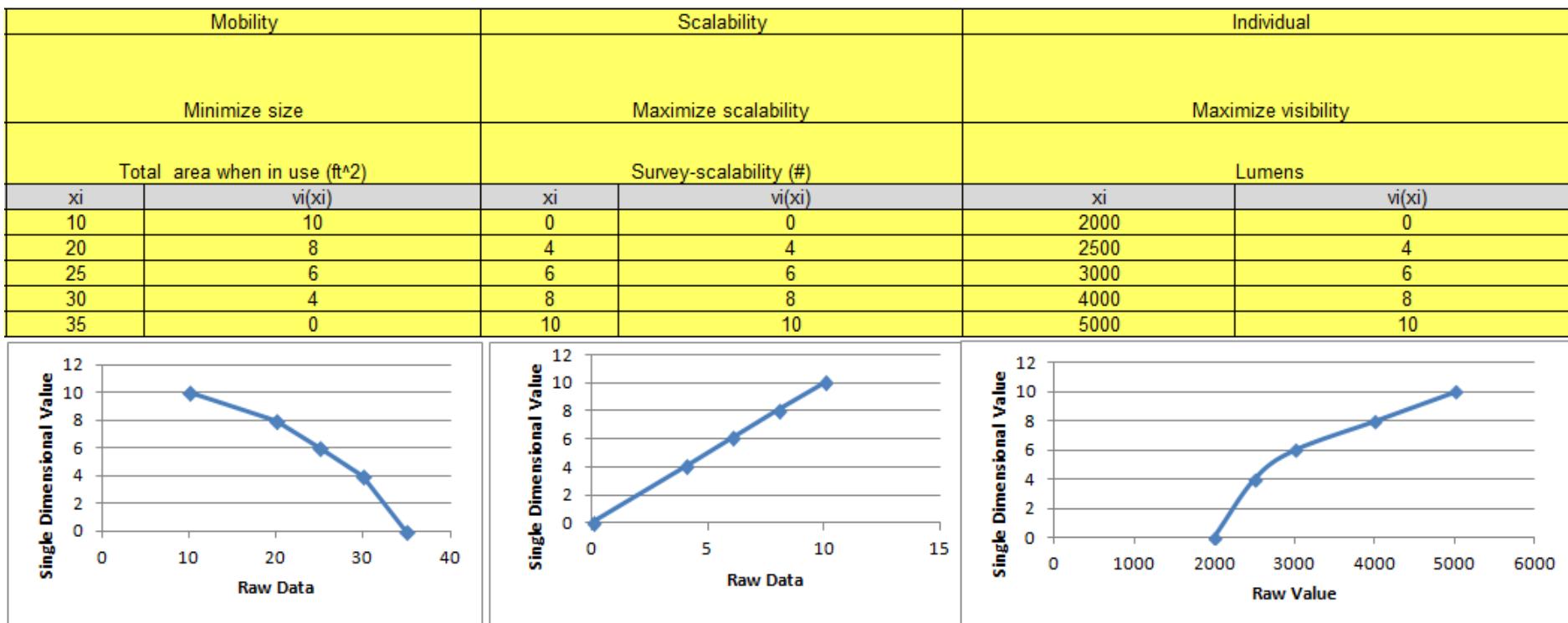
- Why decisions are hard:
 - Multiple objectives
 - Multiple stakeholders (opinions)
 - Uncertainty
- A value model is a multi-objective decision analysis tool
- It is based on weighting the multiple objectives to give them a relative importance to each other

Value Model Example

- There are common objectives for any CP that were given. These are:
 - Set-Up time/ Agility
 - Energy informed operation
 - Complexity
 - Mobility
 - Integration
 - Size
 - Scalability
- Additionally there are objectives for each subsystem, say a visual display:
 - Lumens/brightness

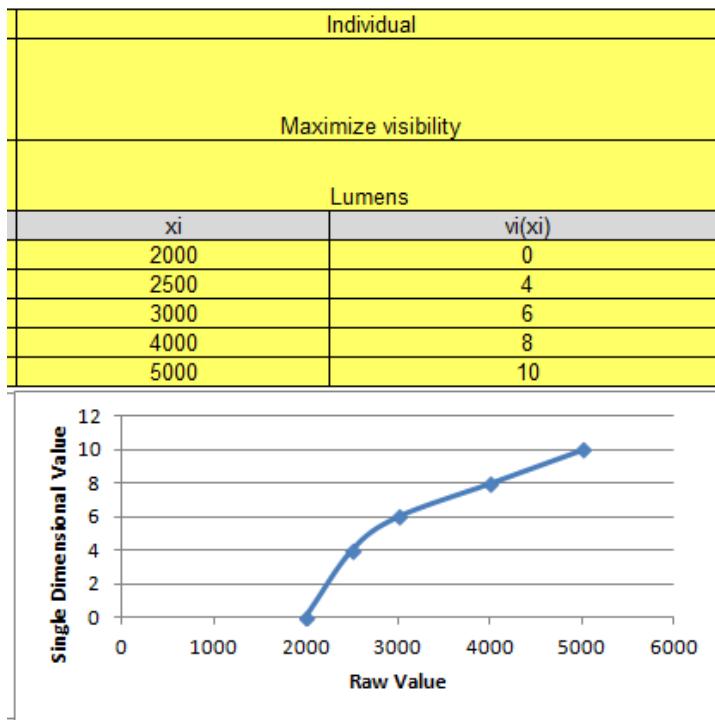
Value Model Example

- The first step is to give a common value scale and provide a value curve for each objective



Value Model Example

- The next step is provide the actual performance for each objective for each alternative and then the value score is calculated



Alternatives

TV (original)	3500.0	7
Projector	4000.0	8
Smartboard	2250.0	2

Value Model Example

- Now assign each objective a weight

	Swt	Mwt		Swt	Mwt
Energy consumption (watt)	20		Set up time (minutes)	10	
Number of cables (#)	10		Cubic footage when packed (ft^3)	20	
Survey-integration (#)	10		Total area when in use (ft^2)	10	
Survey-scalability (#)	5		Lumens	10	

Value Model Example

- Then calculate a relative weight

$$w_i = \frac{f_i}{\sum_{i=1}^n f_i}$$

	Swt	Mwt		Swt	Mwt
Energy consumption (watt)	20	0.211	Set up time (minutes)	10	0.105
Number of cables (#)	10	0.105	Cubic footage when packed (ft^3)	20	0.211
Survey-integration (#)	10	0.105	Total area when in use (ft^2)	10	0.105
Survey-scalability (#)	5	0.053	Lumens	10	0.105

Value Model Example

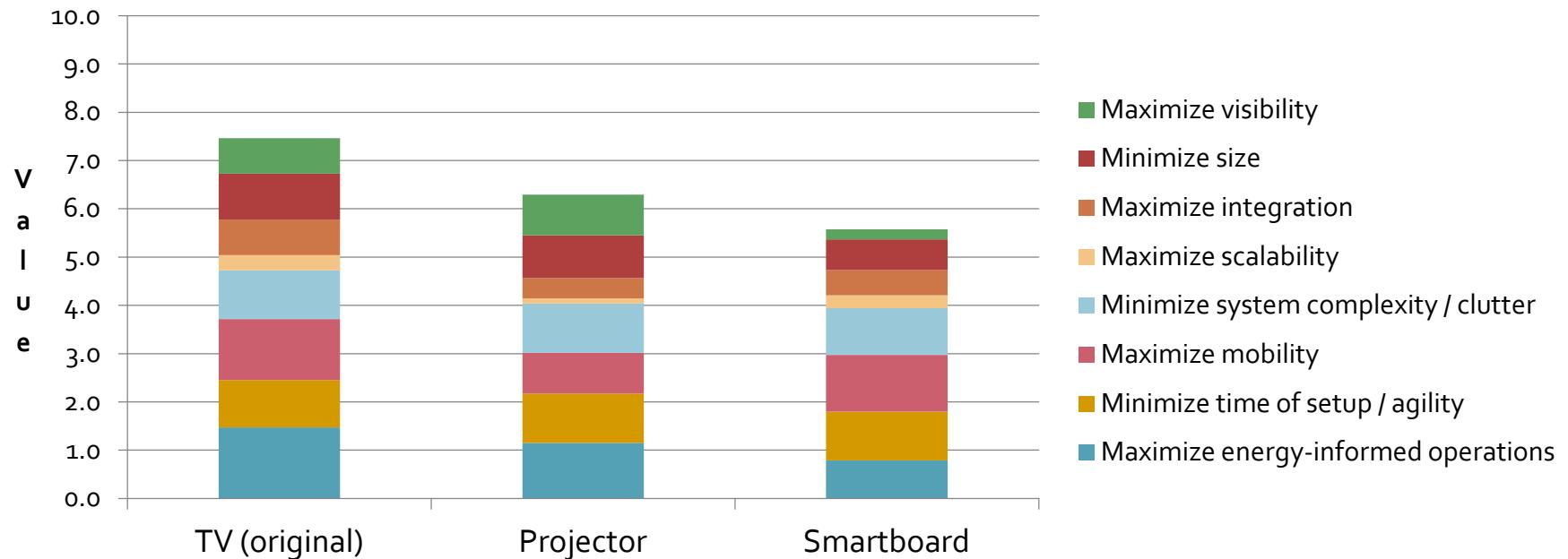
- Finally each objective's value is multiplied by its weight and summed to provide an overall total value score

$$v(x) = \sum_{i=1}^n w_i v_i(x_i)$$

- This is done for each alternative and the values can be compared numerically and graphically

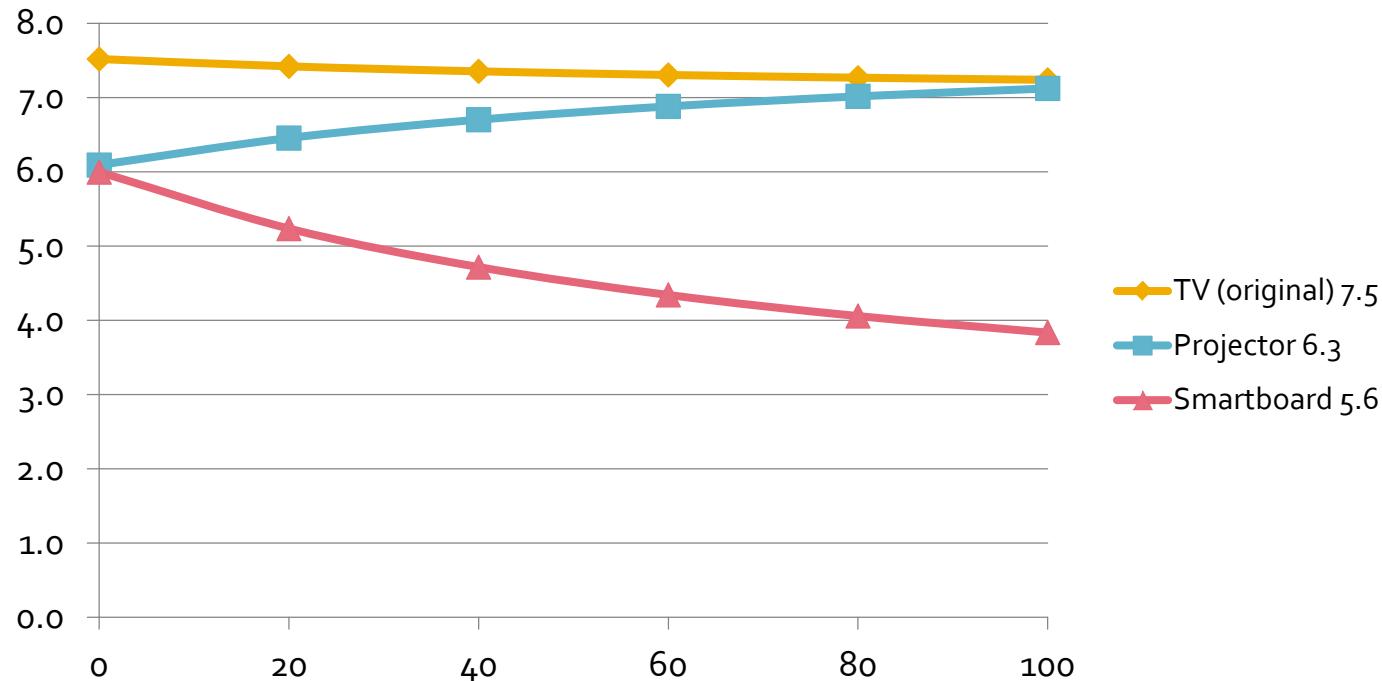
Value Model Example

"Visual" Alternative Comparison



Value Model Example -Sensitivity Analysis

Sensitivity of Lumens



The Hierarchical Value Model

Concept of the Hierarchal Value Model

- Value models provide a way to compare alternatives with multiple objectives
- However, with Command Posts there are many competing subsystems
- The Hierarchal Value Model uses a tiered value model approach from the smallest subsystem to the whole system

Big Picture

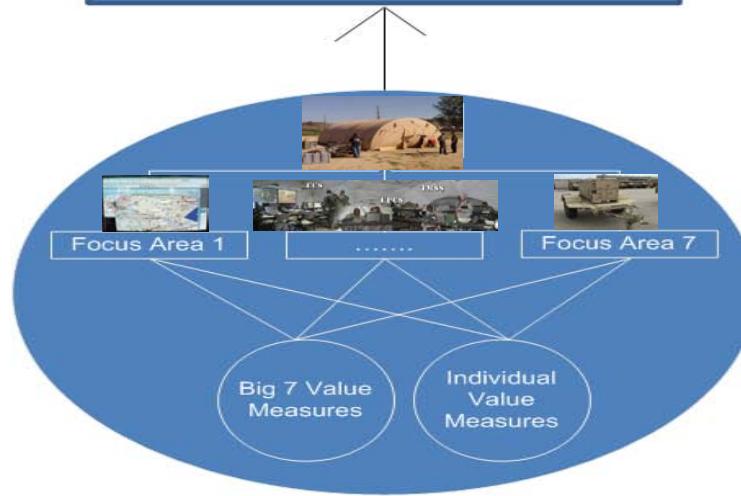
Whole System



Intermediate Subsystem



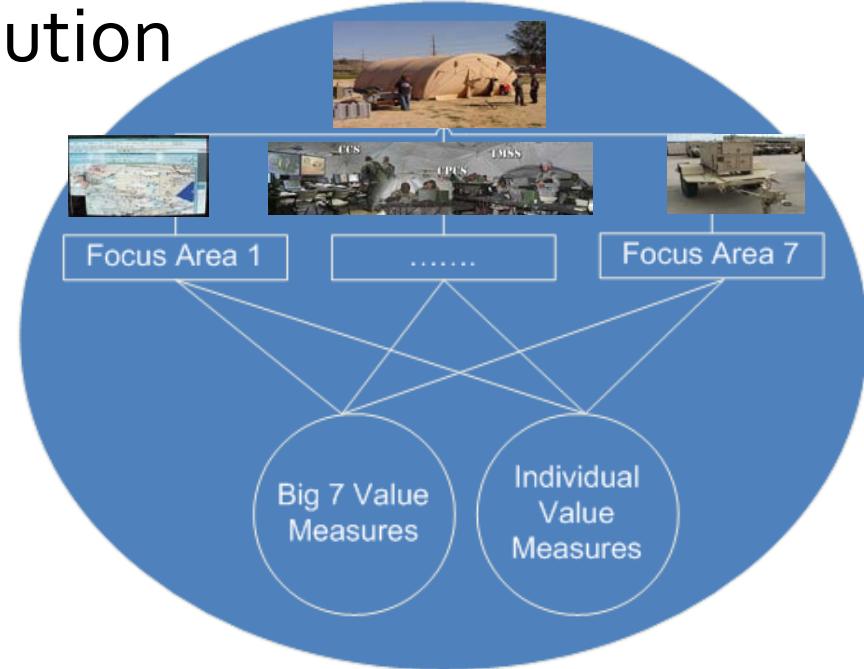
Base Level Subsystem



Base Level Subsystem

Focus Areas

- Displays, Tables, Chairs, Network, ECU, Power Generation, Power Distribution



“Big 7” Objectives

- Set-Up time/ Agility, Energy informed operations, Complexity, Mobility, Integration, Size , Scalability

Intermediate Level Systems



Intermediate Subsystem

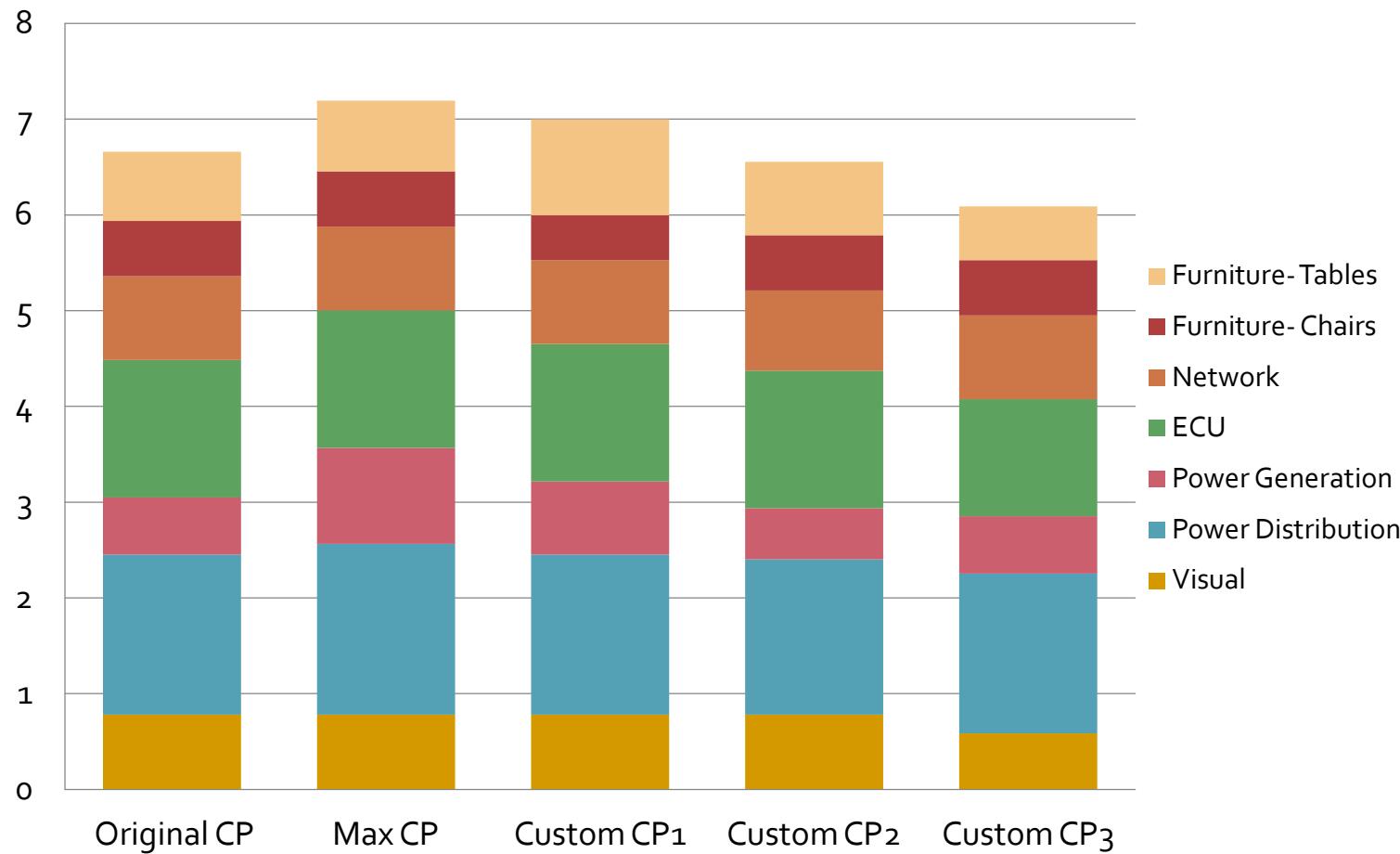
- The intermediate subsystem would be a tent structure
- A comparison can be made using different combinations of the subsystems
- The same process occurs and weights are applied to importance of each subsystem

How important is each component to accomplishing the CP's mission?

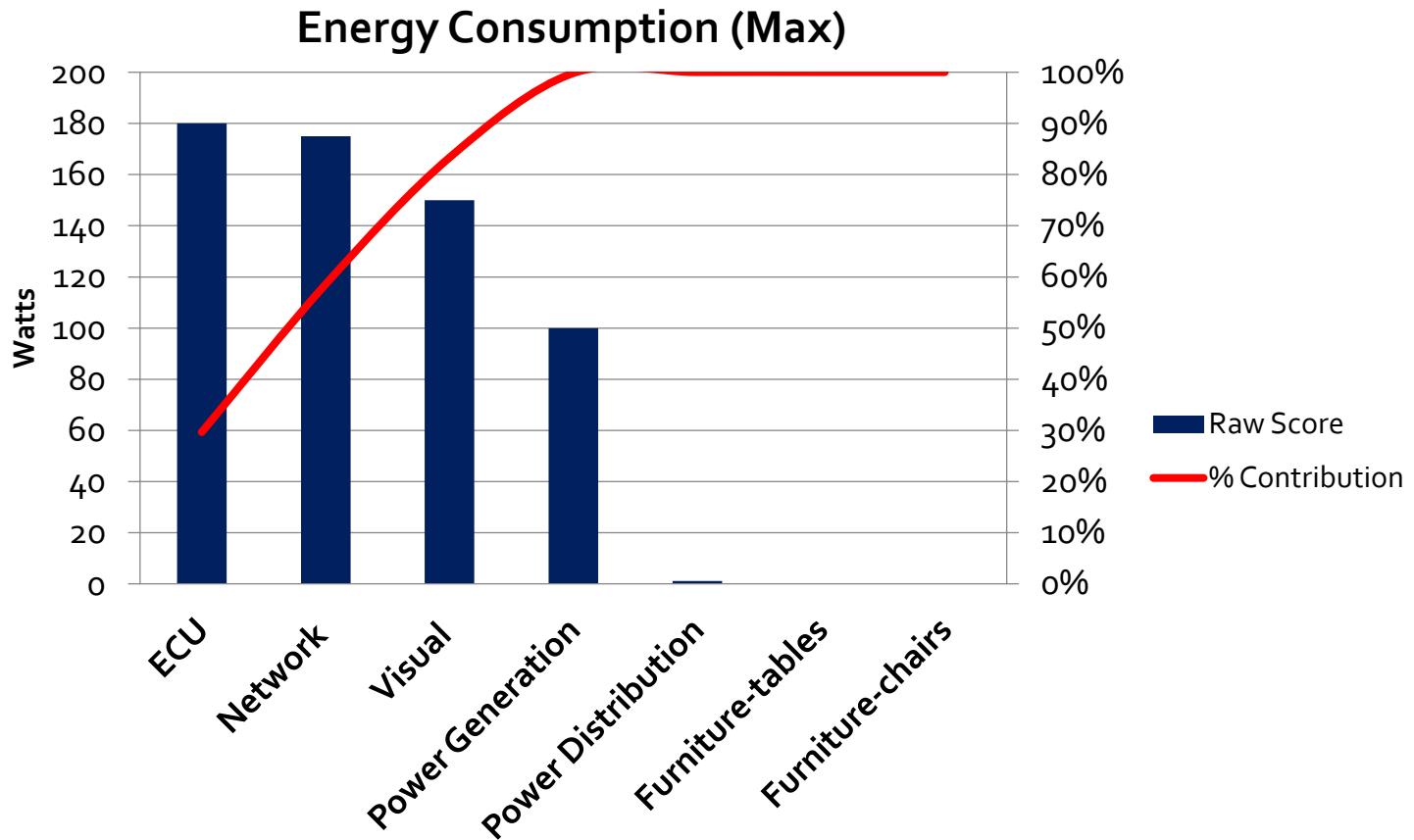
	Weights
Visual	35
Power Distribution	80
Power Generation	40
ECU	65
Network	45
Furniture- Chairs	30
Furniture- Tables	40

Intermediate Subsystem Value Model

Airbeam Layout Comparison



Intermediate Subsystem Pareto Chart



Whole System

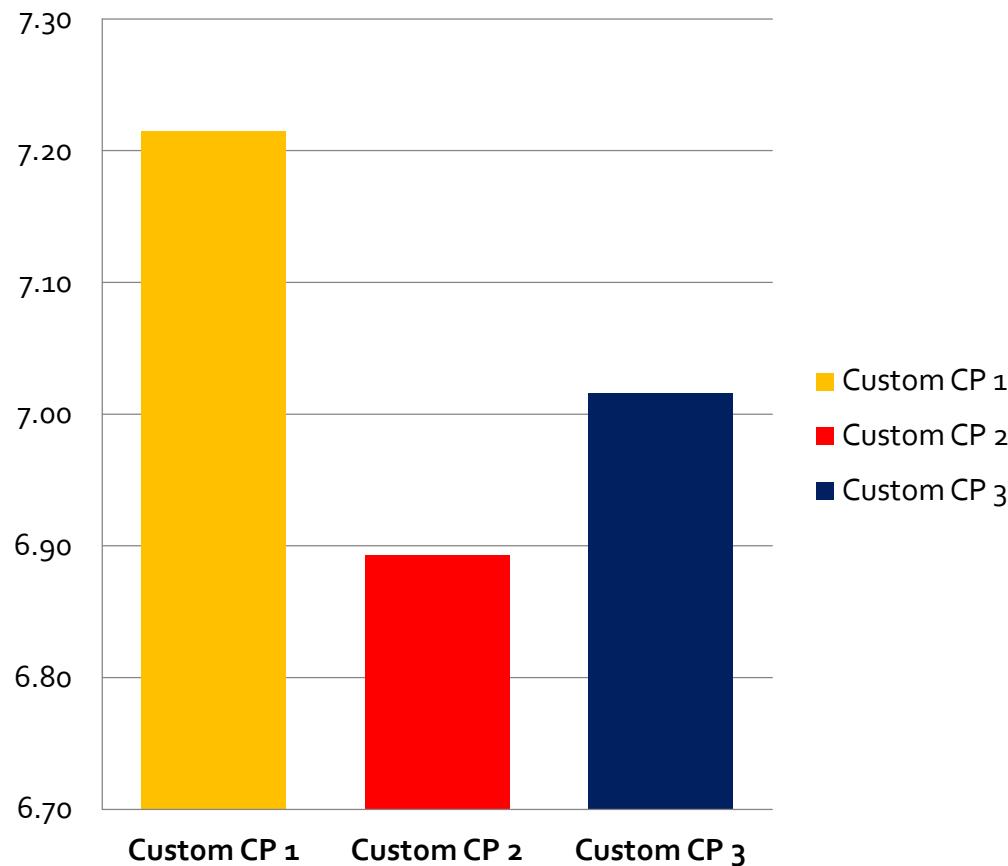


Whole System

- Subject matter experts propose alternative Command Post configurations based upon mission requirements and intelligence
- Weights are again assigned to the “Big 7”
- Main difference is that total value score takes into account the number of intermediate subsystems
- A value bar chart is again produced and a winner can be determined

Whole System

CP Layout Comparison



Conclusions

- Value modeling is an effective way to evaluate multiple objective decisions
- The hierachal value model approach ties the analysis together from subsystems to the whole system
- The hierachal model allows flexibility for changes in circumstances
- We believe this tool does a pretty good job at answering the call for all stakeholders

Recommendations

- Serious thought needs to go into determining the weights
- Update the model with user feedback from testing exercises and field use

Tool Demo

Questions?