



Lean Aerospace Initiative Annual Symposium

***Improving Avionics Affordability Through
Product Development***

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Overview

- *Thesis perspective, problem statement, objectives and premise*
- *Source data*
- *Key Variables*
 - *Cost as a design requirement*
 - *Role of integrating downstream knowledge*
 - *Development methodology*
 - *Role of requirements*
- *Summary*

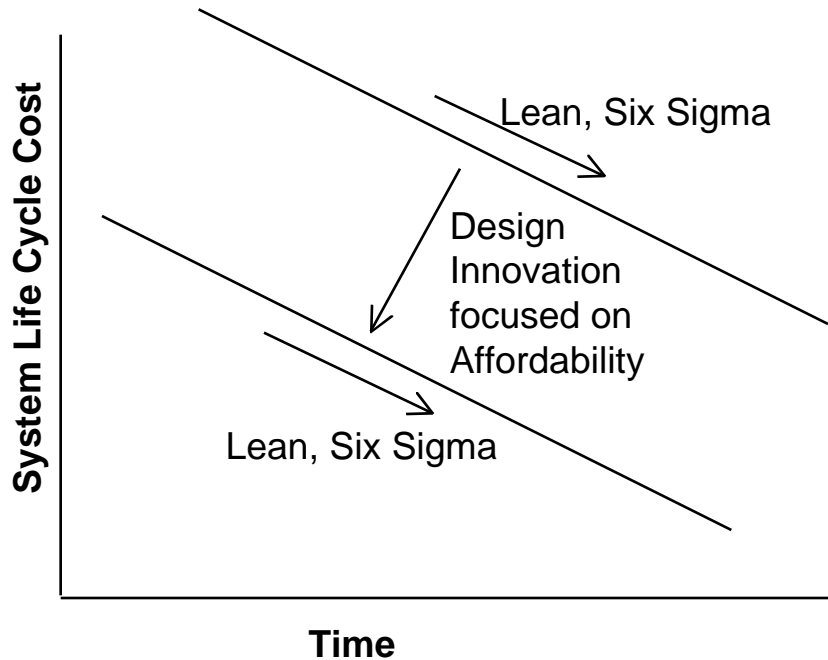


Research Introduction

- Thesis Perspective
 - Looking at affordability from the perspective of an avionics Tier 1 supplier
 - Where lifecycle cost is dominated by production, operations and support costs and not development costs
- Definition of affordability
 - Meeting customer needs for performance and lifecycle cost
 - When initial development budget, schedule, performance and lifecycle cost requirements are not all achievable
 - Optimization is a value-added part of the development program



Design Innovation and Lean Processes Are Required to Improve Affordability



Necessary	<u>Lean and Six Sigma</u> <ul style="list-style-type: none">• Cumulative, incremental improvement• Can be applied to ~any system concept• Everyone can implement• Necessary but not sufficient
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Sufficient	<u>Design Innovation focused on Affordability</u> <ul style="list-style-type: none">• Architectural innovations• Modular innovations• Technology opportunities• Cost - performance trades
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**Trying to Discover Methods We Can Implement During Development
to Improve Lifecycle Affordability**



Source Data Description

Program	Development Manyears	Weight (lbs)
Program 1	4,000 - 6,000	385
Program 2	8 - 10	10
Program 3	60 - 80	4
Program 4	15 - 25	4
Program 5	400 - 800	250
Program 6	200 - 400	75
Program 7	200 - 400	75

**Avionics systems ranged from 8 to 6,000 man-years, 4 to 650 lbs
Interviewed 40 managers and design/manufacturing engineers**



Key Variables

- Cost as a design requirement
- Development process (spiral, waterfall, what focus)
- Role of requirements
- Role of integrating manufacturing knowledge into product design



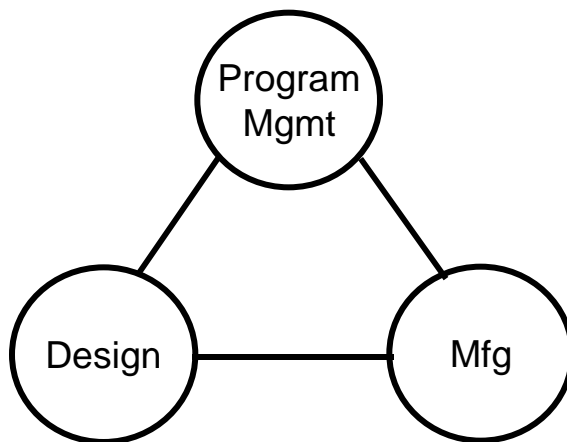
Cost as a Design Requirement

Cultural and Pragmatic Issues



Why cost must be a design requirement owned by the Integrated Product Team

- When Manufacturing owns affordability....
 - Best tracking of production costs, but little influence on the outcome
- When Program Management owns affordability....
 - Sets program culture and has significant influence but can lead to overly risky technical approaches
- When Engineering owns affordability...
 - Best balance of technical risk and affordability but inadequate ability to analyze & predict lifecycle costs



- When the IPT collectively owns affordability...
 - PM sets affordability focus
 - Design innovates and performs technical risk mitigation
 - Manufacturing provides cost analysis and brings downstream knowledge



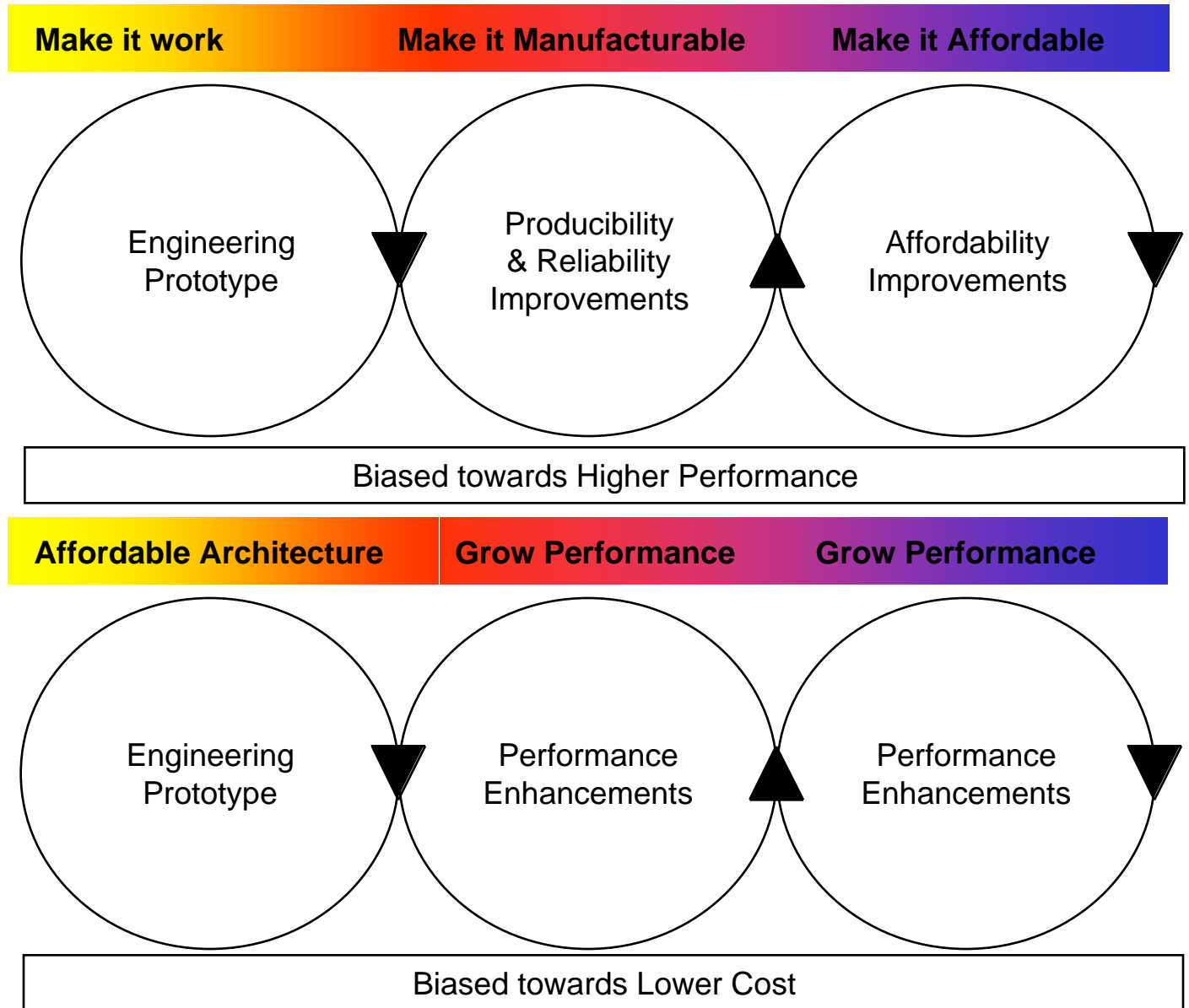
Development Methodology

Two models for the nature of development focus in
each iteration



Development Process

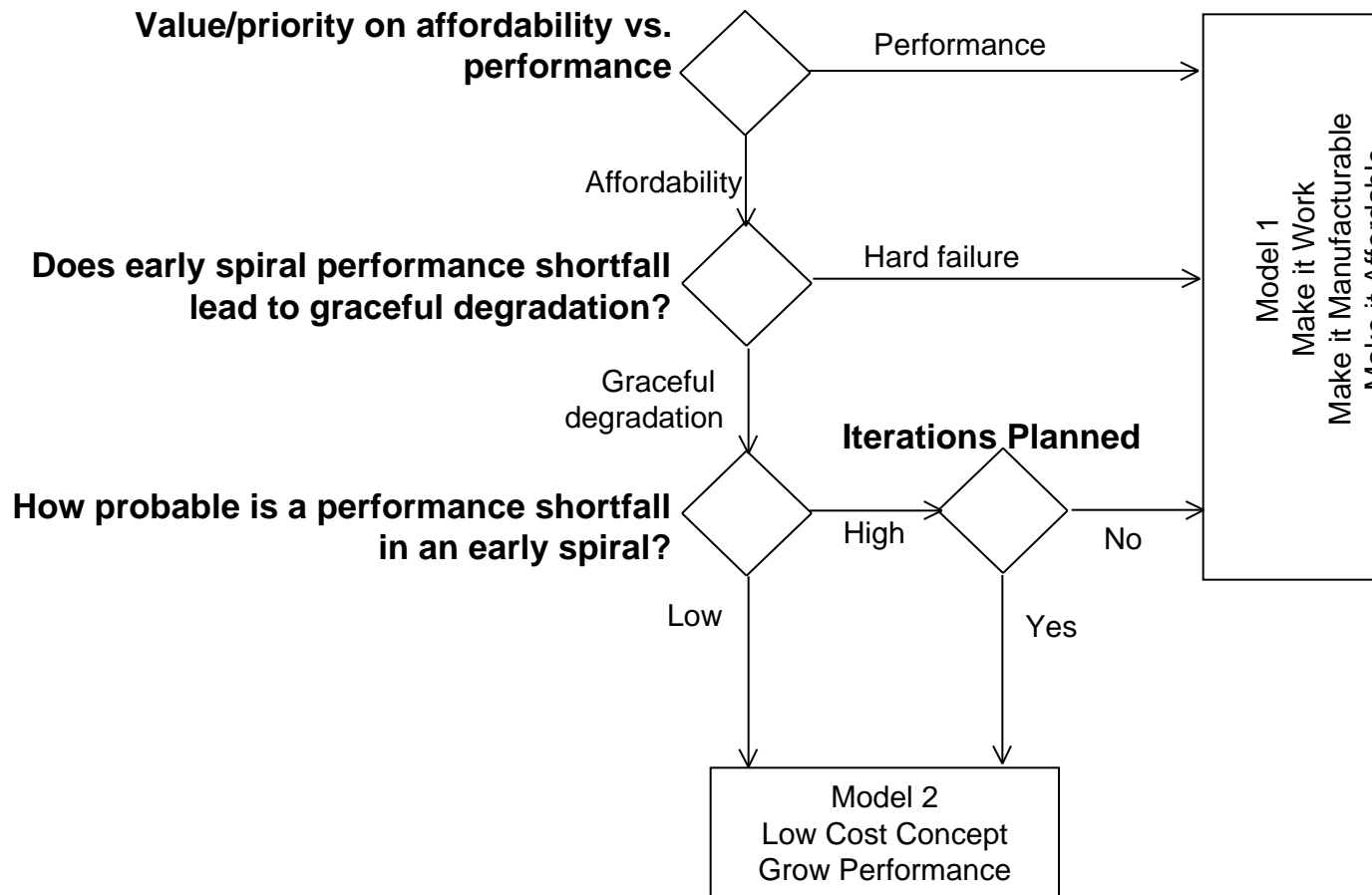
Found 2 Models - Both Iterative in Nature





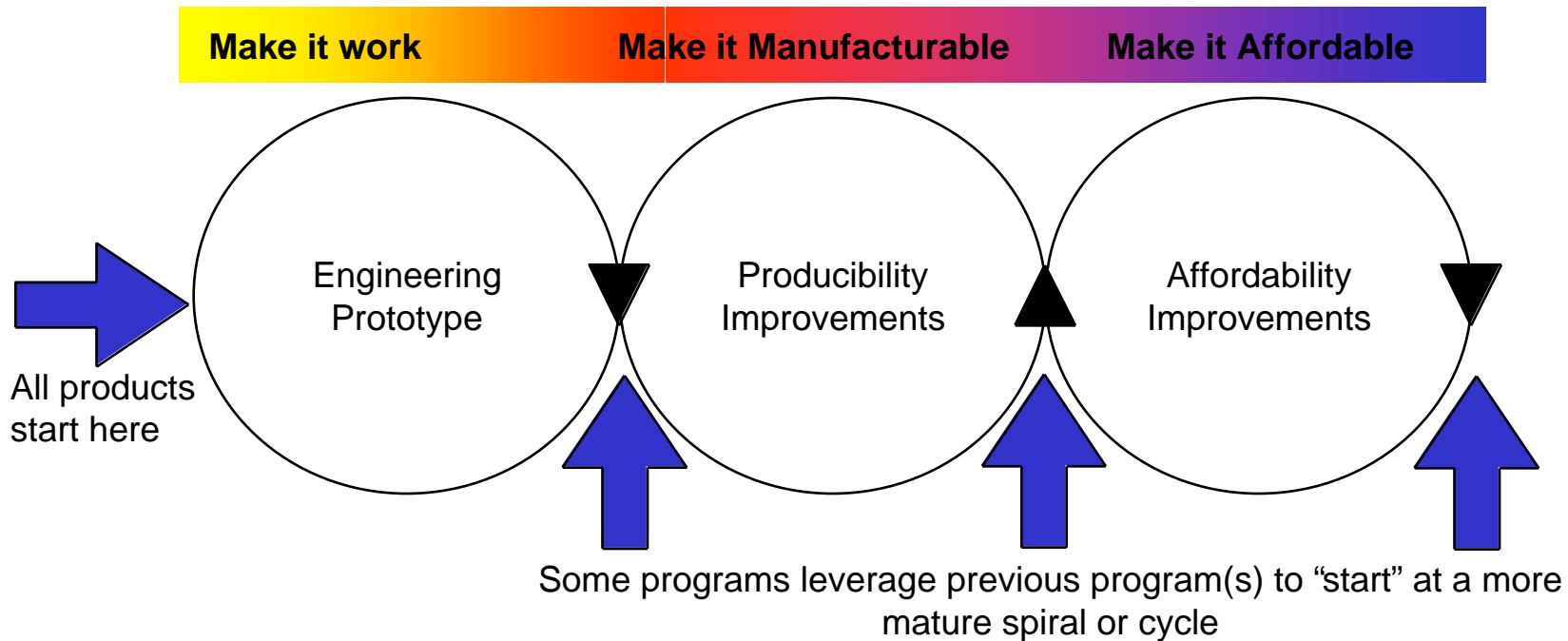
When to Apply Model 1 or 2

- Each model is adapted for different conditions
 - Value or priority on performance vs. cost
 - Technical risk - particularly consequence of performance shortfalls
 - Planned iterations





Model 2 can be viewed as a subset of Model 1 entering at a more mature stage



- All products studied went through the Model 1 progression
- Some programs leveraged previous products to start at a more mature stage

Prior knowledge and technology base is a required entrance criteria for successful implementation of Model 2



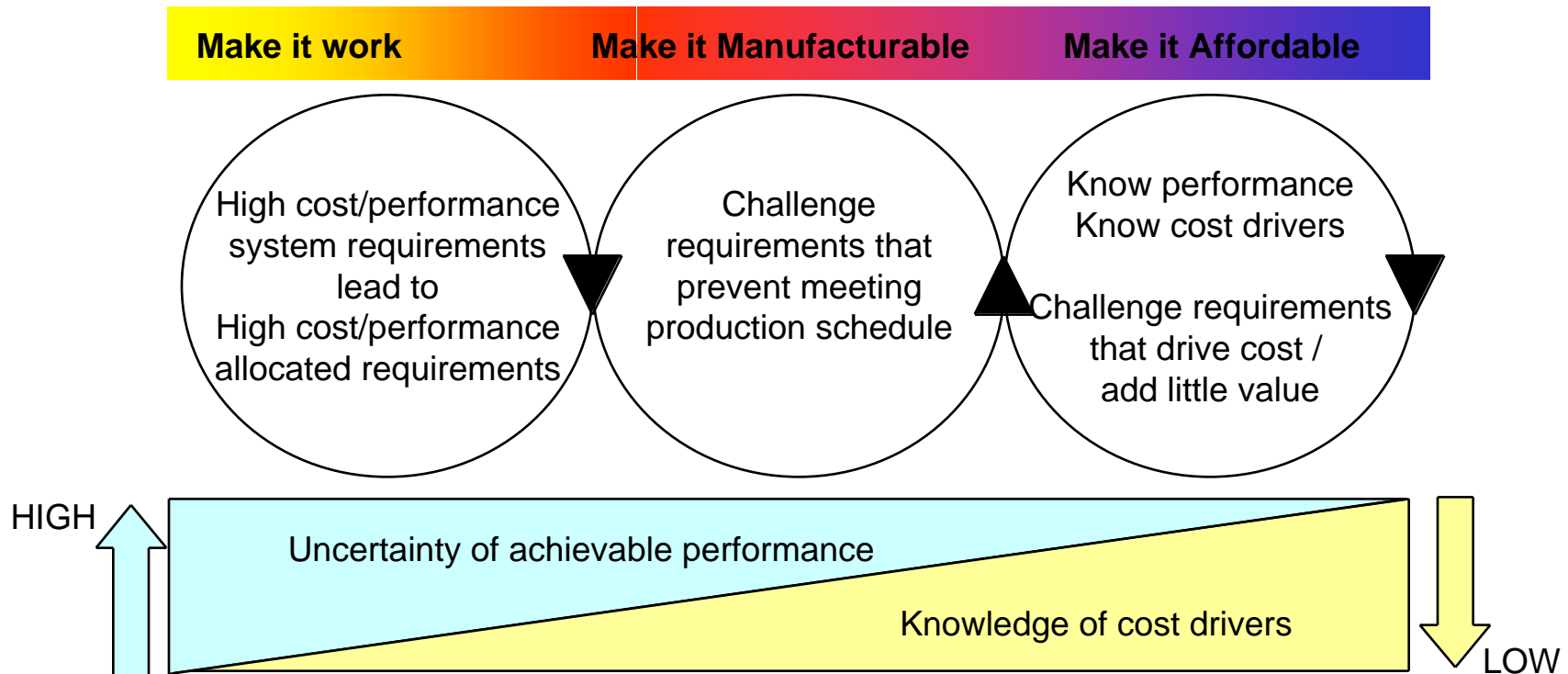
Role of Requirements

Understanding the
Requirements - Architecture - Cost trade space
During requirements development



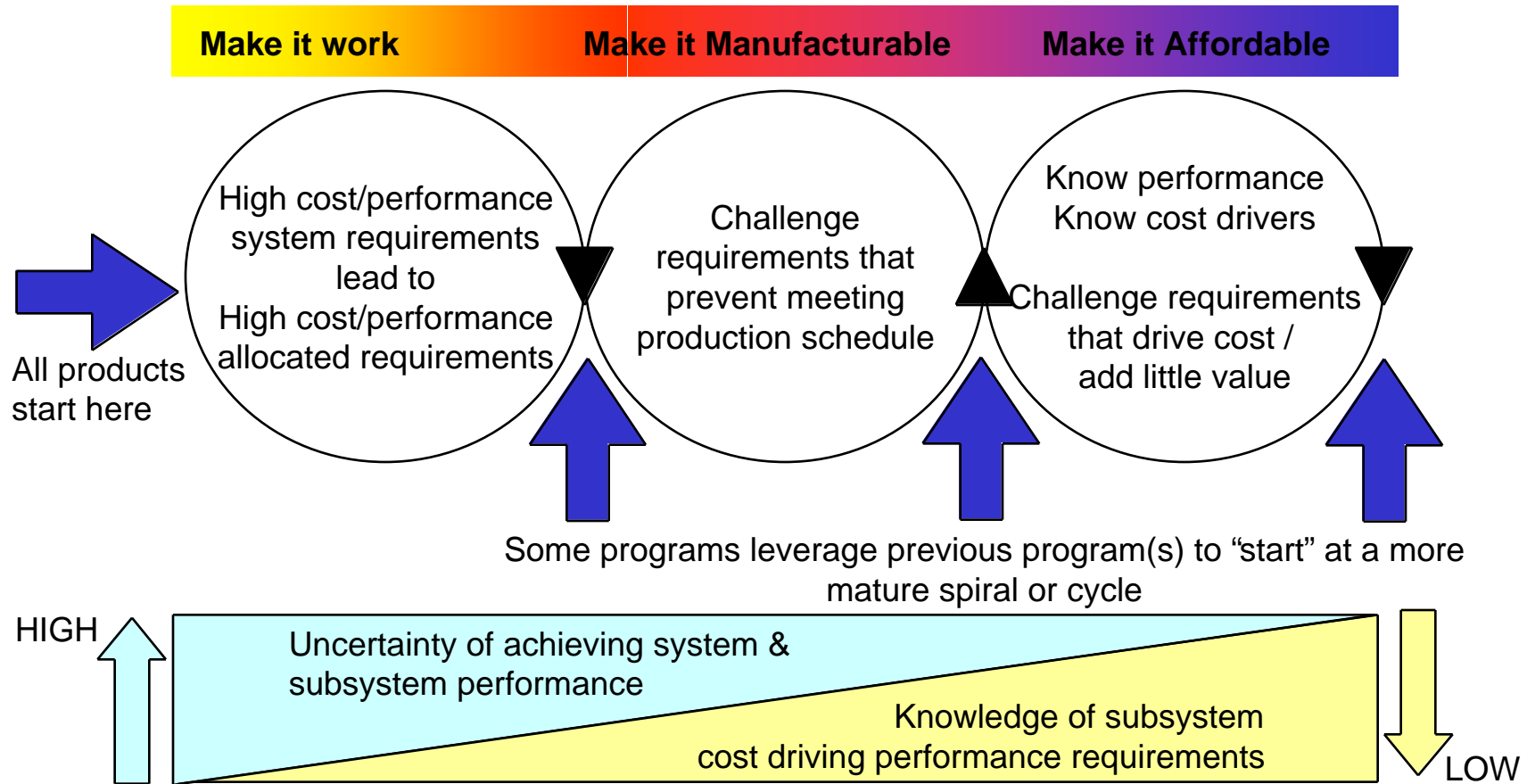
Role of Requirements in Design Innovation in a Model 1 Program

- Performance priority
- + High uncertainty of achievable performance
- + Low knowledge of cost drivers
- = Higher cost, higher performance requirements





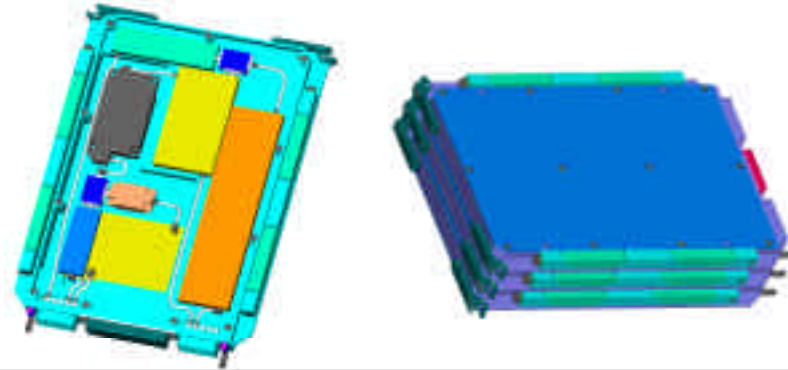
Model 2 can be viewed as a subset of Model 1 entering at a more mature stage



**Model 2 starts at a more mature phase
Starts with Lower Performance Uncertainty and Higher Cost Knowledge**



Cost of Key Requirements

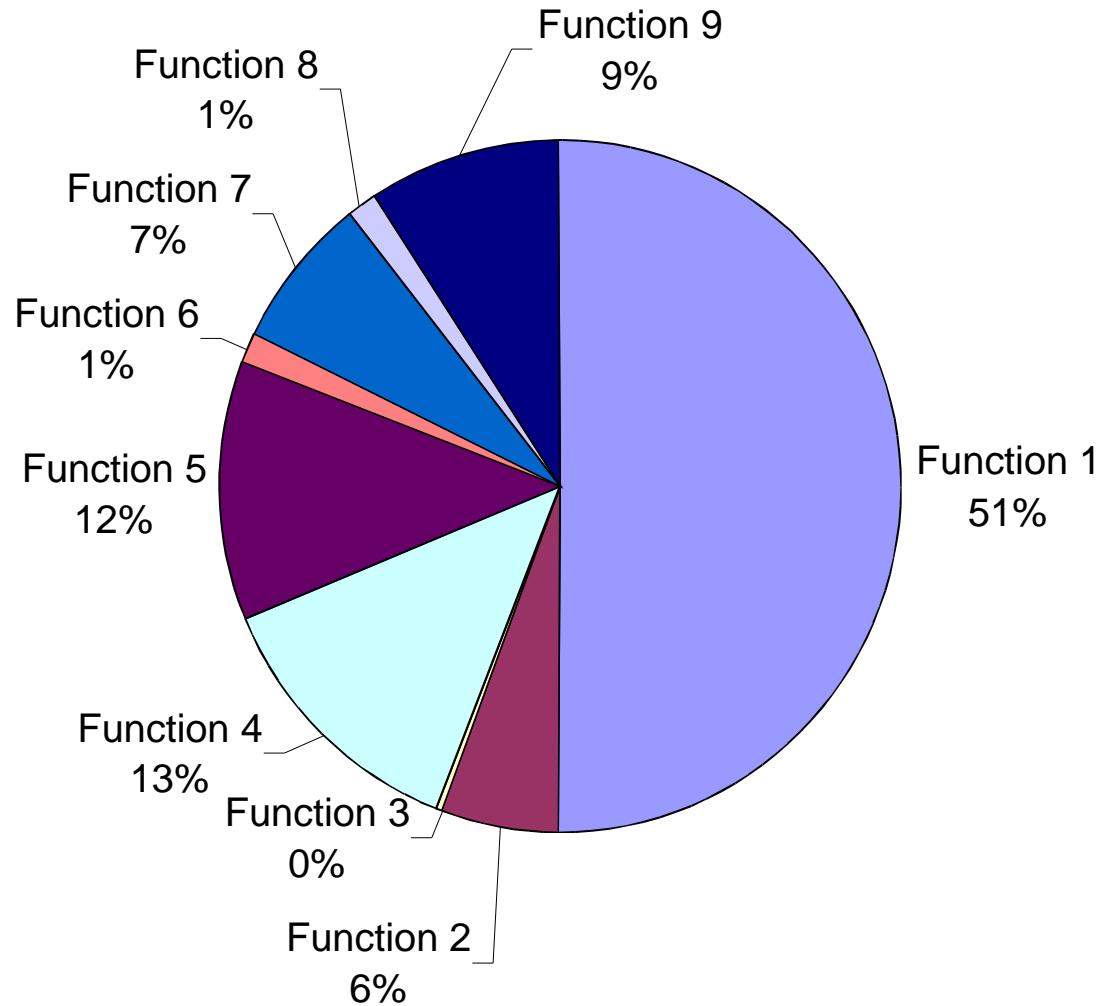


Requirement Description	Lower Perform		Nominal Perform		High Perform	
	Performance	Cost	Performance	Cost	Performance	Cost
Requirement 1	1.0	(\$50,000)	3.0	----	5.0	\$75,000
Requirement 2	1.0	(\$25,000)	3.0	----	5.0	\$15,000
Requirement 3	1.0	(\$10,000)	3.0	----	5.0	\$30,000
Requirement 4	1.0	(\$25,000)	3.0	----	5.0	\$20,000
Requirement 5	1.0	(\$5,000)	3.0	----	5.0	\$20,000

Understanding Cost of Key Requirements BEFORE Freezing Specifications Enables Model 2 Development



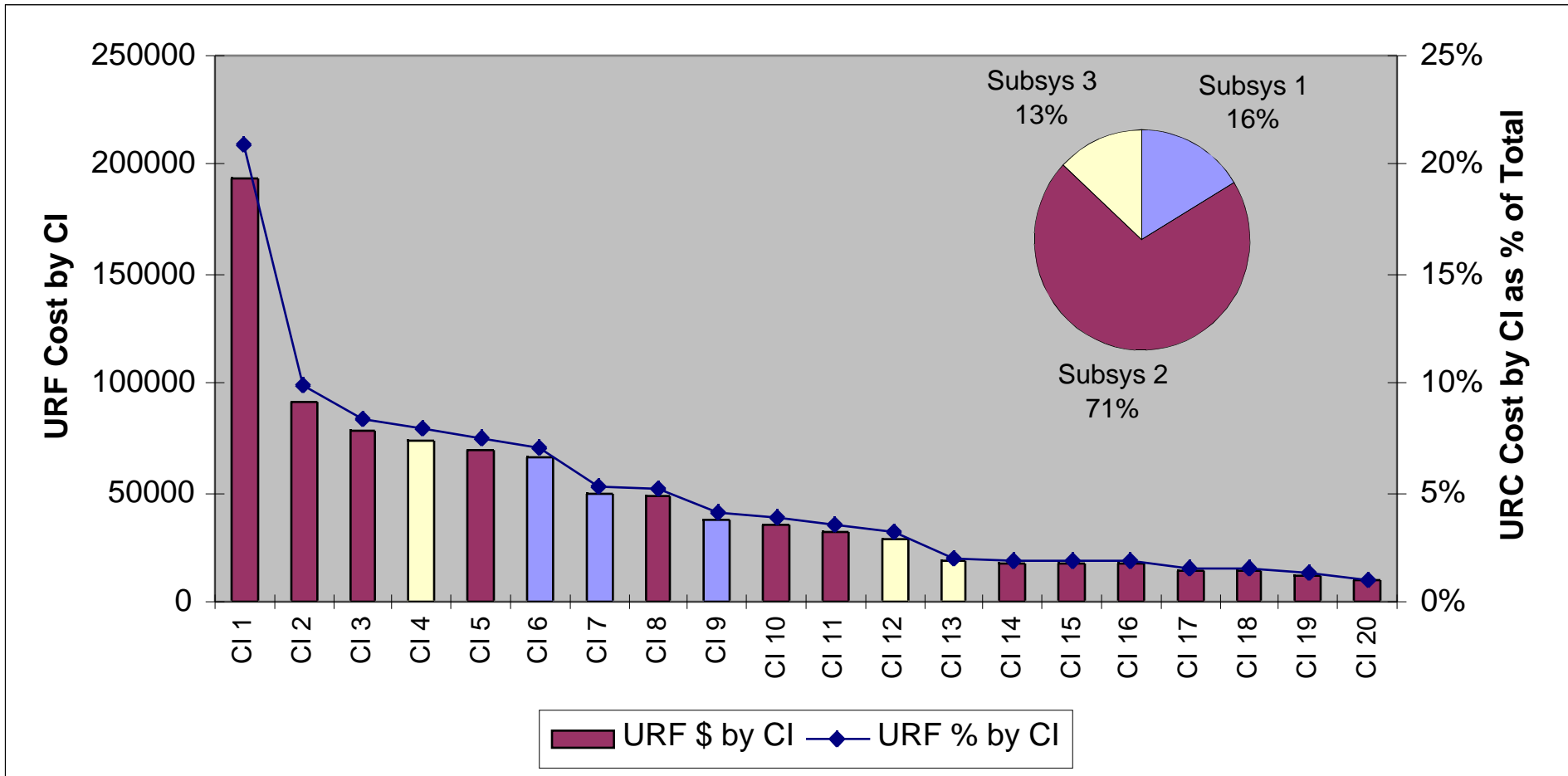
Cost Drivers by Function



Understanding Cost Drivers by Function BEFORE Committing to a System Architecture Enables Model 2 Development



Cost Drivers by Hardware Configuration Item



**Understanding Cost Drivers BEFORE Committing to HW Design
Enables Model 2 Development**



Integrating “downstream” knowledge

A powerful source of innovative ideas



Role of program dynamics in integrating downstream knowledge

- If affordability is the top priority in the program culture
- And requirements - architecture - cost trade space is well understood
- And cost is considered a design requirement
- Then, integrating downstream knowledge is easier

**Downstream knowledge is affordability focused
Easier to integrate when it supports the program's underlying dynamics**



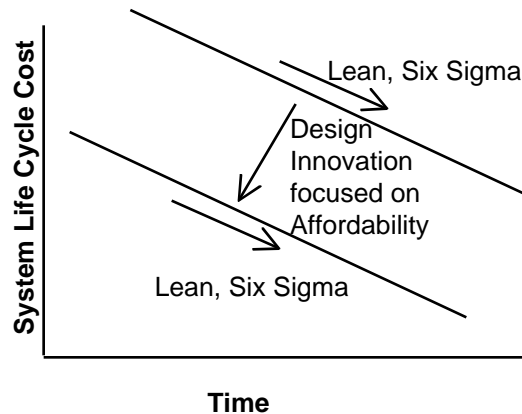
Role of program dynamics in integrating downstream knowledge

- If performance is the top priority in the program culture
- And requirements - architecture - cost trade space is poorly understood
- And cost is considered a manufacturing or management requirement
- Then, integrating downstream knowledge is harder

The Key Challenge is Balancing Performance and Affordability



Summary



- Continuous incremental improvement PLUS design innovations offer the most complete solution to improving affordability

- Framing cost as a design requirement can shift the development focus towards affordability
- Consciously selecting a Model 1 or Model 2 development approach offers the choice between focusing more on performance or more on affordability
- Focusing on understanding cost drivers as early as possible can shift development focus towards affordability
- Increased focus on affordability makes integrating downstream knowledge easier