Using RACE for Affordability

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Affordable Innovation

In order to figure out the sweet spot, we must be able to determine the cost and performance of the exquisite solution ~ then back down with alternative solutions.
Why is Systems Engineering Responsible for Evaluating Affordability?

• It requires that system level trades (AoA, CAIV, etc.) be conducted
• It requires the identification of baseline and alternative architectures
• Optimization should be done at the system level
• It requires evaluations of system cost and system performance
• It may result in ‘push back’ on requirements
Rapid Affordability and CAIV Exploration (RACE)

- An Excel COM addin that was developed in Visual Studio™ using Visual Basic .NET (VB.NET)

- Suite of Decision Analysis Capabilities
  - Analysis of Alternatives
  - Optimization
  - Pair wise Comparison
  - Tornado / Spider Plot
  - Design Space
  - Carpet Plot
  - Model Sleuth
  - Surface Plot
RACE Inputs

- Design alternatives
- Bins and metrics
- Threshold and objective requirements values
- Weightings
- Utility curves
- Performance of each alternative
Setting Up Analysis of Alternatives

Bins help organize metrics

Value Function

Relative weightings of each metric

Determine value & optimization constraints
Value Functions

Value Function
- Metric: LaunchCost
- Units: lower limit
- Weight: 1
- Value Function: convex
- Threshold: 450
- Objective: 300
- Goal: Best
- Val at Threshold: 0.2

Value Function
- Metric: AUC
- Units: lower limit
- Weight: 3
- Value Function: linear
- Threshold: 70
- Objective: 12
- Goal: Best
- Val at Threshold: 0.1

Value Function
- Metric: TotalCost
- Units: lower limit
- Weight: 8
- Value Function: step
- Threshold: 6000
- Objective: 2000
- Goal: Best
- Val at Threshold: 0.2

Value Function
- Metric: Service Load
- Units: lower limit
- Weight: 5
- Value Function: step
- Threshold: 1500000
- Objective: 7000000
- Goal: Wow
- Val at Threshold: 0
Weighting Sensitivities

**WAM Score vs Performance Wtg**

**WAM Score vs Schedule Wtg**

**WAM Score vs Risk Wtg**

**WGM Score vs Cost Wtg**
### Contribution to Metric Scoring

- Why did an alternative score well?
- Quickly determine where strengths and weaknesses exist
- Preview to weighting sensitivity
- Promotes objectivity
- Look for the ‘balanced’ solution

#### Bin Contribution to Score (WAM)

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<th>Performance</th>
<th>Size</th>
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- Lowest Cost
- Smallest Size
- Highest Performance
Surface Plots

- 3 dimensional surface plots allow us to evaluate the robustness of the optimal solution
This is Harder Than it Looks

• System designers sometimes have trouble even establishing a baseline

• Limited resources

• Weightings and utility curves can be subjective

• The utility of any application is highly dependent on the validity of its input
What Systems Engineering Can Do to Promote Affordability Studies

• Solicit customer input on weightings and utility curves

• Get a feel for customer willingness to accept ‘push back’ on requirements
  – Focus on those that may be flexible

• Lock down the system baseline
Conclusions

• The trade study *process* is the important element here
  – RACE is simply one of many applications that can be used

• Trade study results are more credible when using a tool like RACE because they produce a *more objective* evaluation of the design alternatives