Ball Aerospace Program Process Tailoring

Aligning Development Processes with Mission Classifications

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Agility to Innovate, Strength to Deliver

Ball Aerospace & Technologies Corp.

Agenda

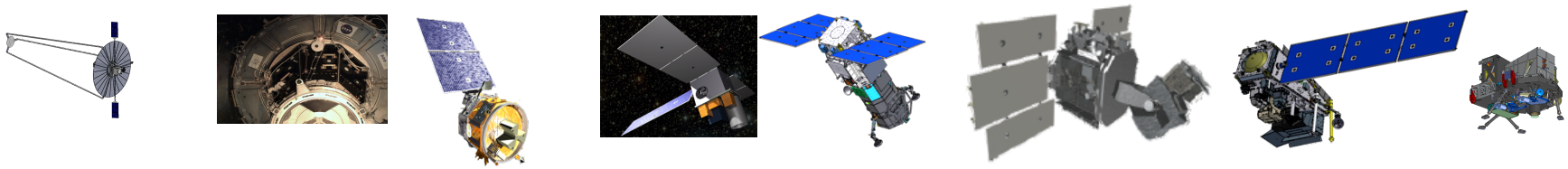
- **Purpose**
  - Share Ball's capability to save cost by tailoring program specific product development processes to meet customer expectations
- **Method**
  - What is Program Process Tailoring?
  - How does it work?
  - How do we align expectations?
- **Outcome**
  - Understanding of customer-aligned cost-saving opportunities

Industry Mission Classification Framework Established

- **Framework provided by**
  - **NASA NPR 8705.4, DoD Handbook 343**
  - **Mission Risk Planning and Acquisition Tailoring Guidelines for National Security Space Vehicles 2010 (TOR-2011(8591)-21)**
  - **Mission Assurance Guidelines for A-D Mission Risk Classes 2011 (TOR-2011(8591)-21)**

	Class A	Class B	Class C	Class D
Mission Risk Acceptance	Lowest	Low	Moderate	Highest
National Significance	Extremely Critical	Critical	Not Critical	Not Critical
Payloads	Operational	Demonstrates Operational Utility May become Operational	Typically Experimental	Typically Experimental
Acquisition Cost	Highest	High	Medium	Lowest
Development Time	May take 4 or more years	May take 3 or more years	May take 2 or more years	May take 1 or more years
Mission Life	Long, Greater than 5 yrs (typically 8–10+ yrs)	Medium, Up to 5 years	Short, typically less than 2 years	Short, typically less than 1 year
Launch Constraints	Critical	Medium	Few	Few to none

Spectrum of Program Risk Profiles Demands Process Agility



Research and Development	Development and Demonstration	Operational Systems	National Needs Programs

- **Multiple variable affect the ability to tailor in alignment with customer needs**
  - **Complexity of mission requirements**
  - **Command media and organizational maturity**
  - **Customer confidence in cost, performance, reliability, and risk capabilities**
  - **Demonstrated ability to adapt to a variety of customer requirements**

Program Process Tailoring Foundation

- **Why Process Tailoring?**
  - Meet cost point by matching customer requirements for different types of missions
  - Apply more cost effective path to same mission success endpoint

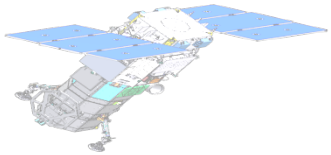
- **What does Execution Tailoring mean?**
  - Tailor execution strategy to save cost on low-likelihood risks
  - Same flight hardware processes with less evidence of assurance
  - No change to mission risk or probability of success
  - Greater tolerance for programmatic risk

- **How does Execution Tailoring work?**
  - Leverage mature processes and experience
  - Program flow down of requirements accommodates execution tailoring
  - Program specific control with documented tailoring

What is Process Tailoring?

- **Ball's Program Process Tailoring system allows programs to meet the specific expectations of multiple customers with differing needs**

Customer Needs and Expectations



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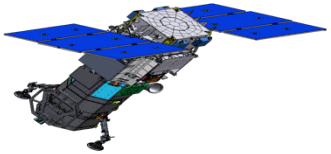
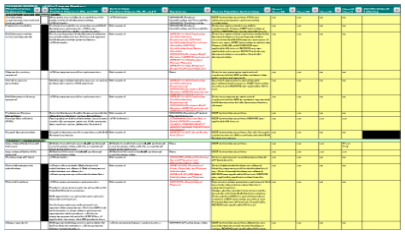
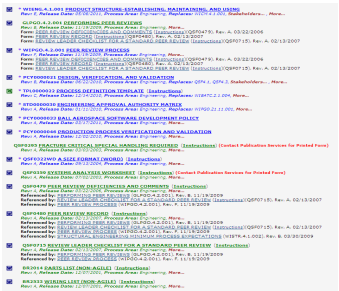


- Cost
- Schedule
- Performance
- Methodology

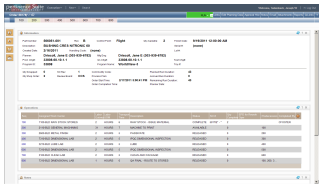
Program Specific Execution Tailoring

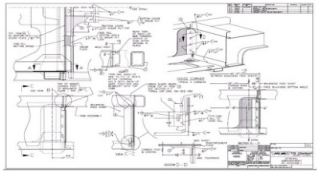


Ball Process



Program Execution Aligned with Expectations





Process Standards Ensure Quality Product Consistency

- Internal Standard examples
  - Fastener processing
  - Packaging for contamination and electrostatic discharge protection
  - Surface preparation for bonding
  - Cleaning and preparation of aluminum and aluminum alloy surfaces
  - Material handling equipment
  - Foreign object debris (FOD) prevention
  - Parts de-rating
  - Fastener torque

- External Standards
  - AS9100C Certified Quality Management System
  - Others as required by contract
  - Ball standard practices may exceed external standard requirements

Process Tailoring does not permit deviation from applicable standards

Distinctions between Types of Risk

- **Mission Risk**
  - Probability of inability to meet specifications on orbit
  - Example: Manufacturing defect leads to reduced mission life

- **Programmatic Risk**
  - Probability of cost or schedule impact (as a result of reduced development rigor)
  - Example: Program does not screen electronic parts, so part defects would be found during board or box-level functional or environmental testing.

- **Acquisition Risk Tolerance**
  - Acceptance of risk by forgoing levels of oversight of the development process in exchange from reduced development cost
  - Example: Customer not on parts selection board or approver of detailed designs

Execution Tailoring Methodology

1. **Obtain clear understanding of customer expectations and values**
   - **Mission needs**
   - **Programmatic needs**

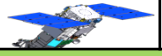
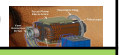
2. **Tailor our product architectures and execution for cost control**
   - **Timely information and transparency balance reduced evidence of assurance**
   - **Mission risk mitigation aligns to performance requirements**
   - **Programmatic risk mitigation aligns to contract requirements**
     - Fixed price contracts allow Ball to control programmatic risk

3. **Partner with customer for shared control**
   - **Provide a high level of program insight**
   - **Provide customer timely information**
   - **Provide appropriate program influence and control**

Mapping of Mission Class Maintains Acceptable Risk

Mission Risk Class	Class A	Class B	Class C	Class D
Ball Internal Product Class or Product Type	Class 1	Class 1: Operational Class 2: Commercial	Class 3	Class 3: Enhanced D Class 4: Safety Only
Mission Success	All Mission Requirements Met	All Mission Requirements Met	All Mission Requirements Met	All Mission Requirements Met
Driving Factors	• >> mission length • Custom developed • Highest Cost • Customer oversight • Low Pf: large number of mitigations	• > mission length • Heritage developed • Lower cost • Customer Insight/ Oversight • Low Pf: Part quality, margins, redundancy	• < mission length • Heritage developed • Low cost • Customer insight • Corporate practices • Low Pf: Part quality, test actions	• << mission length • Cubesat/Prototype • Lowest cost • Corporate practices • Low Pf: Threshold and safety focus

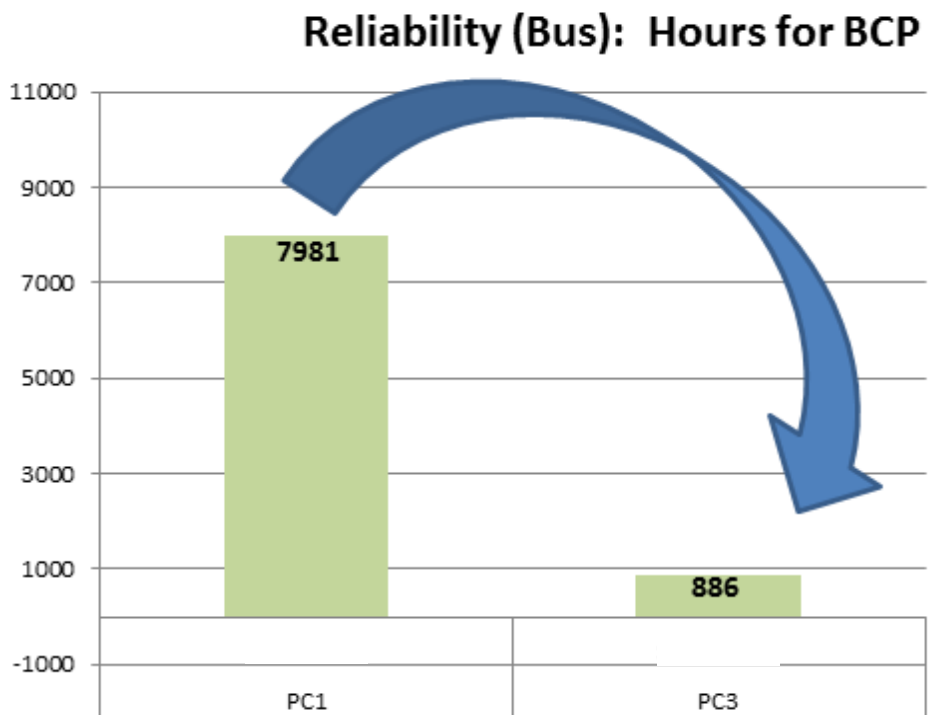
What Changes Across Product Class?

Product Class	1 	2 	3 	4 	5 
Design					
Design Integrity	Comprehensive design practice using state-of-the-art tools. High designer qualifications, strong overall responsibility and accountability				
Design Review	Peer, MA, *Industry Partner*, Program designated reporting and review	Peer, MA, Program designated review of *Ball format*	Peer, *MA on critical areas, Program insight through hands-on interaction*	Peer, *Program acceptance of final test*	Program specific Peer review on critical areas
Released Engineering	Production Release Program defined reporting	Production Released *Minor adjustment of Ball formatted reporting*	Production Release *Ball format and control*	Prod. or *Limited* Release Ball format and control	
System Engineering	Tech/architecture authority and control, Risk/ Requirement implementation, Program V&V and planning under revision control		Tech/Architecture authority, Risk/Req. Implementation, *BATC V&V, Planning documented*	Best Engineering Practice as required	
Evidence of Assurance - Level (1 2 3 4 5)	<u>Comprehensive</u> program driven (format and method) verification attributes	Comprehensive BATC driven verification attributes *with appropriate program additions and deliverables*	BATC Engineering attribute verification *with BATC MA verification for critical areas*	Best Engineering practice	
Manufacturing					
Mfg Process	Comprehensive, approved manufacturing processes, implemented by highly trained and appropriately certified practitioners			Build documentation formality streamlined	
Build Control	State-of-the-art Electronic Manufacturing Control System(s) , released engineering BOMs and procedures			Released engineering with *streamlined* build docs	
Test	Comprehensive Test like you fly approach, Formal released plans, full facilities and test readiness reviews and approvals by Program		Comprehensive test-like-you-fly approach, documented test plans, and test readiness *reviews*	*Thorough* Test like you fly approach with *subsystem test reductions*	
Material and Subcontractor Approval	Parts approval board, Program Approved Parts List (PAPL), approved suppliers, Full MRP		*Approval managed through PAPL*, approved suppliers, Full MRP	*Lead Eng. approval*, PAPL used for visibility, *P-Card option*, MRP	

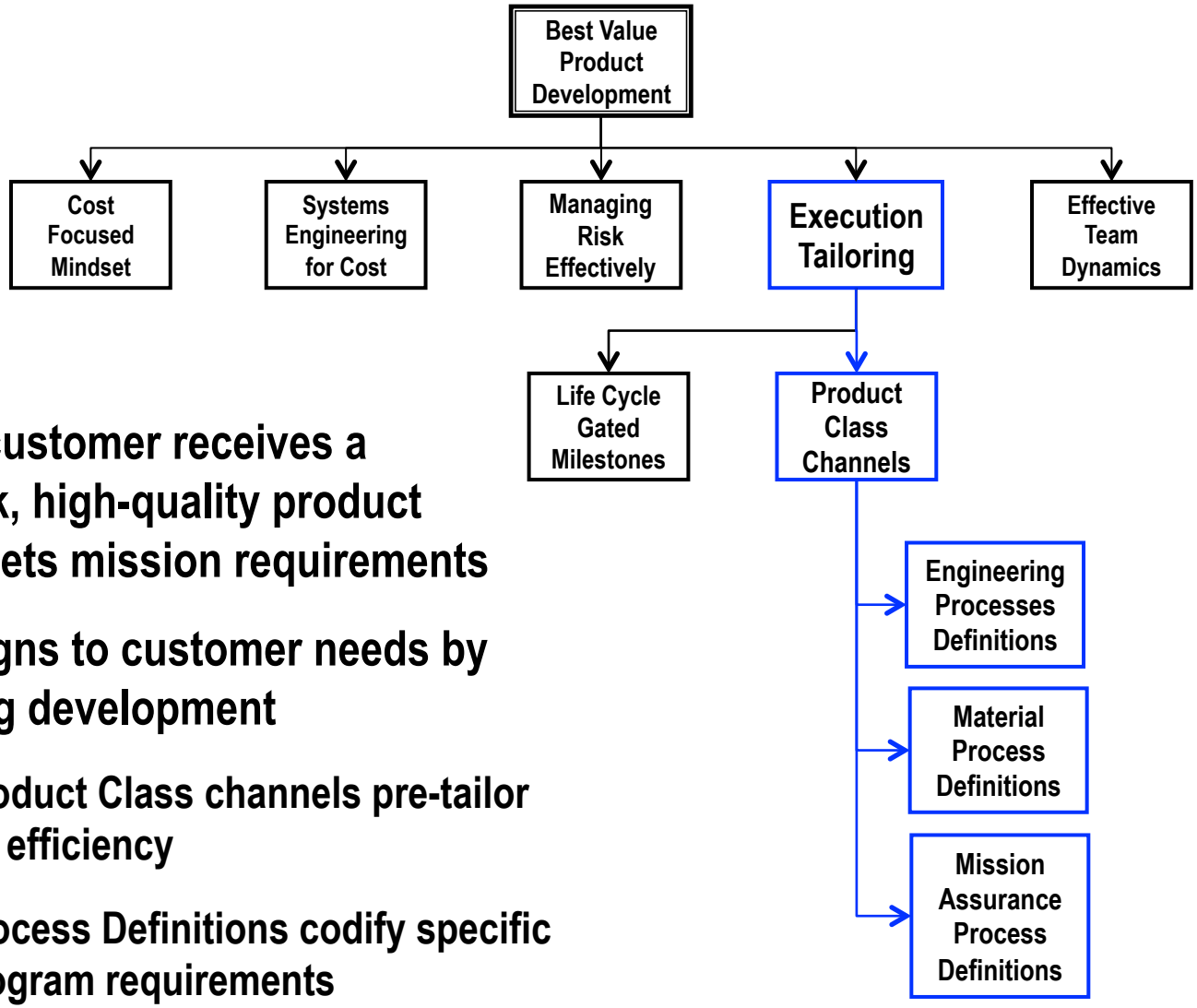
Specific Example of Process Tailoring and Cost Savings

Activity	PC1	PC2	PC3
EE Reliability (FMEA/CIL)	FMEA/CIL required to demonstrate credible SPFs are controlled/mitigated, and no fault propagation to redundant hardware.	FMEA/CIL required to demonstrate credible SPFs are controlled/mitigated, and no fault propagation to redundant hardware.	FMEA/CIL required to demonstrate that a failure cannot propagate across external interface(s).

- **Very high leverage of existing designs and procurements**
- **High end-item verification ability**
- **Low evidence of assurance requirements**
- **Low required oversight**

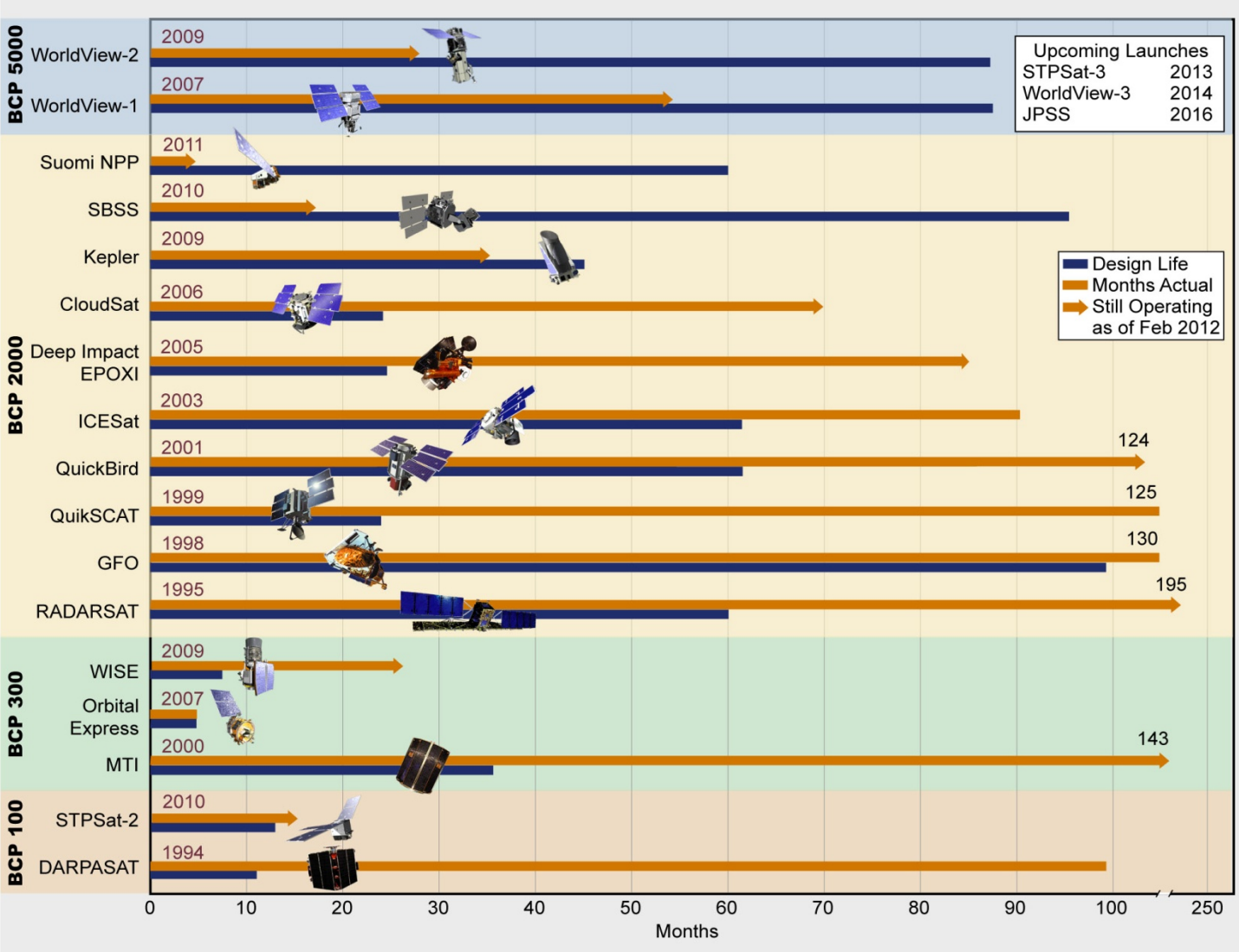


Execution Tailoring is Part of a Portfolio of Best-Value Practices to Meet Cost Objectives



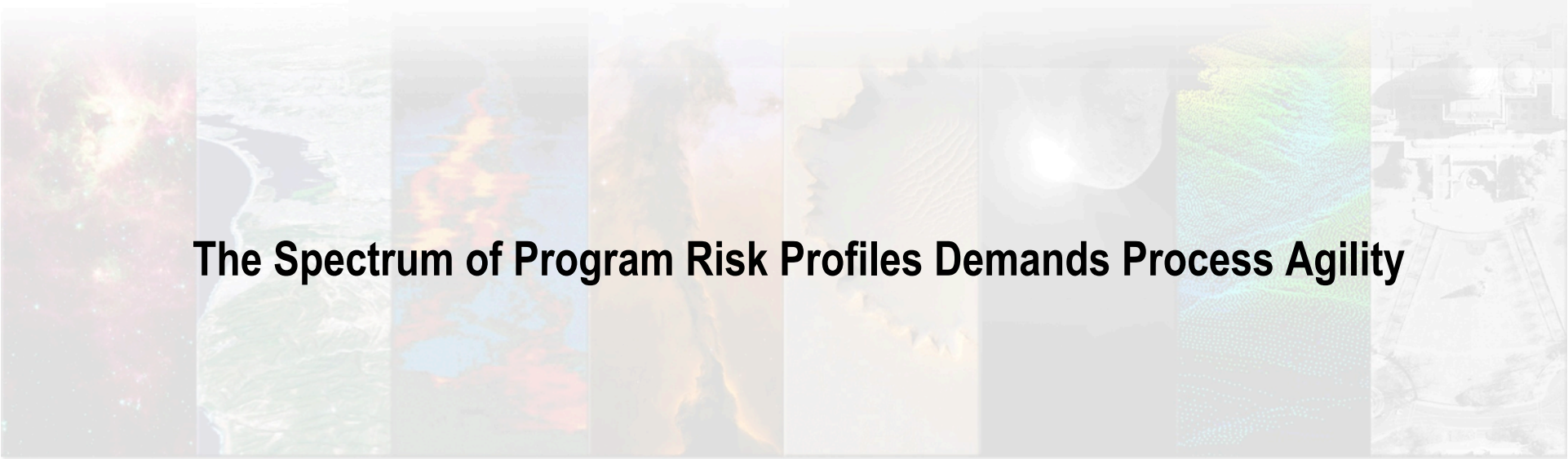
- Every customer receives a low-risk, high-quality product that meets mission requirements
- Ball aligns to customer needs by tailoring development
  - Product Class channels pre-tailor for efficiency
  - Process Definitions codify specific program requirements

Mission Success is the Goal of Process Implementation



Mission Success is of Highest Importance

Questions?



The Spectrum of Program Risk Profiles Demands Process Agility

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