Using RACE for Affordability

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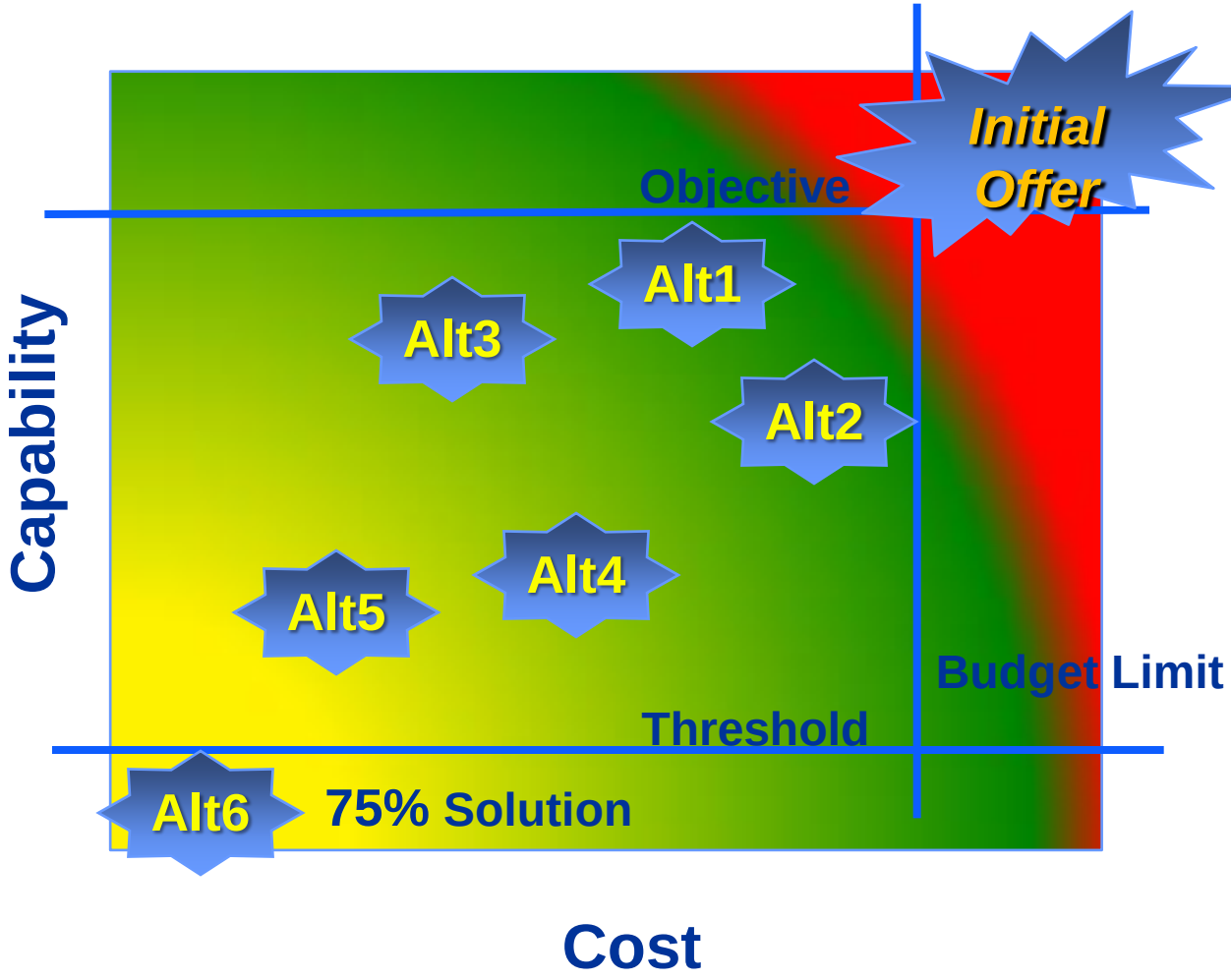
Affordable Innovation

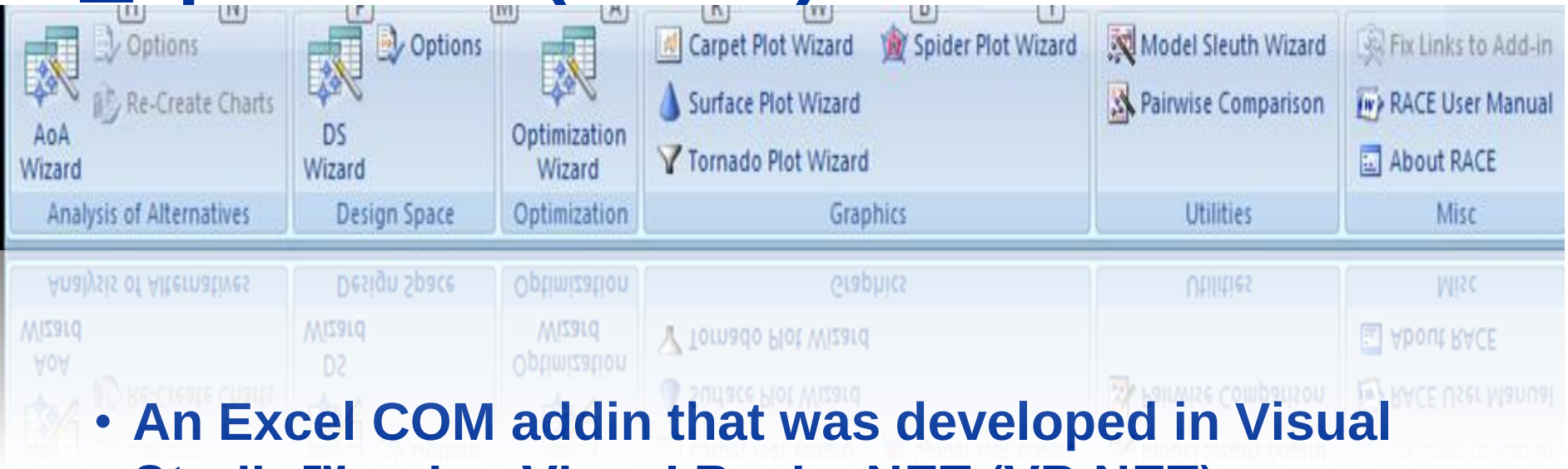


In order to figure out the sweet spot, we must be able to determine the cost and performance of the exquisite solution ~ then back down with alternative solutions

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)

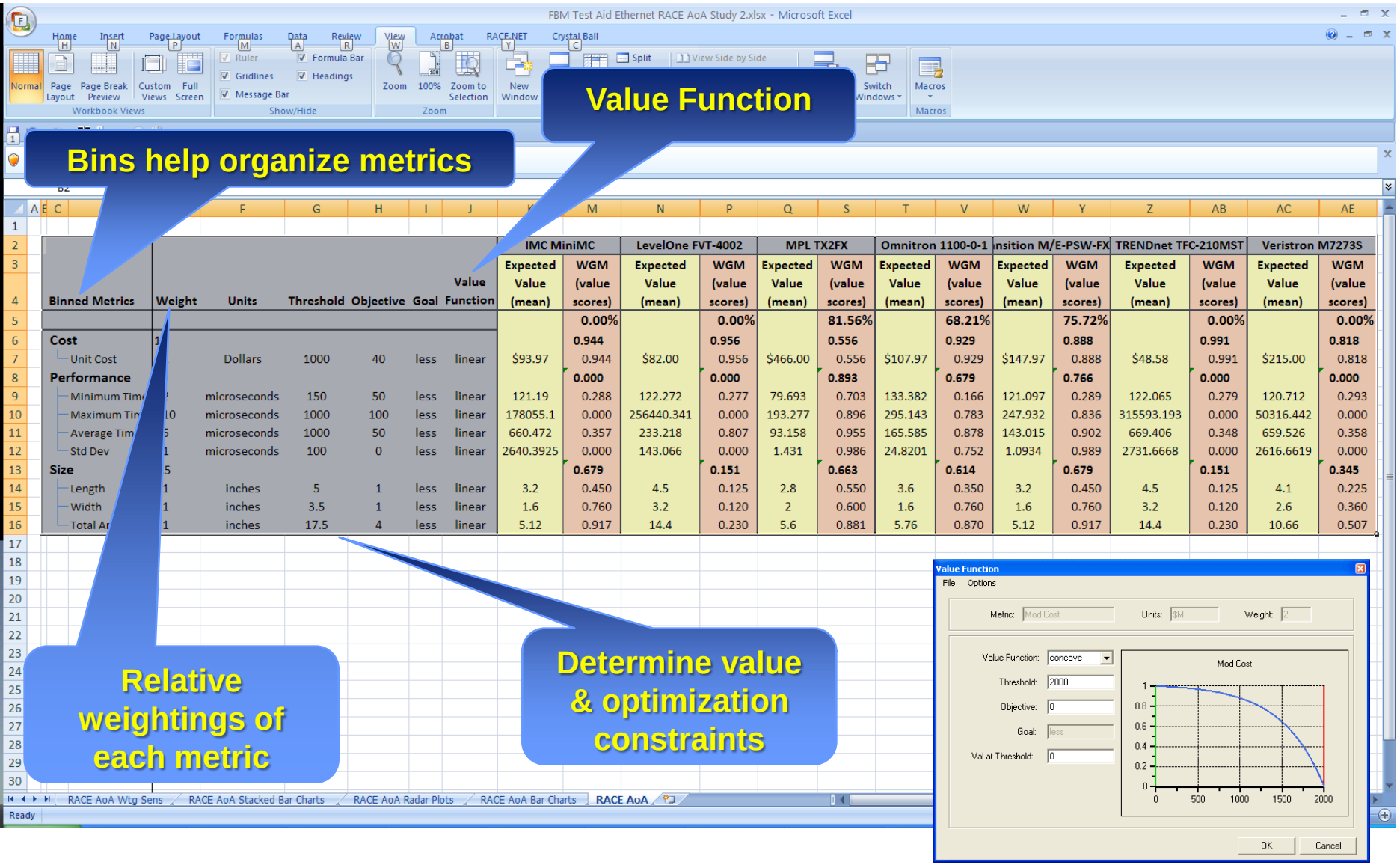


- An Excel COM addin that was developed in Visual Studio™ using Visual Basic .NET (VB.NET)
- Suite of Decision Analysis Capabilities
  - Analysis of Alternatives
  - Optimization
  - Pair wise Comparison
  - Tornado / Spider Plot
  - Design Space
  - Carpet Plot
  - Model Sleuth
  - Surface Plot

RACE Inputs

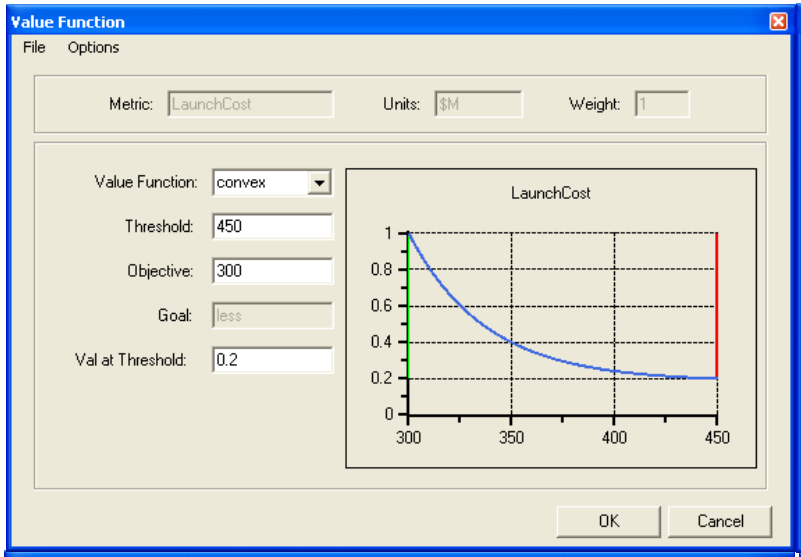
- Design alternatives
- Bins and metrics
- Threshold and objective requirements values
- Weightings
- Utility curves
- Performance of each alternative

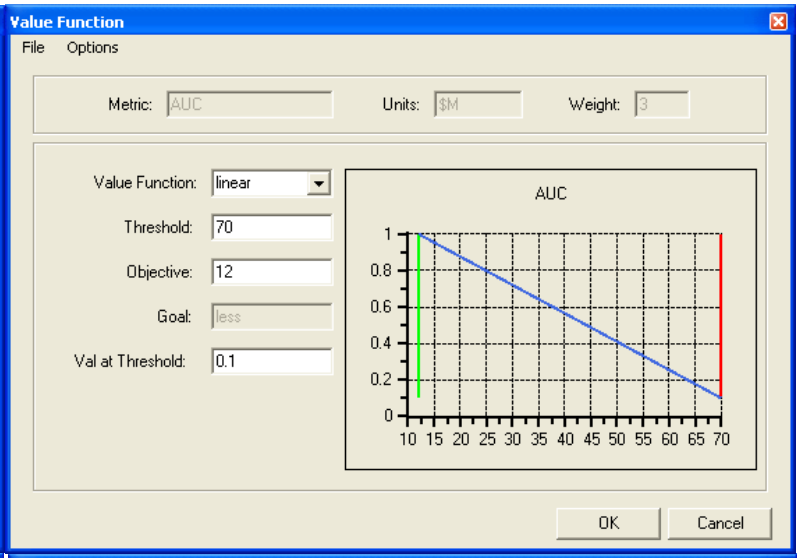
Setting Up Analysis of Alternatives

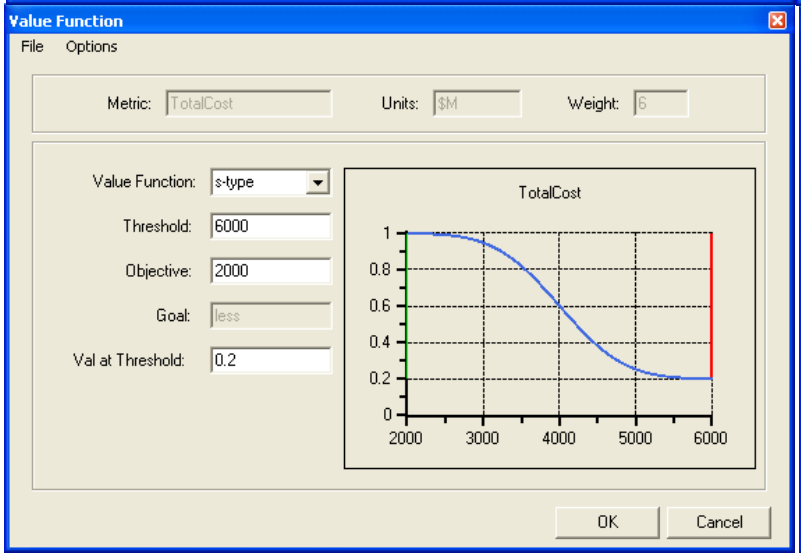


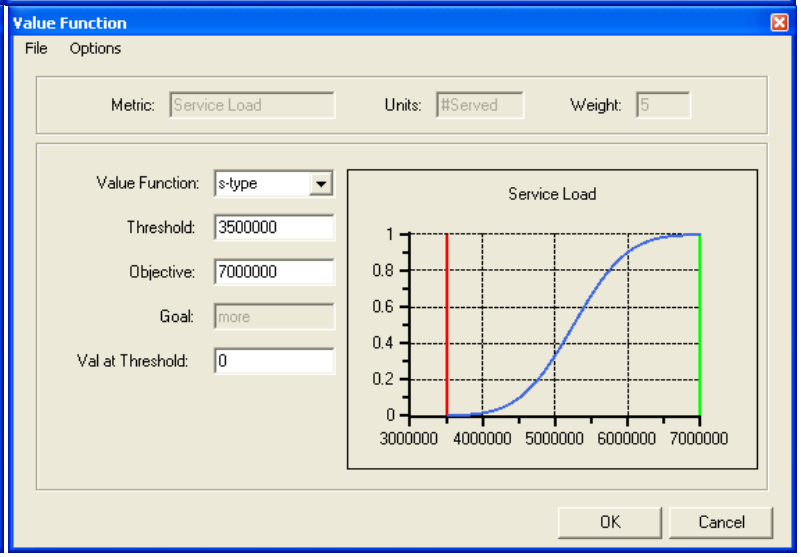
Binned Metrics	Weight	Units	Threshold	Objective	Goal	Value Function	IMC MiniMC		LevelOne FVT-4002		MPL TX2FX		Omnitron 1100-0-1		nsition M/E-PSW-FX		TRENDnet TFC-210MST		Veristron M7273S	
							Expected Value (mean)	WGM (value scores)	Expected Value (mean)	WGM (value scores)	Expected Value (mean)	WGM (value scores)	Expected Value (mean)	WGM (value scores)	Expected Value (mean)	WGM (value scores)	Expected Value (mean)	WGM (value scores)	Expected Value (mean)	WGM (value scores)
								0.00%		0.00%		81.56%		68.21%		75.72%		0.00%		0.00%
Cost	1							0.944		0.956		0.556		0.929		0.888		0.991		0.818
Unit Cost		Dollars	1000	40	less	linear	$93.97	0.944	$82.00	0.956	$466.00	0.556	$107.97	0.929	$147.97	0.888	$48.58	0.991	$215.00	0.818
Performance								0.000		0.000		0.893		0.679		0.766		0.000		0.000
Minimum Tim	1	microseconds	150	50	less	linear	121.19	0.288	122.272	0.277	79.693	0.703	133.382	0.166	121.097	0.289	122.065	0.279	120.712	0.293
Maximum Tin	10	microseconds	1000	100	less	linear	178055.1	0.000	256440.341	0.000	193.277	0.896	295.143	0.783	247.932	0.836	315593.193	0.000	50316.442	0.000
Average Tim	5	microseconds	1000	50	less	linear	660.472	0.357	233.218	0.807	93.158	0.955	165.585	0.878	143.015	0.902	669.406	0.348	659.526	0.358
Std Dev	1	microseconds	100	0	less	linear	2640.3925	0.000	143.066	0.000	1.431	0.986	24.8201	0.752	1.0934	0.989	2731.6668	0.000	2616.6619	0.000
Size	5							0.679		0.151		0.663		0.614		0.679		0.151		0.345
Length	1	inches	5	1	less	linear	3.2	0.450	4.5	0.125	2.8	0.550	3.6	0.350	3.2	0.450	4.5	0.125	4.1	0.225
Width	1	inches	3.5	1	less	linear	1.6	0.760	3.2	0.120	2	0.600	1.6	0.760	1.6	0.760	3.2	0.120	2.6	0.360
Total Ar	1	inches	17.5	4	less	linear	5.12	0.917	14.4	0.230	5.6	0.881	5.76	0.870	5.12	0.917	14.4	0.230	10.66	0.507

Value Functions

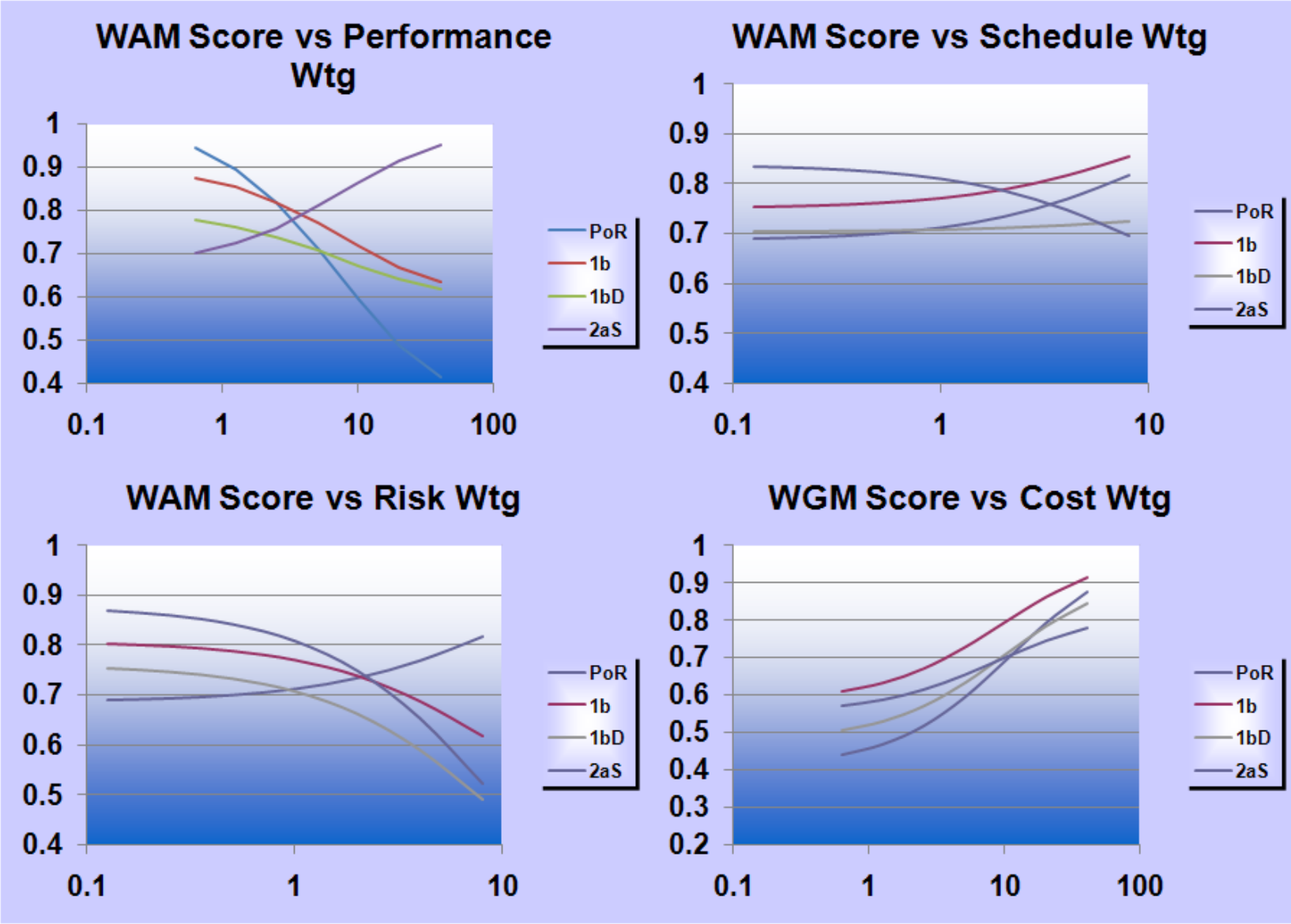




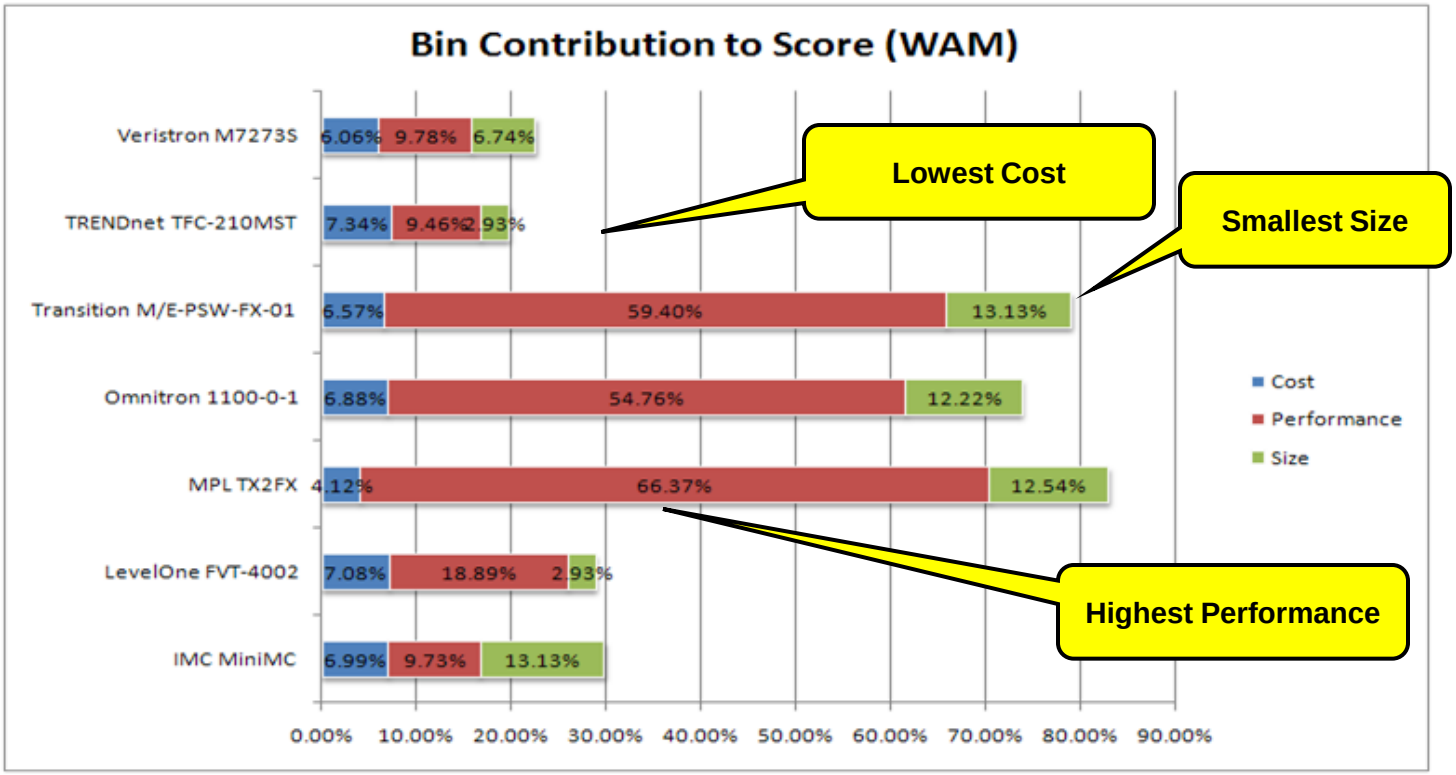




Weighting Sensitivities

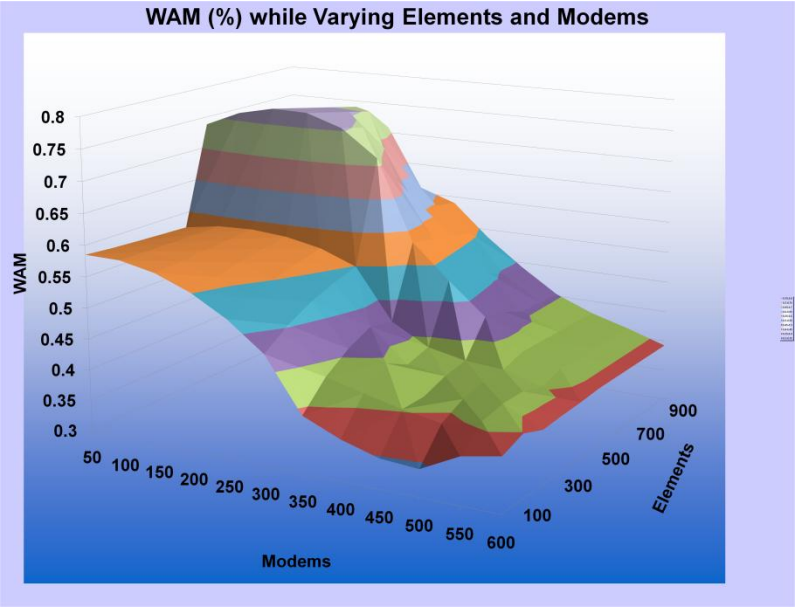


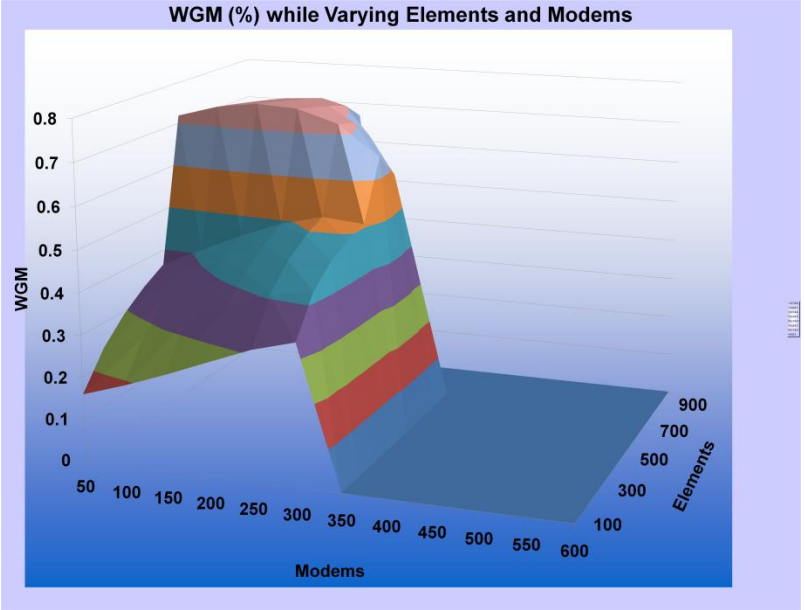
Contribution to Metric Scoring



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

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**