STPA RETURN ON INVESTMENT INDUSTRY PERSPECTIVE

LORI SMITH

MARC NANCE

MARK VERNACCHIA

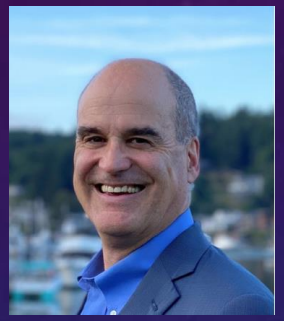
INTRODUCTIONS

LORI SMITH

RETIRED BOEING

23 YEARS AEROSPACE

CURRENTLY STAMP ENGINEERING SERVICES VP SYSTEMS ENGINEER



MARC NANCE

RETIRED BOEING

35 YEARS AEROSPACE & AUTOMOTIVE

CURRENTLY STAMP ENGINEERING SERVICES COO

MARK A. VERNACCHIA

GENERAL MOTORS COMPANY

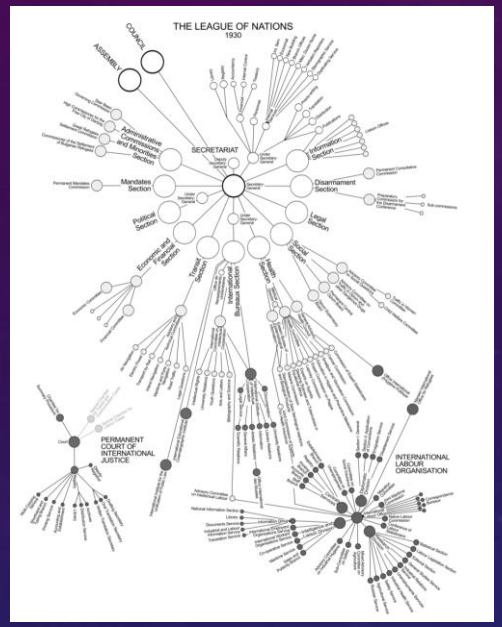
TECHNICAL FELLOW – PRINCIPAL SYSTEMS SAFETY ENGINEER

35 YEARS AUTOMOTIVE

AGENDA

- BACKGROUND AND ASSUMPTIONS
- FINDINGS AND RECOMMENDATIONS
- EXAMPLES

BACKGROUND



ORGANIZATIONAL DESIGN

PRODUCTION SYSTEMS

MANNED VEHICLES

TEST PLANNING

UNMANNED VEHICLES

ROI ASSUMPTIONS

"FORESIGHT IS NOT ABOUT PREDICTING THE FUTURE; IT'S ABOUT MINIMIZING SURPRISE"

FUTURIST KARL SCHROEDER

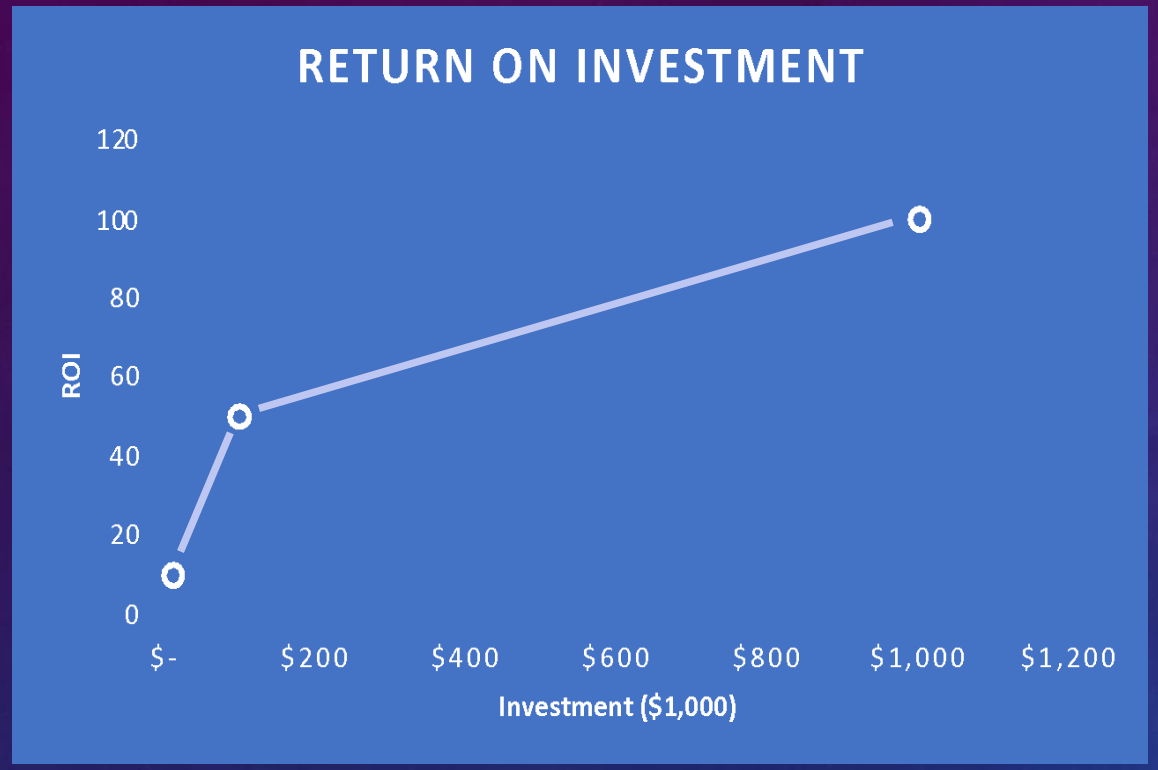
ROI ASSUMPTIONS

- STPA ANALYSIS CONDUCTED EARLY IN CONCEPT / REQUIREMENTS DEVELOPMENT PHASE
- IDENTIFIED LOSSES ARE CORRECTED
- SYSTEM LEVEL COST IMPACTS
- LARGER SYSTEMS HAVE MORE INTERACTIONS AND INTERFACES WITH GREATER COST RISK
- LARGER SYSTEMS REQUIRE MORE ANALYSIS (LABOR)

"FORESIGHT IS NOT ABOUT PREDICTING THE FUTURE;
. . . IT'S ABOUT MINIMIZING SURPRISE"

FUTURIST KARL SCHROEDER

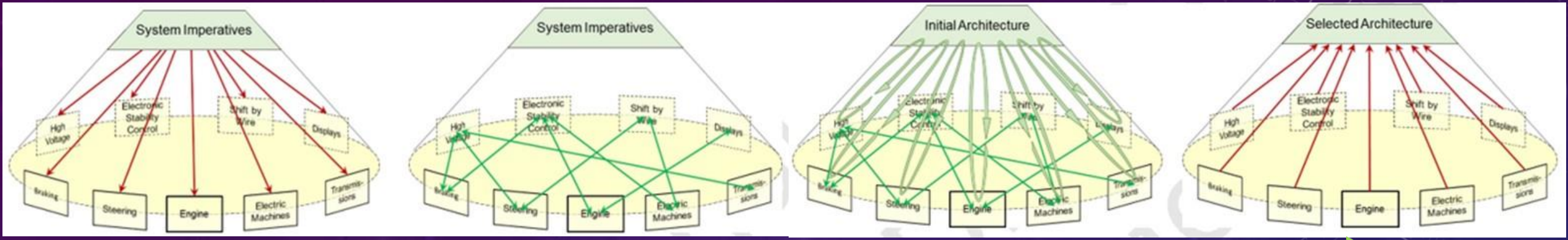
ROI FINDINGS



RECOMMENDATIONS

- START EARLY AND ITERATE
- LEVERAGE STPA “JEDI KNIGHTS”
- INCLUDE ENGINEERING, CYBER, FINANCE, MANUFACTURING AND SUPPLY CHAIN
- COMMIT TO RECTIFYING IDENTIFIED LOSSES
- EXPECT SIGNIFICANT OPPORTUNITIES IN CYBER AND SUPPLY CHAIN

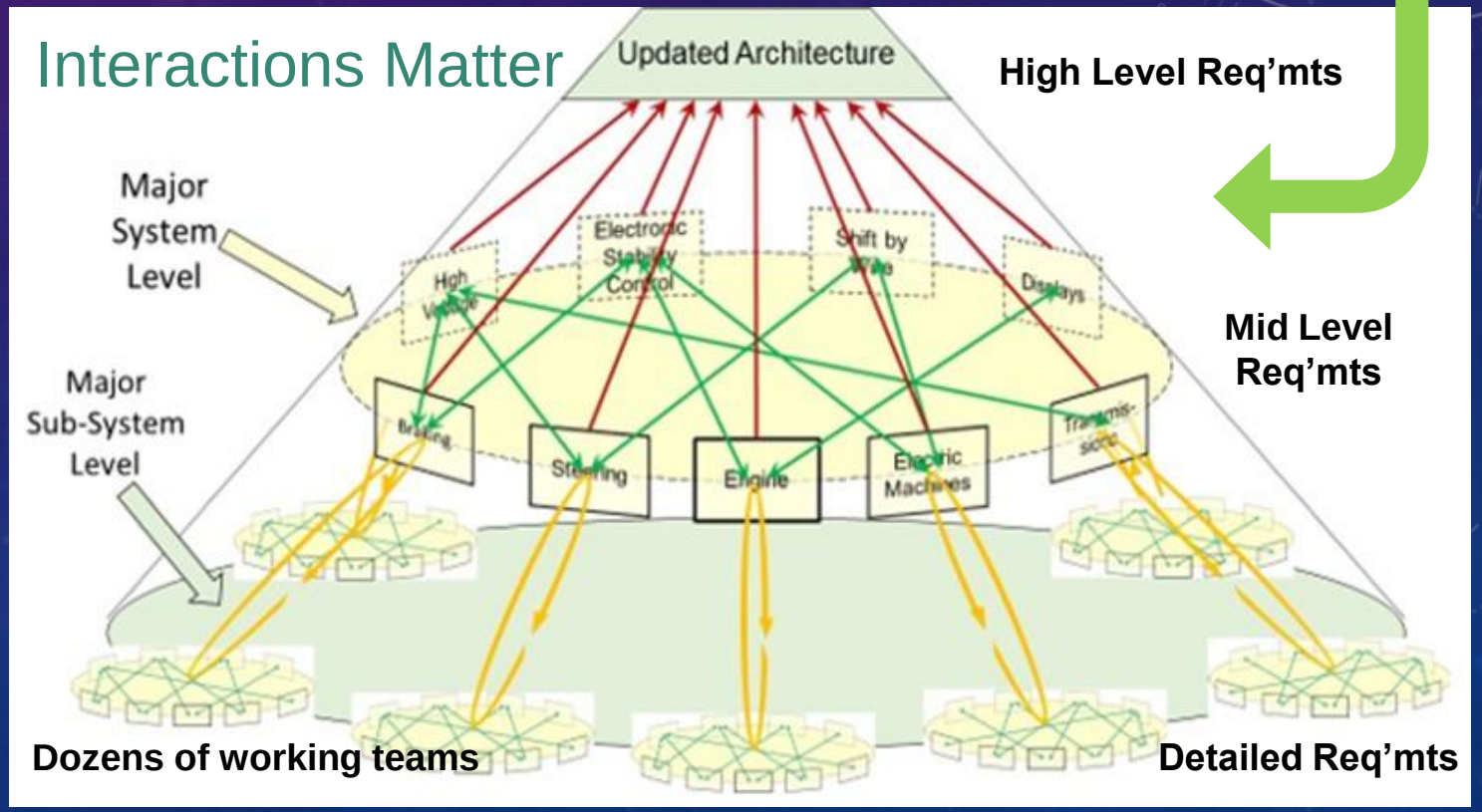
Examples – STPA System Engineering Leverage Perspective



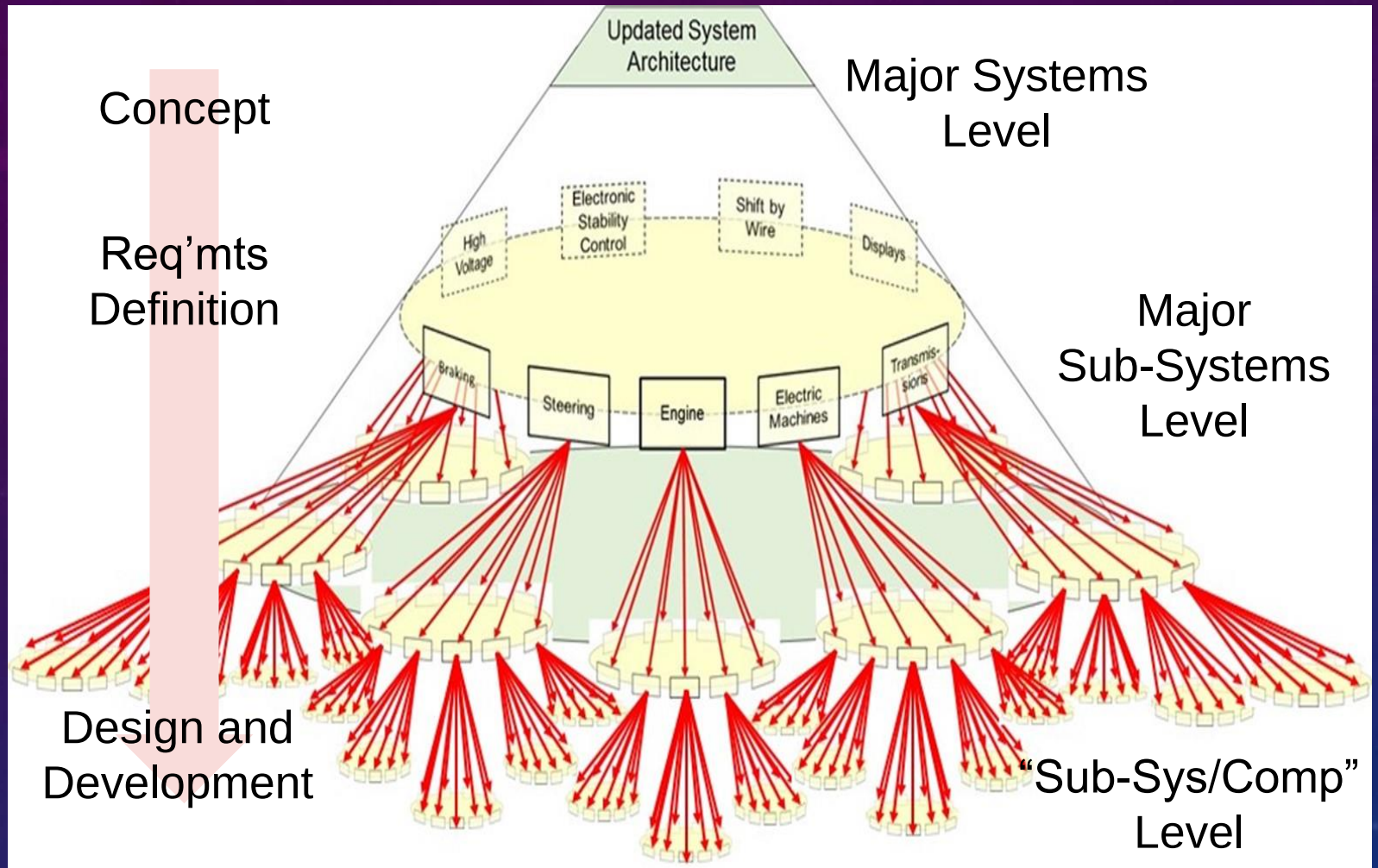
Top-down system design allows the:

- Right Requirements, at the
- Right Time, at the
- Right Level of Detail

to be defined and delivered to system-level, HW, and SW engineers



Examples – Cascading Change Avoidance – For just one project



Major Level:

Teams: 5 – 11
Req'mt Changes Avoided: 10
Hours to Execute: 5 * 50 = 250

Major Sub-Systems Level:

Teams: 25 - 75
Req'mt Changes Avoided: 100
Hours to Execute: 15 * 100 = 1,500

Sub-System/Comp Level:

Teams: > 200
Req'mt Changes Avoided: 1000
Hours to Execute: 40 * 1,000 = 40,000

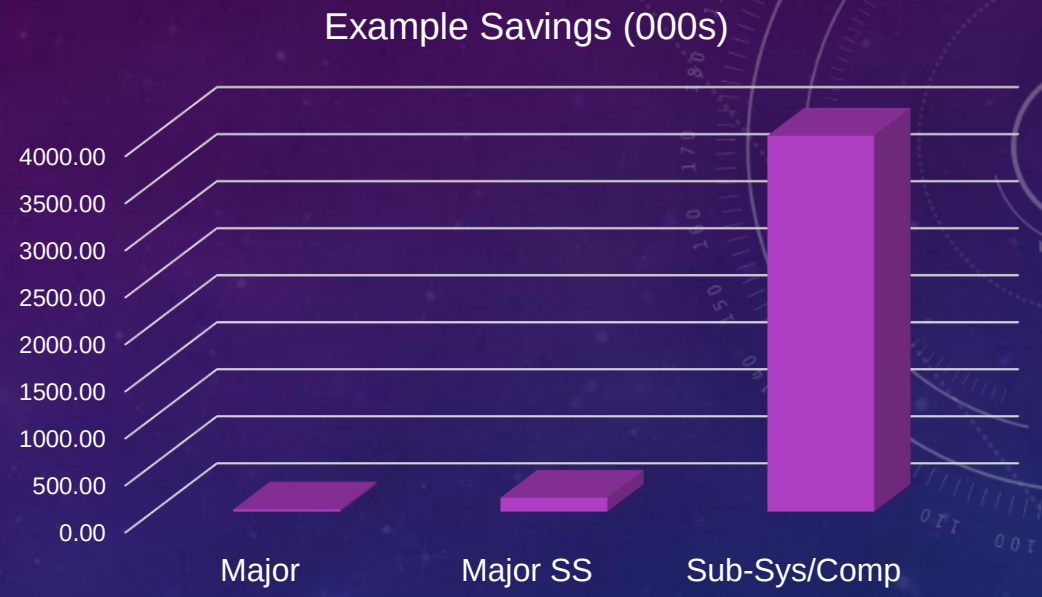
- With this cascading effect, what is the cost of wrong requirements at the start of the project?
- What about impact of finding missing requirements as project design and development continues?
- What about the cost of never finding requirements that lead to field incidents?

EXAMPLE - Effort Savings and Potential Tooling Cost Avoidance

Major Level:
Savings Estimate: $100/hr * 250 - $25,000

Major Sub-Systems Level:
Savings Estimate : $100/hr * 1,500 = $150,000

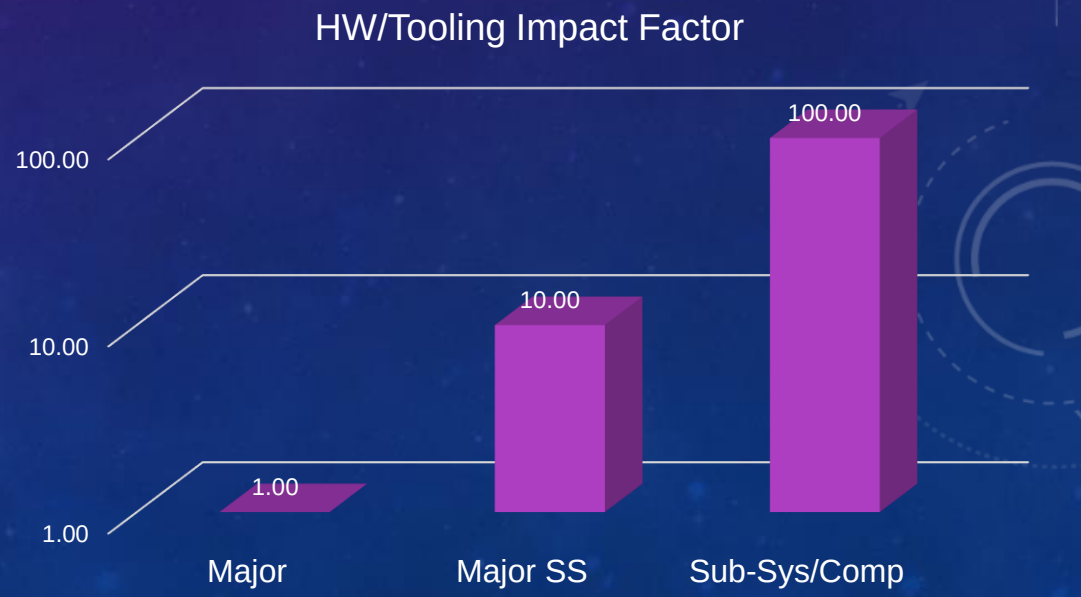
Sub-System/Component Level:
Savings Estimate : $100/hr * 40,000 = $4,000,000



Major Level:
Hardware Change Impact Factor: 1

Major Sub-Systems Level:
Hardware Change Impact Factor: 10

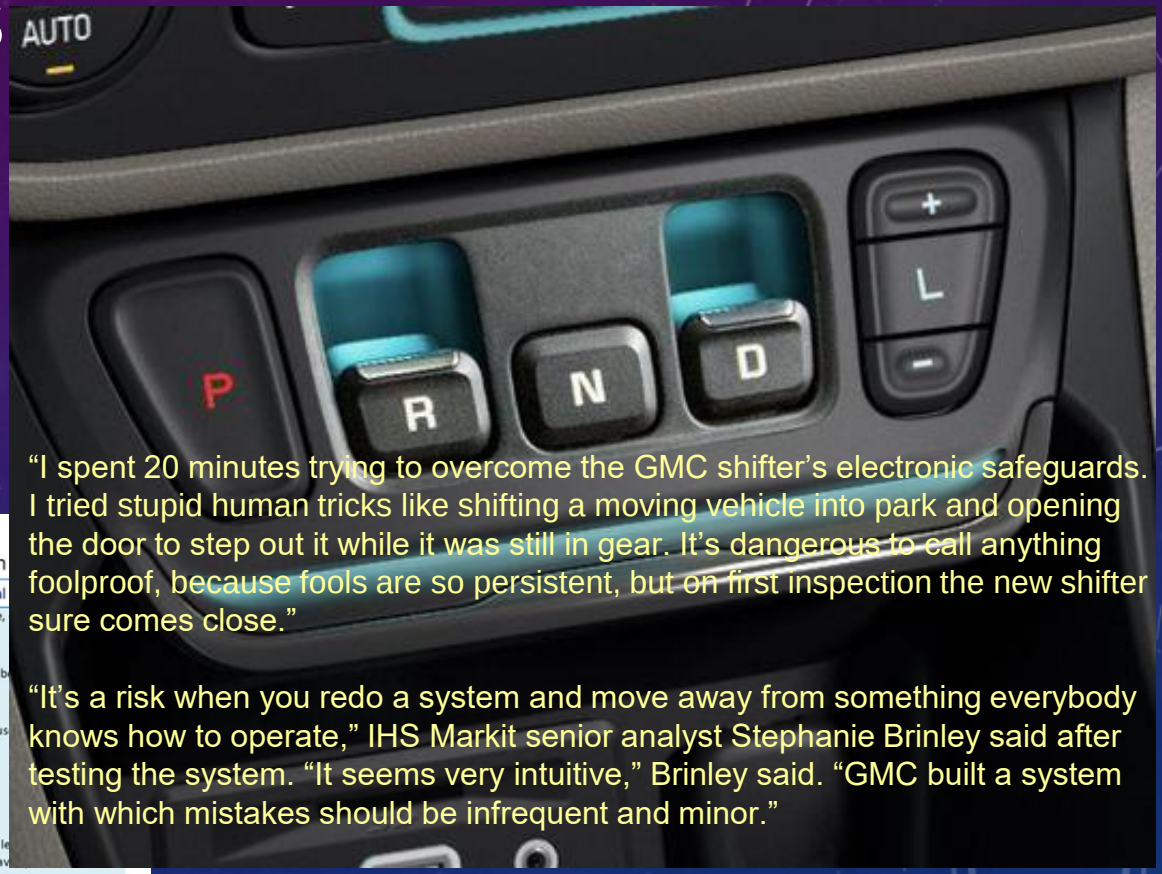
Sub-System/Component Level:
Hardware Change Impact Factor: 100



Examples – General Motors Company

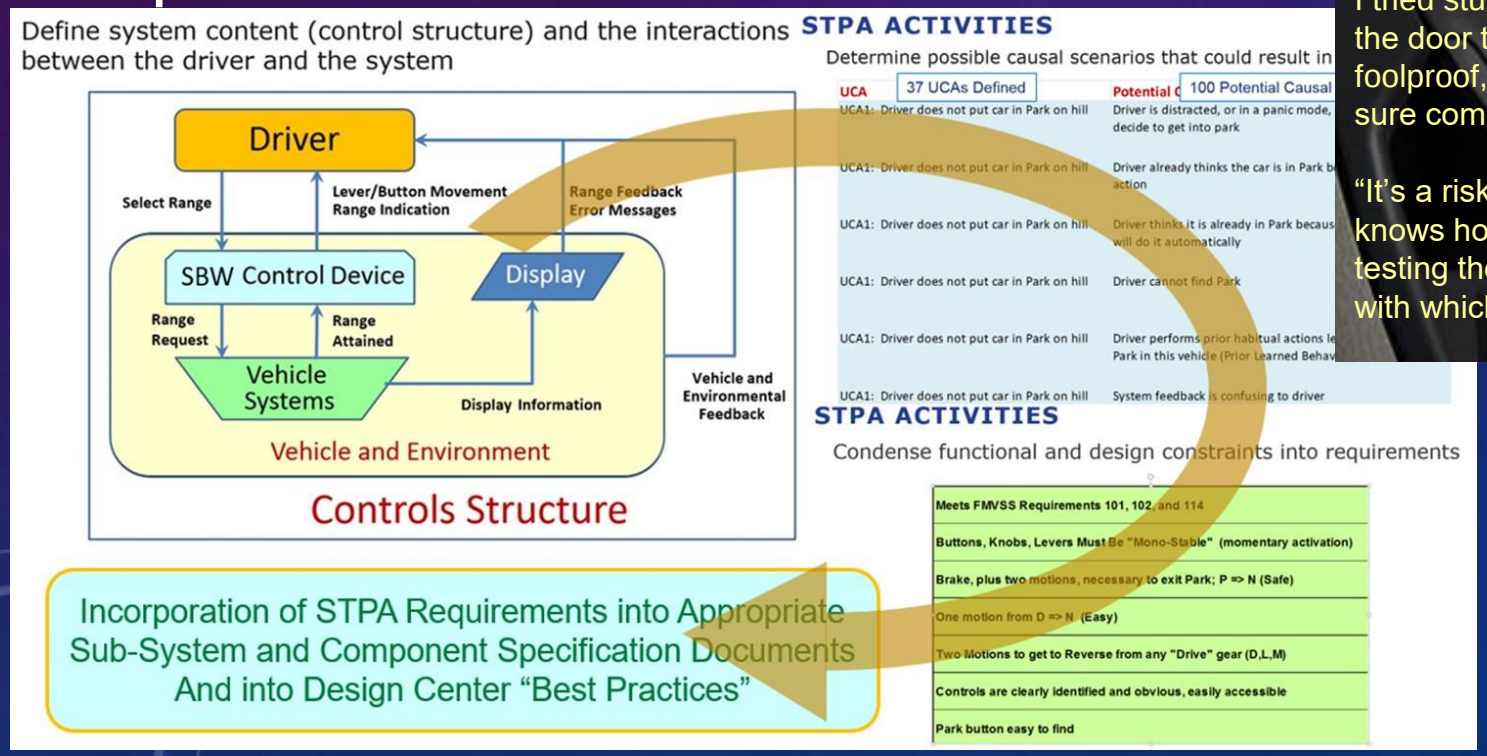
SHIFT-BY-WIRE – HMI INTERACTIONS

- Early use of STPA enabled tradeoff studies and alternative concepts
- Control issues discovered and corrected before HW/SW requirements dates



"I spent 20 minutes trying to overcome the GMC shifter's electronic safeguards. I tried stupid human tricks like shifting a moving vehicle into park and opening the door to step out it while it was still in gear. It's dangerous to call anything foolproof, because fools are so persistent, but on first inspection the new shifter sure comes close."

"It's a risk when you redo a system and move away from something everybody knows how to operate," IHS Markit senior analyst Stephanie Brinley said after testing the system. "It seems very intuitive," Brinley said. "GMC built a system with which mistakes should be infrequent and minor."

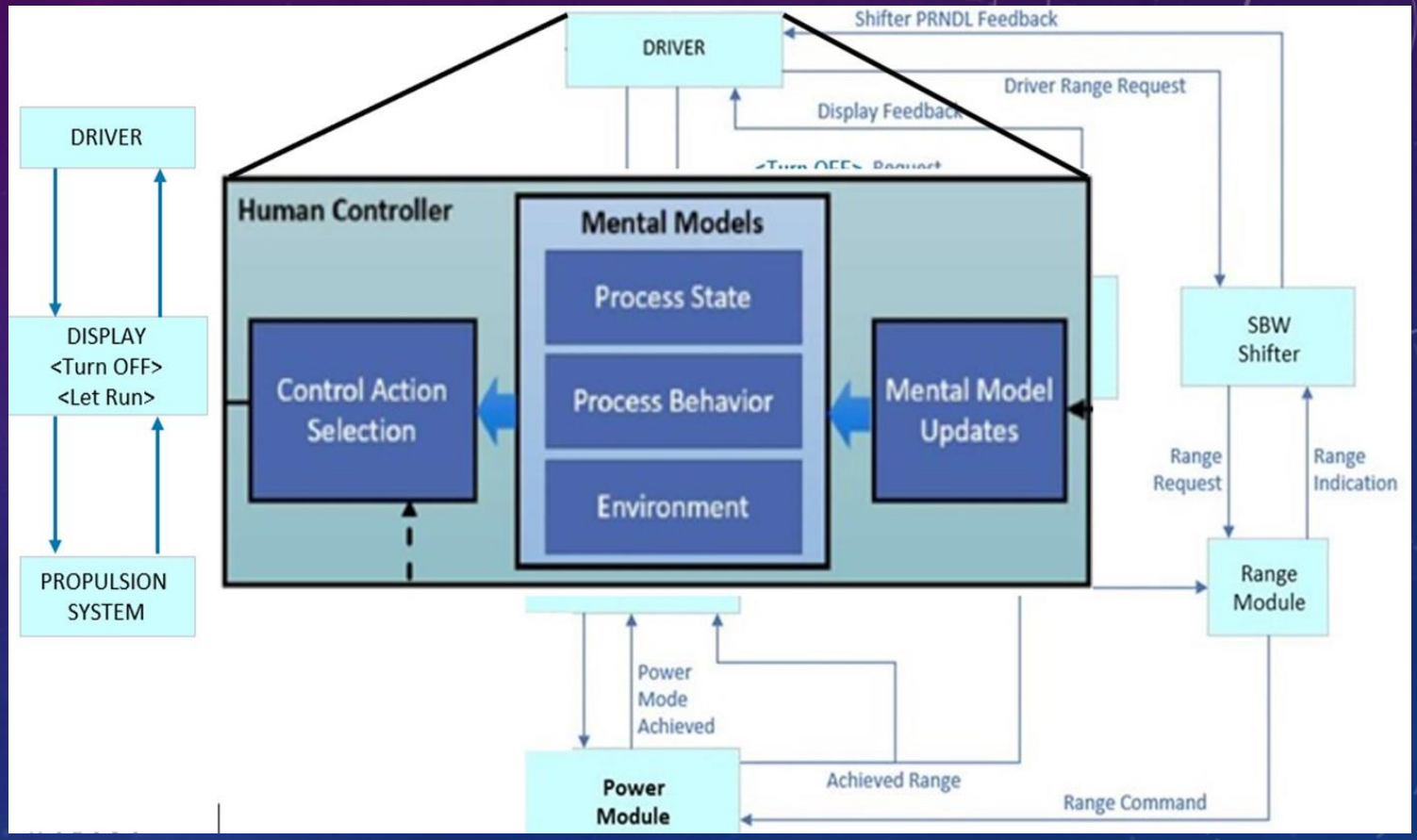


[STPA-Integrated-into-GM-Safety-Process-20feb18-Approved-Rev1.pdf (mit.edu)]

Examples – General Motors company

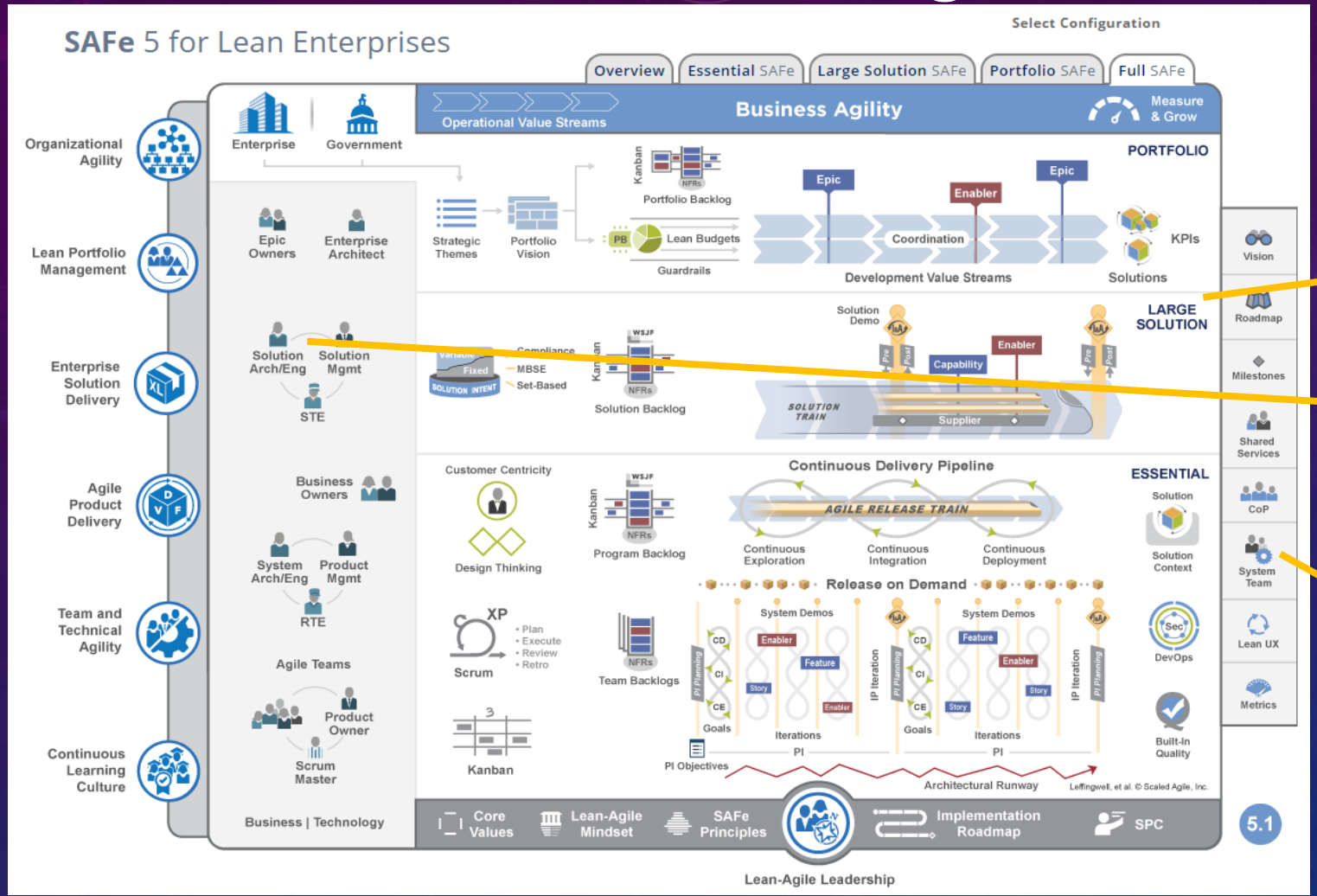
“HUMAN CONTROLLER MODEL” POWER MODE INTERACTION

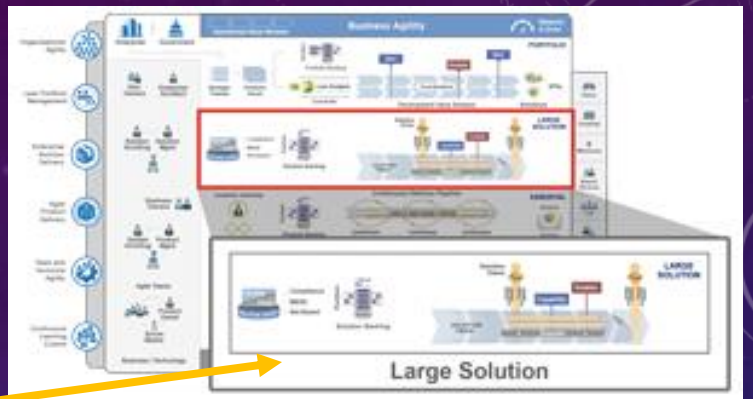
- Early use of STPA drove various design changes that addressed uncovered potential hazards
- Conflicting commands between intelligent control structure elements were identified and precedence established prior to Req'mts being sent to numerous development teams



Vernacchia-Johnston MIT 2020 Workshop

STPA and SAFe – Initial Thoughts





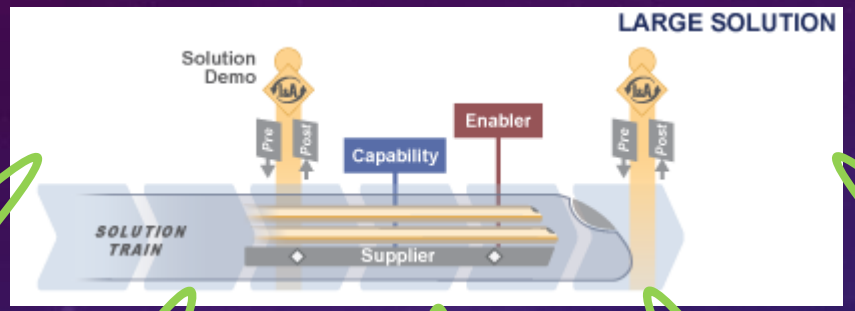
- Propose that STPA useful at “Large Solution” Level
- Right Requirements, Right Time, Right Level of Detail
- Risk is that numerous SAFe teams at ESSENTIAL level are quickly working on wrong requirements, or they are missing requirements

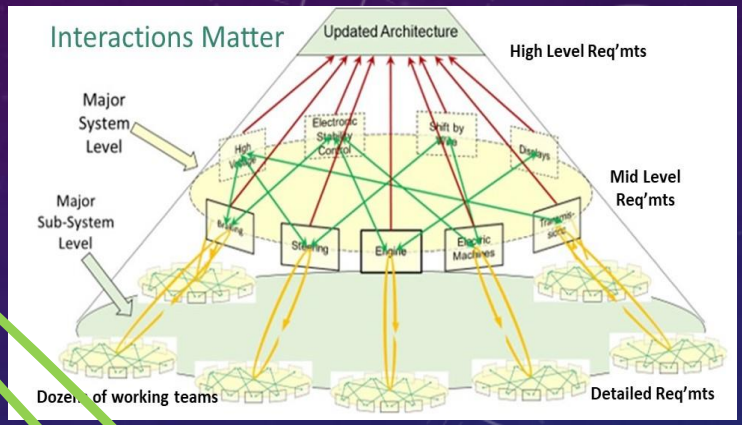
SAFe 5 for Lean Enterprises (scaledagileframework.com)

STPA and SAFe – Initial Thoughts

SAFe deals with hierarchal approach and same principles would apply

STPA in Top-Down System Design Role





SUMMARY

- STPA CAN PROVIDE POSITIVE AND SIGNIFICANT RETURN ON INVESTMENT (ROI) FOR LARGE AND SMALL PROJECTS
- THE EARLIER ONE STARTS STPA IN SYSTEMS CONCEPT DEVELOPMENT, THE MORE OPPORTUNITIES CAN BE REALIZED
- STARTING STPA PRE-ARCHITECTURE PROVIDES MOST BENEFIT
- STPA MAY APPEAR AS EXTRA WORK BUT IT MAY BE CONSIDERED AS THE EXPECTED ENGINEERING THAT SHOULD HAVE BEEN DONE ANYWAY AS PART OF A ROBUST ENGINEERING PROCESS
- FINDING SYSTEM LOSSES IS NOT THE SAME AS FIXING LOSSES

QUESTIONS?