ALTERNATIVES IMPACT IN COMBATANT SHIP DESIGN

Gerardo Sanabria Gaitan, Lt (Colombia)

Co-advisors:

Dr. Fotis Papoulias   Dr. Clifford Whitcomb

Research Motivation

PES (Strategic Surface Platform) Project

- Colombian frigates facing end of lifecycle

- Design and built a replacement class in a Colombian shipyard

Research Approach

- Combat System + Naval Architecture = Ship Design

- Naval Ship Model Based Systems Engineering (MBSE)

- Evaluate Trade Offs in Ship Design

Scope and Limitations

- Create Coupled Mission and Ship Design Space for Exploration

- Integrate Combat System (CS) with Naval Architecture Design and Mission Simulation Tools

- Displacement Range 2500 – 3100 Tons

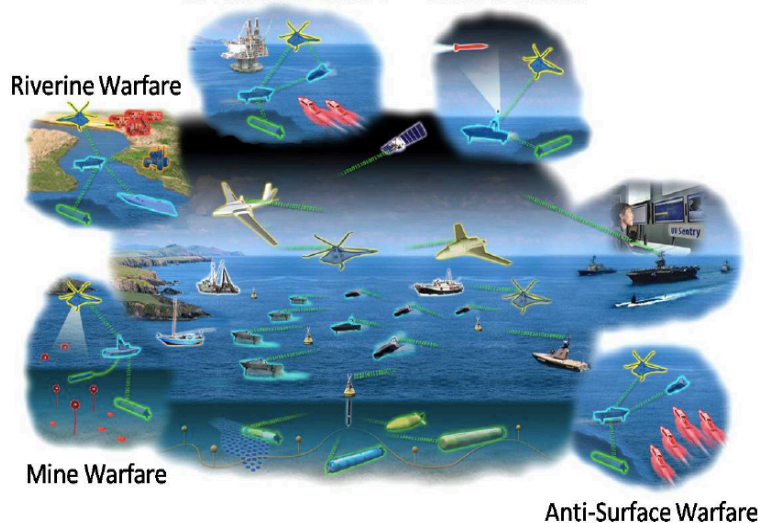- Consider only CODAD propulsion system

- Monohull

Background

- Previous work on Combatant Ship MBSE

- Mission Effectiveness with Ship CS Variables Included in Warfighting M&S (LCDR Jose Gomez – Colombian Navy).

- Naval Architecture & Mission Effectiveness – Explicit CS Variable Consideration Coupled Between Mission Space and Ship Design Space (Jason Fox)

Methodology

Missions/ Operational Requirements

Combat System Selection

Ship Synthesis Model

Analysis Design Space in JMP
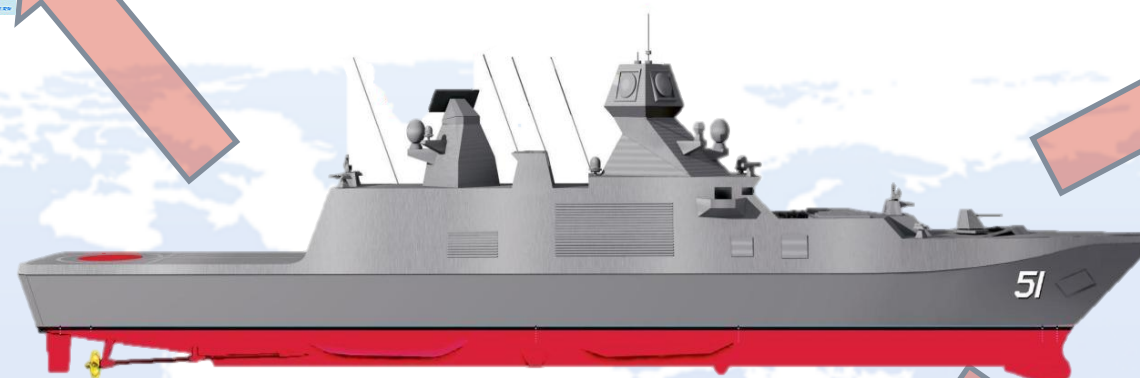
DOE / RSM

Run Experiments

Required Missions

Anti Air Warfare

Electronic Warfare

Anti Submarine Warfare

Surface Warfare

Configuration 1	Configuration 2	Configuration 3
8 SSM	8 SSM	8 SSM
32 SAM	12 SAM	8 SAM
1 Gun 76 mm	1 Gun 76 mm	1 Gun 5 in
6 Torpedoes	6 Torpedoes	6 Torpedoes
1 Medium Helo	1 Medium Helo	1 Medium Helo
3D Phased Array Radar	3D Radar	2D Radar
Hull Mounted Sonar	Hull Mounted Sonar	Hull Mounted Sonar
Decoys	Decoys	Decoys

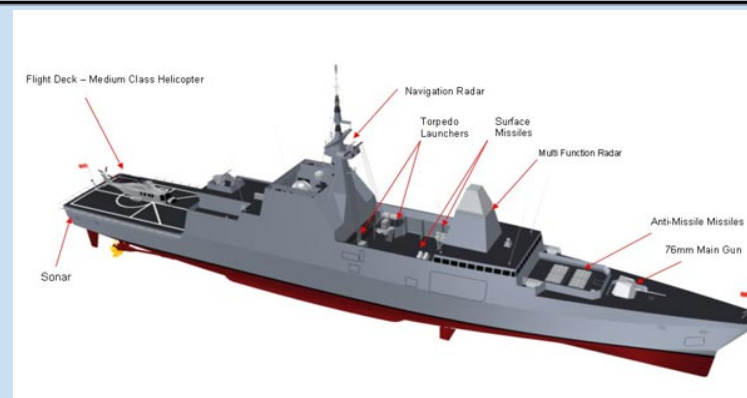# 3 Ship Baselines Form DOE Basis

DISPLACEMENT

2500

3100

SPEED

25

30

35

Lwl	288	ft
B	44.4	ft
T	12.5	ft
Δ	2510	t
V_{max}	25	kn
Range	4000	nm

Lwl	386	ft
B	42.2	ft
T	12.3	ft
Δ	2850	t
V_{max}	32	kn
Range	4500	nm

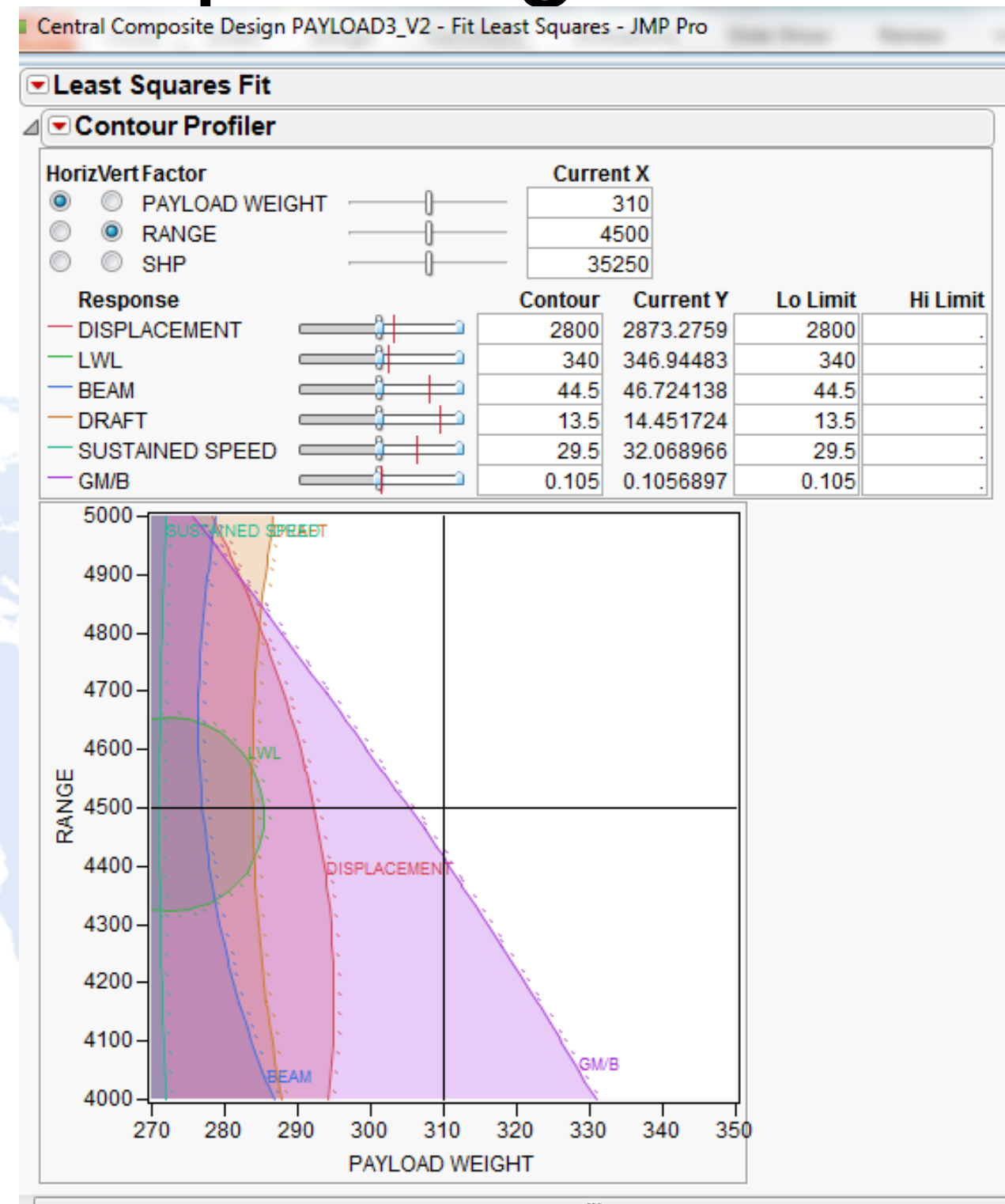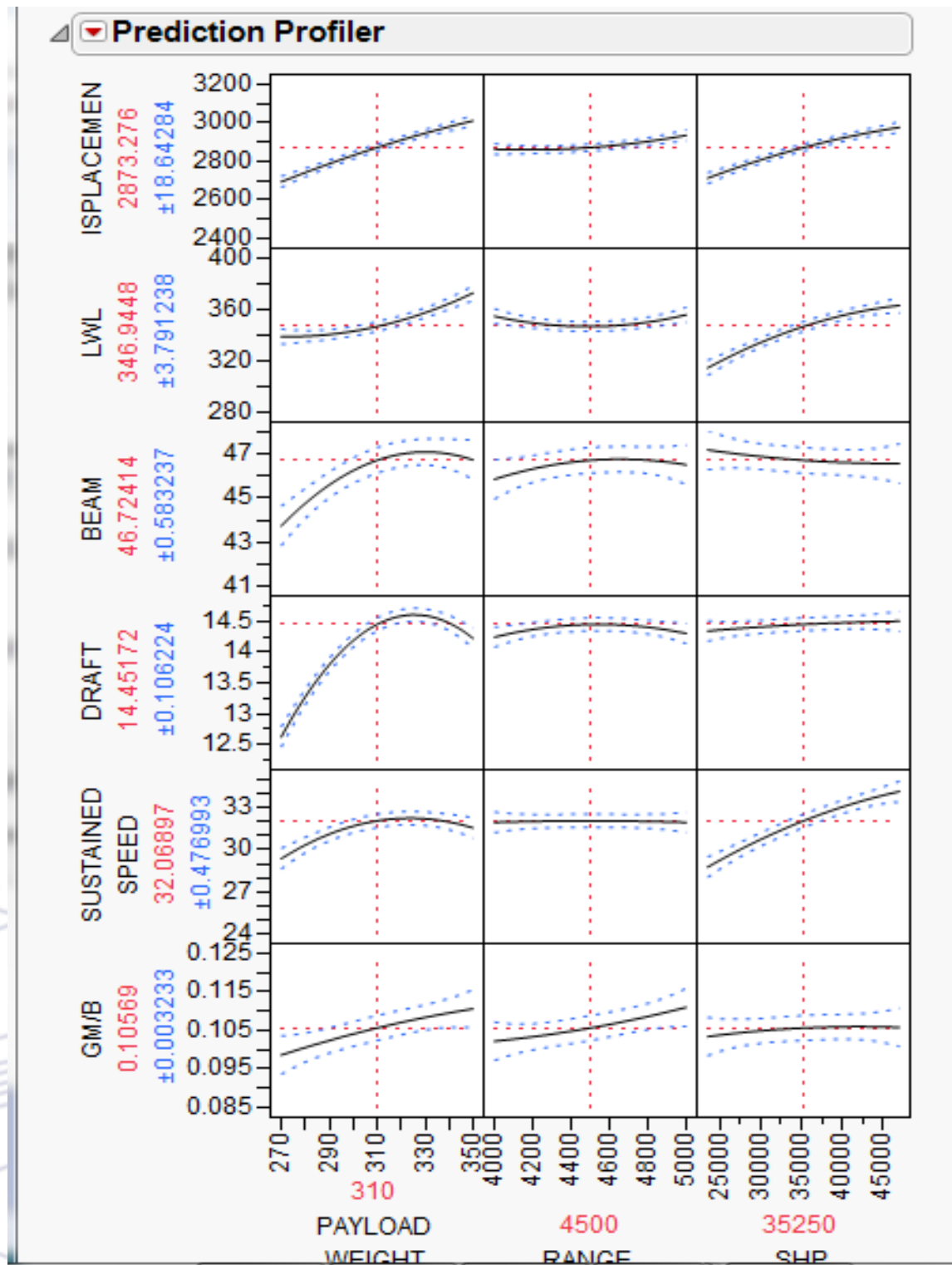| Lwl | 371.6 | ft |
B	46.9	ft
T	14.2	ft
Δ	3060	t
V_{max}	30	kn
Range	4000	nm

DOE – Ship Design- Screening

DOE – Ship Design - Model

Link Mission Outcome – Ship Synthesis

Ship within Feasible Region

Mission not within Feasible Desired Outcome Region
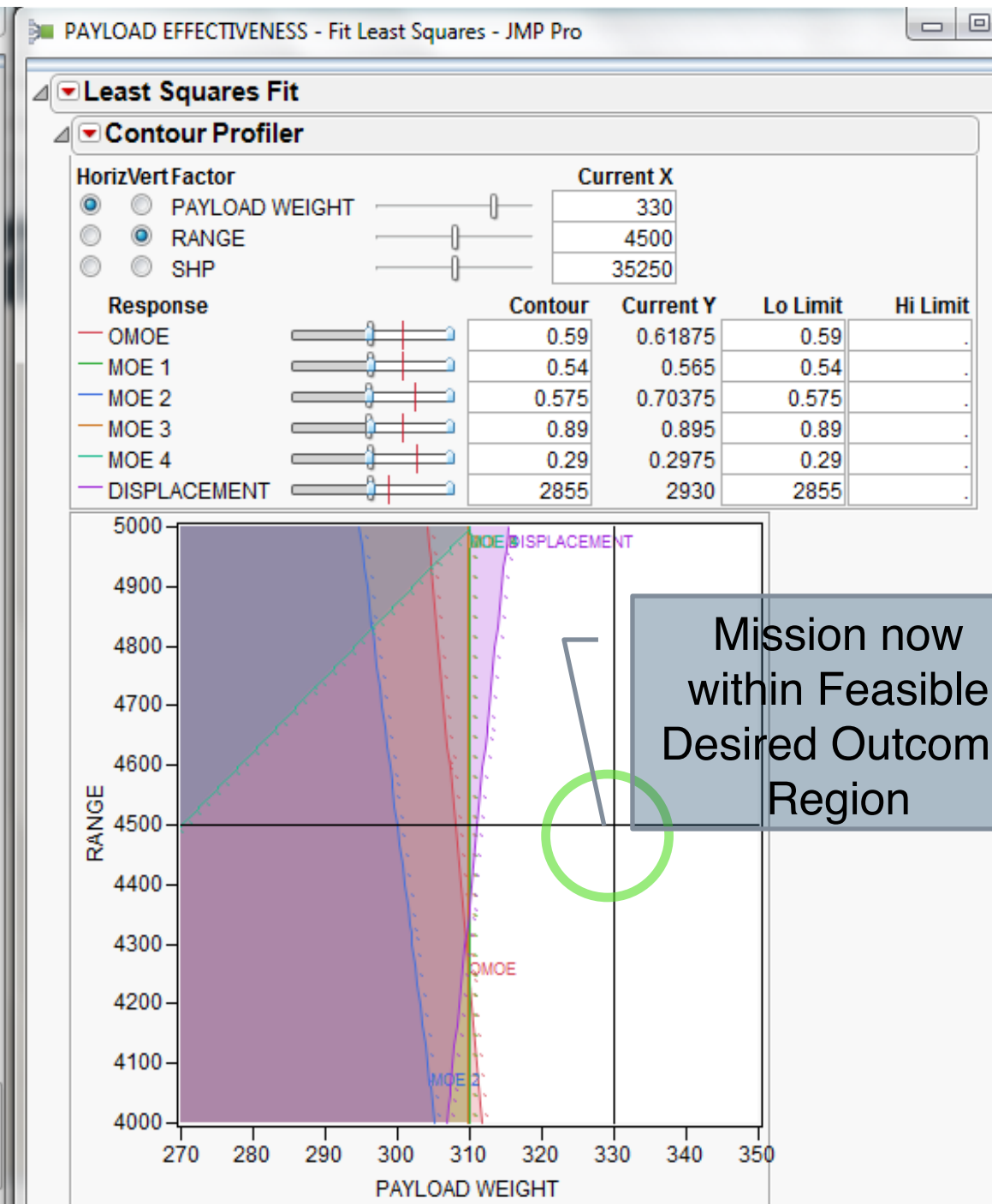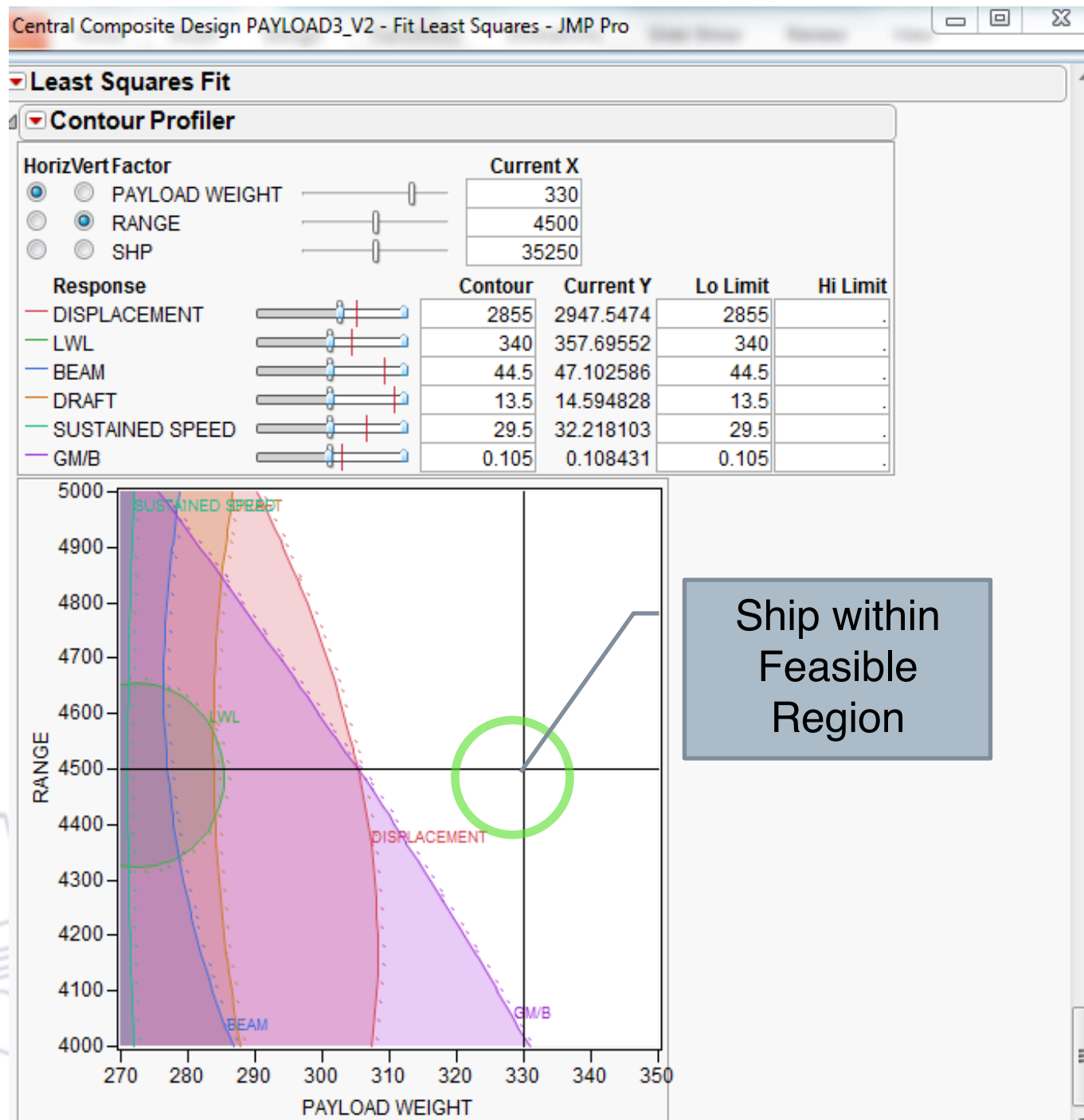
Link Mission Outcome – Ship Synthesis

Conclusions

- Design space exploration allows interactive analysis of many alternatives

- Use of DOE and Response Surface Methodology is an effective method

- Link between CS related mission effectiveness and naval architecture demonstrated

- Provides improved decision making insight

QUESTIONS?