OPTECH Inc.

Optimal Solutions for a Technical World

Quantitative Improved ATO

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This Briefing is:

UNCLASSIFIED

Question

Can an qualitative created air battle plan be quantitatively optimized using Response Surface Methodology (RSM) ?

Overview

- Definitions
- History
- Representative environment
- Full Factorial Design
- Significance
- Conclusion/Questions

Definitions

- Air Operations Center (AOC or CAOC) it is large (>2000 people) that is responsible for controlling all the Air Power in a single geographic area (5 world wide).
- Air Tasking Order (ATO) the document created daily that tells aircraft when to take off, what tanker to use to get gas and where to drop their bombs. (several 100 pages of information)
- Air Control Order (ACO) the document created daily that divides up the airspace to maximize its use and to minimize the potential of a collision.
- Forward Edge of the Battle Area (FEBA)
- Mission Number- each flight is assigned a unique tracking number in the ATO

An example AOC

CENTAF AOC; Al Udeid AB, Qatar 2003

Operation Bolo
(ATO Qualitatively Created)

TODAY the ATO is still Qualitatively created

- 30 Plus years unable to incorporate quantitative "betterment" methods
- Attempts have been tried at the strategy level
- Rejected by the operators – "I would not fly that piece of crap"
- Quantitatively optimized ATO's would have to be "proven better"
- Our "black box" becomes the entire theater

Our Black box

- Unclassified Scenario
- 631 pieces of airspace, 550 blue missions, 197 red missions
- Blue Sub set studied - required air refueling and forward firing ordnance and going beyond FEBA
- Each run took 25 min at max speed (65 time normal)
- Real ATOs much larger, max speed about 3.5 times normal

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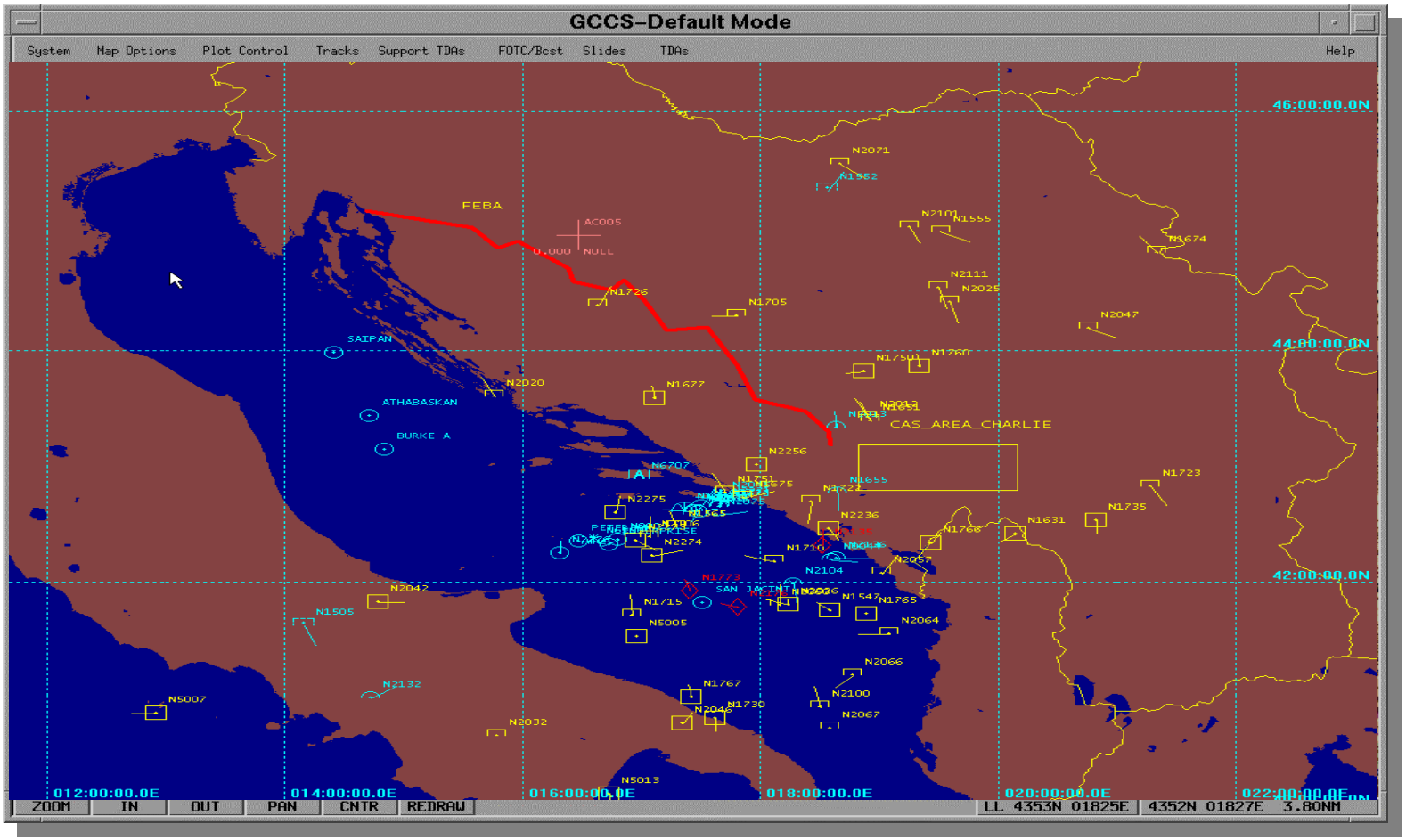
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Stochastic problem

- Limit Factors – 4 (F-18, F16, F15C, F15E)
- 2 Levels – full up and 30% reduction
- Ran same day ATO and ACO with the same takeoff times for each experiment
- Turn OFF all Surface to Air Missiles (SAMs)
- Cancelled the same mission numbers when type of aircraft was reduced
- Ran only “Most Likely” did not run “Worst Case”

Data Collected

Expent Number	MAIN EFFECTS					
	A	B	C	D	Blue Lost Y	Red Lost Y
1	-1	-1	-1	-1	36	56
2	+1	-1	-1	-1	39	56
3	-1	+1	-1	-1	35	54
4	+1	+1	-1	-1	35	54
5	-1	-1	+1	-1	39	56
6	+1	-1	+1	-1	34	56
7	-1	+1	+1	-1	34	53
8	+1	+1	+1	-1	33	52
9	-1	-1	-1	+1	34	56
10	+1	-1	-1	+1	35	57
11	-1	+1	-1	+1	37	53
12	+1	+1	-1	+1	33	55
13	-1	-1	+1	+1	33	55
14	+1	-1	+1	+1	33	55
15	-1	+1	+1	+1	35	53
16	+1	+1	+1	+1	39	55

Full Factor Interactions

INTERACTION EFFECTS										
AB	AC	AD	BC	BD	CD	ABC	ABD	ACD	BCD	ABCD
+1	+1	+1	+1	+1	+1	-1	-1	-1	-1	+1
-1	-1	-1	+1	+1	+1	+1	+1	+1	-1	-1
-1	+1	+1	-1	-1	+1	+1	+1	-1	+1	-1
+1	-1	-1	-1	-1	+1	-1	-1	+1	+1	+1
+1	-1	+1	-1	+1	-1	+1	-1	+1	+1	-1
-1	+1	-1	-1	+1	-1	-1	+1	-1	+1	+1
-1	-1	+1	+1	-1	-1	-1	+1	+1	-1	+1
+1	+1	-1	+1	-1	-1	+1	-1	-1	-1	-1
+1	+1	-1	+1	-1	-1	-1	+1	+1	+1	-1
-1	-1	+1	+1	-1	-1	+1	-1	-1	+1	+1
-1	+1	-1	-1	+1	-1	+1	-1	+1	-1	+1
+1	-1	+1	-1	+1	-1	-1	+1	-1	-1	-1
+1	-1	-1	-1	-1	+1	+1	+1	-1	-1	+1
-1	+1	+1	-1	-1	+1	-1	-1	+1	-1	-1
-1	-1	-1	+1	+1	+1	-1	-1	-1	+1	-1
+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1

Analysis

- Blue lose minimize math model 33.75 which is within the low range (33-34)
  - Minimize F-18, F-16, F-15C and keep F15 E at full strength
- Red lose maximize math model 56.75 which is within the high range (56-57)
  - Minimize F-16 and F-15C and keep F15 E and F-18 at full strength
- Can give F-15C and F-16 some slack in flying one day without major impact to war effort (blend Experiment 10 and 11)

Analysis

Linear regression provides a R^2 value allowing the determination of how good one term is as a predictor of another.

- The model for Blue Lost was weak as it had a low R^2 value.
- The math model for Red aircraft lost was much stronger with a higher R^2 value indicating a higher confidence in the results.

Indicated the need for a more complex math model and/or other factors not included in the study were in play.

Conclusion

Response Surface Methodology (RSM) and other parameter optimization techniques are appropriate to be used to scientifically study improving combat air power because of the massive number factors and interactions – most likely would require a small dedicated team trained in the techniques.

QUESTIONS?

The Science of Control and the Art of Command

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