AEROSPACE REPORT NO.
TOR-2016-02121

Process Change Assessment Techniques Product Overview

May 5, 2016

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Prepared for:

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Contract No. FA8802-14-C-0001

Authorized by: National Systems Group

Developed in conjunction with Government and Industry contributors as part of the U.S. Space Programs Mission Assurance Improvement Workshop.

Abstract

Preventing process changes from causing unintended consequences is important to achieving mission success. Process changes, often in the name of improvement, continue to be identified as contributors to hard and expensive lessons. These lessons can be linked to inadequately assessed processes or changes in upstream processes. This presentation was given at the 2016 Mission Assurance Improvement Workshop and provides an overview of the full report, *Process Change Assessment Techniques* (Aerospace Report No. TOR-2016-02187).

Acknowledgments

This document was created by multiple authors throughout the government, the aerospace industry, and academia. We thank the following contributing authors for making this collaborative effort possible:

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A special thank you for co-leading this team and efforts to ensure completeness and quality of this document goes to Thomas Reinsel, Raytheon Space and Airborne Systems.

The authors deeply appreciate the contributions of the subject matter experts who reviewed the document:

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Process Change Assessment Techniques

Product Overview

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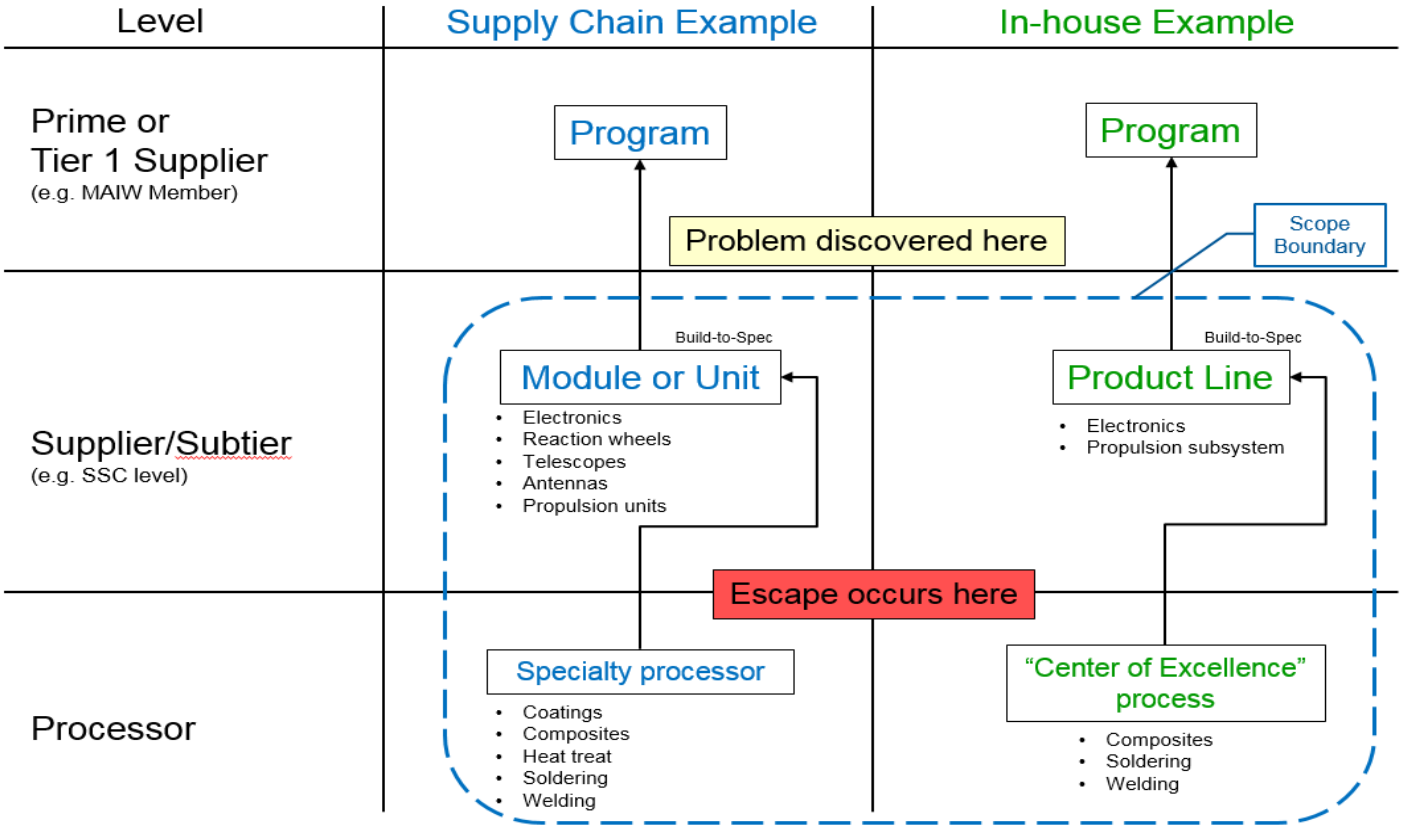
May 5, 2016

Motivation for Process Change Assessment Techniques

- Process change, often in the name of "improvements," can introduce unintended consequences for qualified hardware
  - *Design changes traditionally vet through engineering change boards*
- Process changes are not consistently assessed for high risk
  - *The less a supplier knows about the end use of a product, the less likely that supplier is to consider that a proposed process change could cause unwanted product impacts*
  - *Some companies have developed their own policies to manage process change, but there is no industry consensus on approach*
- "Late" escapes are infrequent, but can have high impact on mission success

Problem

Process changes may happen at outside specialty processors or in-house process "Centers of Excellence." Problems occur when these changes manifest as unintended consequences at higher module- or unit-level builds, risking mission success.

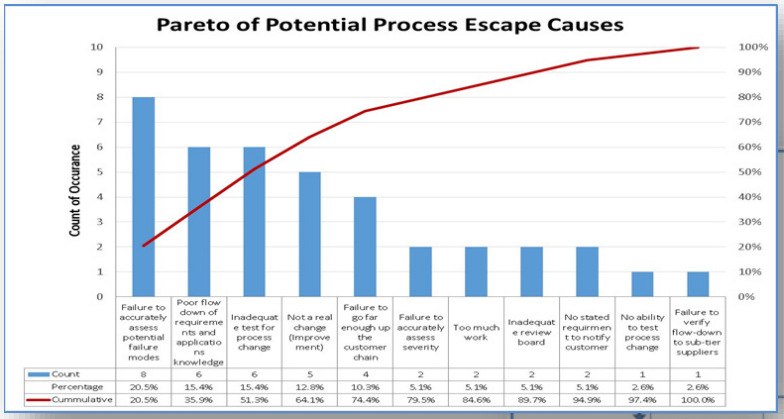


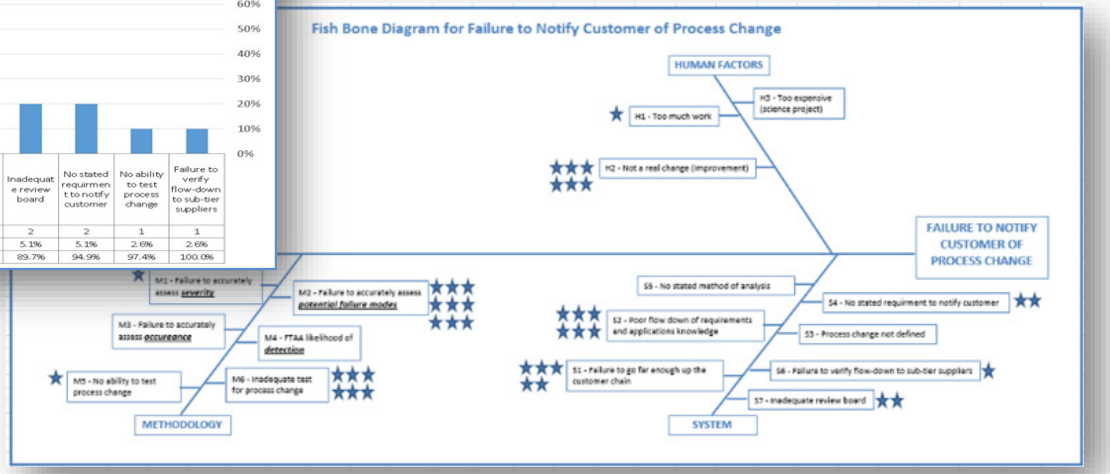
Team Charter

- Survey data from integration and test (I&T) (failure review board [FRB], material review board [MRB], etc.) for examples of failures resulting from supplier or in-house process changes
- Identify and categorize causal themes and drivers from data
  - *e.g., facility relocations, equipment or workforce changes, breaks in procurement or manufacturing, etc.*
- Benchmark trade associations for methods that have addressed control of process changes
- Survey/assess effectiveness of existing **customer** process change notification (PCN) and control requirements
- Compile best practice methods and tools for effective identification and evaluation of **supplier** PCNs
- Prioritize guidance on when and how to use existing methods and tools versus introduction of new or unfamiliar methods or tools

Process Escape Data Analysis

- The team analyzed data from various sources (lessons learned and root cause corrective action databases, FRB, MRB, etc.) for process changes that created hardware failures at subsequent levels of assembly, integration, test, or customer use
- Each escape was assigned to a potential cause on a fishbone
- Potential causes were ranked and the top three were investigated further





Escape Examples

Example 1

Process Change: Change of gold plating supplier for connector pins resulted in intermittent connectivity failures at cold temperatures (found in vehicle-level thermal vacuum [TVAC] testing).

Result: Reach-across to multiple programs and customers at all phases of development and integration.

Recognition of potential impact from change of source could have been mitigated earlier by perceptive screening test.

Example 2

Process Change: A dynamic load (i.e., wiggle) test was implemented to screen for failures during manufacturing. The new screen induced unexpected latent stress failures in adjacent chip components.

Result: New failures found at higher-level printed wiring board (PWB) assemblies, necessitating more investigation and remove-and-replace (R&R).

Recognition of potential impact from "improved" screening could have been prevented with a thorough risk analysis.

Trade Association Summaries

- Conducted review of six trade associations' policies and publications
  - *For guidance to their practitioners to manage and control process changes*
    - before the change was initiated
    - after an escape had occurred to assess the risk

- These associations were selected because together they comprise the space system industry's most well-developed sources for procedural guidance on the design and manufacture of hardware used in space applications

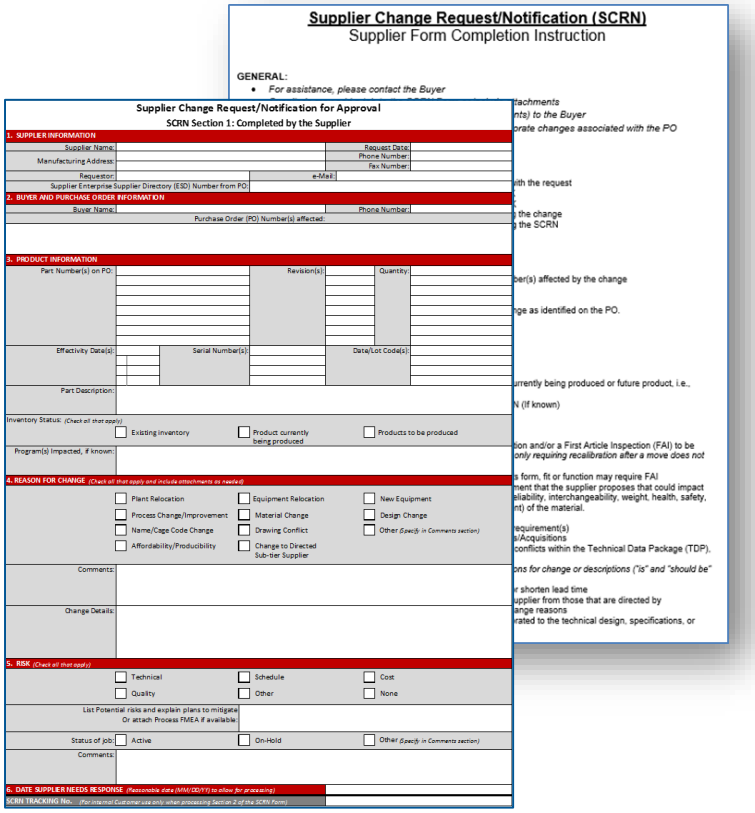
International Aerospace Quality Group (IAQG)—Process Failure Modes and Effects Analysis (PFMEA)

- PFMEA was seen as the most effective available technique for preventing a process change-related escape
- Implementation of a PFMEA (which is one element of the new AS9145 standard) can be applied specifically to evaluate a proposed process change
- This methodology is particularly valuable before a process change is implemented

Current State Assessment												Mitigation Plan						
							Current Process							Action Results				
Process Being Reviewed	Requirement	Potential Failure Modes	Potential Effect(s) of Failure *S - Schedule C - Cost P - Performance*	Severity	Class	Potential Cause(s) / Mechanism(s) of Failure	Controls Prevention	Occurrence	Controls Detection	Detection	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Taken	New Sev	New Occur	New Det	RPN Improved
Add glass to RTV		air inclusions into RTV (at ~40% by surface area)	reduce bond line and thermal control	5		Poor Operator Controls no deairate operation	de-airate process Low viscosity RTV	2	variation in IR signature at end customer	#	100	1.) Determine acceptable void % RF thermal analysis	1.) LaKomski	If taken will reduce the severity	4	2	10	80
												2.) Provide supplier with IR camera system details to determine liklihood of inclusion into ATP process.	2.) B. Burk	If taken will reduce detection	5	2	5	50

Process Change Notification Benchmark

- Reviewed several companies' flowdown requirements for PCN
- One was selected as a benchmark example
  - *Benchmark PCN policy was selectively provided to key suppliers by the contractual inclusion of a Quality Assurance Provision (QAP), also called Q-note*
  - *Program and Supplier Quality conduct a review of the Supplier Change Request Notification (SCRN) with supply chain and technical SMEs*
  - *The review considers further actions such as conducting a new first article or a re-qualification plan for the part*



Supplier Change Request/Notification (SCRN)
Supplier Form Completion Instruction

GENERAL:
- *For assistance, please contact the Buyer*

Supplier Change Request/Notification for Approval
SCRN Section 1: Completed by the Supplier

1. SUPPLIER INFORMATION
Supplier Name: | Request Date:
Manufacturing Address: | Phone Number:
Fax Number:
Requestor: | e-Mail:
Supplier Enterprise Supplier Directory (ESD) Number from PO:

2. BUYER AND PURCHASE ORDER INFORMATION
Buyer Name: | Phone Number:
Purchase Order (PO) Number(s) affected:

3. PRODUCT INFORMATION
Part Number(s) on PO: | Revision(s): | Quantity:
Effectivity Date(s): | Serial Number(s): | Date/Lot Code(s):
Part Description:
Inventory Status: (Check all that apply)
☐ Existing inventory ☐ Product currently being produced ☐ Products to be produced
Program(s) Impacted, if known:

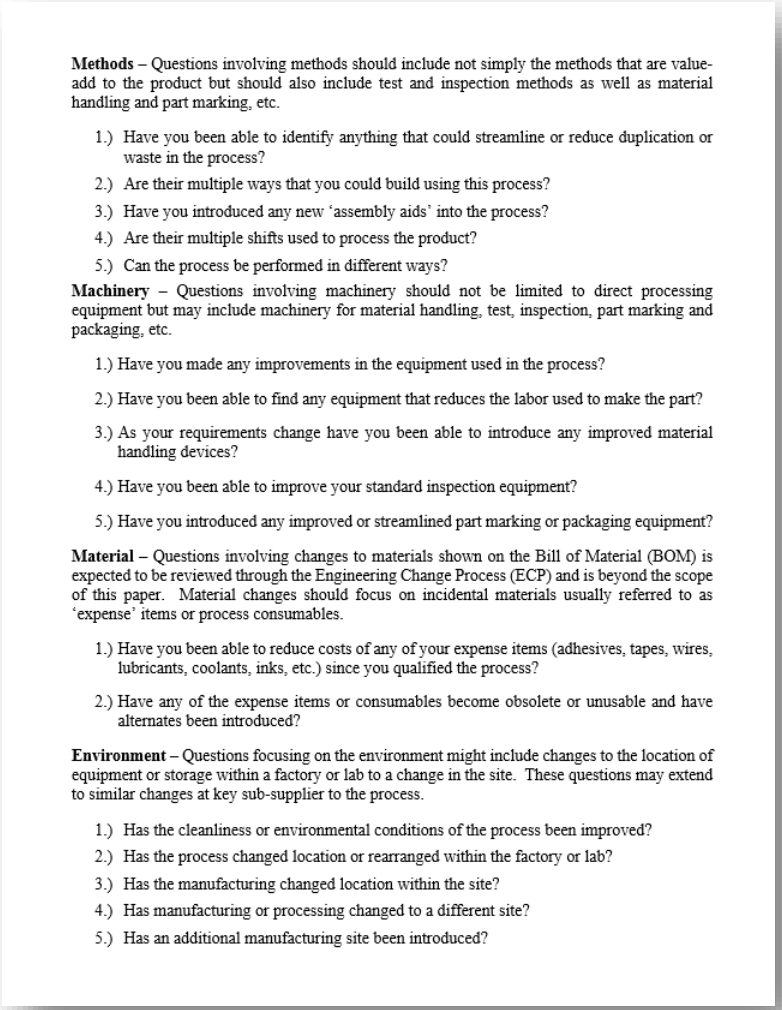
4. REASON FOR CHANGE (Check all that apply and include attachments as needed)
☐ Plant Relocation ☐ Equipment Relocation ☐ New Equipment
☐ Process Change/Improvement ☐ Material Change ☐ Design Change
☐ Name/Cage Code Change ☐ Drawing Conflict ☐ Other (Specify in Comments section)
☐ Affordability/Producibility ☐ Change to Directed Sub-tier Supplier
Comments:
Change Details:

5. RISK (Check all that apply)
☐ Technical ☐ Schedule ☐ Cost
☐ Quality ☐ Other ☐ None
List Potential risks and explain plans to mitigate Or attach Process FMEA if available.
Status of Job: ☐ Active ☐ On-Hold ☐ Other (Specify in Comments section)
Comments:

6. DATE SUPPLIER NEEDS RESPONSE (Reasonable date (MM/DD/YY) to allow for processing)
SCRN TRACKING No. (For Internal Customer use only when processing Section 2 of the SCRN Form)

Process Change "Improvement" Questions

- A set of 27 questions was developed to aid a supplier or in-house processor to identify changes that might affect the end user of the product
- The questions are meant to invite the review of changes that go beyond typical form-fit-function constraints
  - *Questions are not exhaustive*
- The questions help a supplier recognize that a change to an existing process could represent a risk to a product in its end use
  - *Even if the supplier was unaware of all of the conditions of the end use of a product*



Methods – Questions involving methods should include not simply the methods that are value-add to the product but should also include test and inspection methods as well as material handling and part marking, etc.

1.) Have you been able to identify anything that could streamline or reduce duplication or waste in the process?
2.) Are their multiple ways that you could build using this process?
3.) Have you introduced any new 'assembly aids' into the process?
4.) Are their multiple shifts used to process the product?
5.) Can the process be performed in different ways?

Machinery – Questions involving machinery should not be limited to direct processing equipment but may include machinery for material handling, test, inspection, part marking and packaging, etc.

1.) Have you made any improvements in the equipment used in the process?
2.) Have you been able to find any equipment that reduces the labor used to make the part?
3.) As your requirements change have you been able to introduce any improved material handling devices?
4.) Have you been able to improve your standard inspection equipment?
5.) Have you introduced any improved or streamlined part marking or packaging equipment?

Material – Questions involving changes to materials shown on the Bill of Material (BOM) is expected to be reviewed through the Engineering Change Process (ECP) and is beyond the scope of this paper. Material changes should focus on incidental materials usually referred to as 'expense' items or process consumables.

1.) Have you been able to reduce costs of any of your expense items (adhesives, tapes, wires, lubricants, coolants, inks, etc.) since you qualified the process?
2.) Have any of the expense items or consumables become obsolete or unusable and have alternates been introduced?

Environment – Questions focusing on the environment might include changes to the location of equipment or storage within a factory or lab to a change in the site. These questions may extend to similar changes at key sub-supplier to the process.

1.) Has the cleanliness or environmental conditions of the process been improved?
2.) Has the process changed location or rearranged within the factory or lab?
3.) Has the manufacturing changed location within the site?
4.) Has manufacturing or processing changed to a different site?
5.) Has an additional manufacturing site been introduced?

Intended Product Use

- The purpose is
  - *to provide awareness to the general space community for the benefit of mitigating the risks of process changes*
  - *to benchmark the most useful tools and policies currently in use*

- Intended for program management, procurement, and technical disciplines, including engineering, production, and quality organizations responsible for the procurement, design, manufacturing, and quality assurance of space-qualified hardware

- Some of the professional associations or educational organizations that would reach the target audience are AIAA, IPC, IAQG, JEDEC, Nadcap, and SAMPE

Topic Follow-on Recommendations

- Specific recommendations for the space industry:
  - *Enhance existing reference documents (e.g.,* EIA-649-1, Definition of Major (Class I) Engineering Change Proposal*, and similar sources) to include language that goes beyond Class I/Class II or Major/Minor to include unintended consequences from process changes*
  - *Develop a space industry common guideline for mitigating process changes and a common structure for PCN policy that could be selectively applied between Primes ➔ Tier 1 and also from Tier 1 ➔ outside processors*

- Specific recommendations for government:
  - *Review the new AS 9145 and SAE J1739 processes from IAQG and develop a plan to flow these techniques down to suppliers depending on circumstances. May be appropriate to research a larger set of history for AS 9145 and SAE J1739*

Team Introductions - Core Team

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