Quality Assurance Leadership Strategy: Predictive Capability to Meet Cost, Personnel, and Schedule-Constrained Program Environment

1. Get in Early: Complementary and Robust Requirements Flowdown
2. Automate Insight: Data Acquisition, FAIR, Data Analytics, MBQA
3. Predicting Supplier Capability: Focus on Process Capability instead of GMIPs

Office of Safety and Mission Assurance
Mission Assurance Standards and Capabilities Division (MASCD)
Missions and Programs Assessment Division (MPAD)
NASA Safety Center/QA Technical Discipline Leadership
Quality Assurance Program Leadership Steering Group
Quality Assurance Working Group

MASCD Scope: Rules, Tools, Training, SME Consultation

Current Priorities:

- Faster decision velocity
- Competency in risk-based decision-making
- Robust SMA planning
- Evaluate SMA to the plan
- Leverage others' investments: industry, DoD, FAA, DOE, etc.

	Position	**Primary POC for**
Jeannette Plante	OSMA QA Discipline Integrator	NASA QA policies, NASA technical standards, adopted VCSs, External Agency-level Inquiries and Actions, MetCal Program Executive, NDE Program Executive, MSA Tool
Valle Kauniste	OSMA Supply Chain Risk Manager	SCRM, Back-up for External Agency-level Inquiries and Actions, Standard Contracts Content
Don Brandl	NSC QA Technical Discipline Lead	APPG, Advisor to Workmanship Program for Training, QAWG, QLF
Robert Lange	KSC, QA Leadership Consultant	QAWG, QLF, MBQA
Alan Wallace	AFRC QA Leadership Consultant	Advisor for Aviation Quality Assurance

Build in Quality: Get Involved Early

Formulation: QA Not Present
Mission Success Objectives
Program/Project Management Framework
Budget, Schedule
Acquisition Strategy: Contract Type, Likely Prime Offerors, Innovations

First Half of Lifecycle: Low Awareness of QA Program and QA Program Contributions
Risk Posture
Industrial base, SCRM
Critical Items/Attributes
Manufacturability
Flowdown: PQA
Data Management
Risk Characterization and Management

Second Half of Lifecycle: Overemphasis on GCQA
QMS Audit
Process Audit
Witness Production/Events
Review Data
Inspect Product
MRB/RCCA
Risk Characterization and Management

SCRM: Supply Chain Risk Management
QA: Hardware Quality Assurance
QMS: Quality Management System
MRB: Material Review Board
RCCA: Root Cause Corrective Action

Get in Early: If it's such a great idea, why haven't we done it already?

Obstacles to QA Requirements Tailoring and Flowdown

QA: Hardware Quality Assurance
FAR: Federal Acquisition Regulation

- **FAR**:
  - Does not compel projects to plan QA Program well
  - Emphasis on confirming product conformity *to justify supplier payment* rather than full lifecycle risk management in the interest of *mission success*
  - Oversimplification of "**Higher Level Requirements**" as a list of technical standards

46.202-4 Higher-level contract quality requirements.

(a) Agencies shall establish procedures for determining when higher-level contract quality requirements are necessary, for determining the risk (both the likelihood and the impact) of nonconformance, and for advising the contracting officer about which higher-level standards should be applied and included in the solicitation and contract. Requiring compliance with higher-level quality standards is necessary in solicitations and contracts for complex or critical items (see 46.203)or when the technical requirements of the contract require-

(1) Control of such things as design, work operations, in-process controls, testing, and inspection; or

(2) Attention to such factors as organization, planning, work instructions, documentation control, and advanced metrology.

(b) Examples of higher-level quality standards include overarching quality management system standards such as ISO 9001, ASQ/ANSI E4, ASME NQA-1, SAE AS9100, SAE AS9003, and ISO/TS 16949, and product or process specific quality standards such as SAE AS5553.

- NASA Requirements Development Teams (**RDTs**) **are small** and can have difficulty knowing about and using "new" requirements in a timely manner.
- Requirements perceived as *adding* cost rather than *saving* cost.

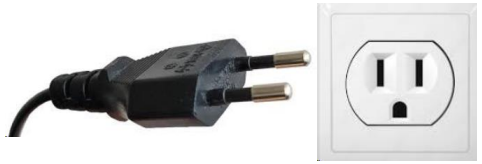
Why can't we change the way we engage in requirements development?

- **Poor tailoring competency** within the discipline domains. All requirements and risks are treated with equal weight.
- **Low TRL/MRL** may rely more heavily on custom procedures than established technical standards; QC/QA criteria not well established and communicated.
- **COTS are retail**. Even for products designed for space applications. Approach must be capabilities accommodation rather than qualification.
- Suppliers may use **different or overlapping quality STDs** based on market target and established command media: IPC vs SAE vs Nadcap vs MIL QML

IPC: Trademarked Corporation, Standards Development Organization (SDO) for electronic packaging
SAE: Society of Automotive Engineers, SDO
Nadcap: Trademarked Corporation, 3rd party accreditor for suppliers of mechanical and chemical manufacturing processes
MIL QML: Military specifications system, qualified manufacturer program
COTS: Commercial off the Shelf

Low Alignment

Buyer's Requirements



Suppliers' Standard Operating Procedures

- Protracted requirements negotiations
- Equivalency reviews
- Waivers
- Requirements fall through cracks: flow down failures

What can we do? *Strategy for Better Planning*

SMAP: Safety Mission Assurance Plan
APPG: Assurance Project Plan Generator
LCR: Life Cycle Review
DRD: Data Requirement Description
CoFR: Certification of Flight Readiness

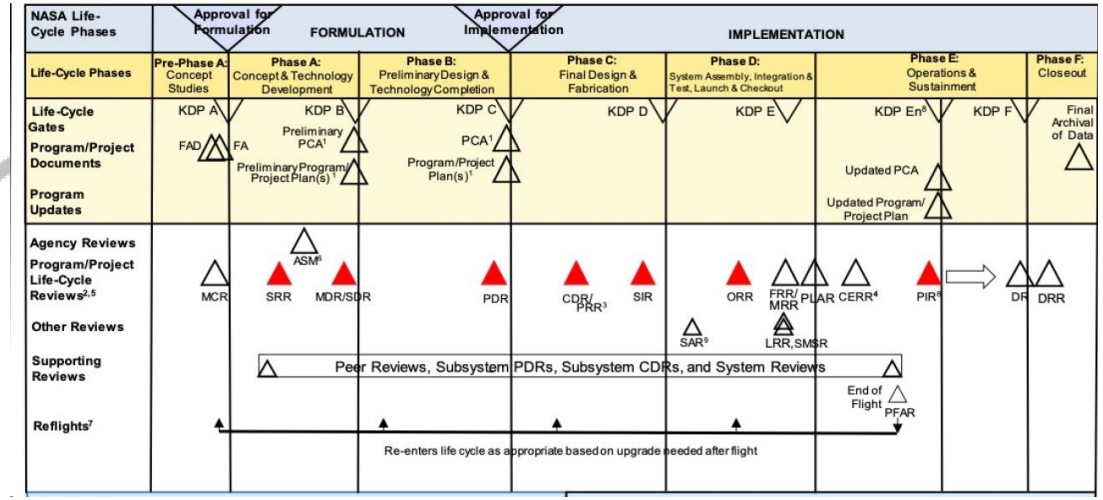
1. Use early days for discovery: MRL, COTS, Stds
2. **Demand a QA Plan**! Use OSMA's SMAP generator: APPG.sma.nasa.gov (NASA only)
3. Maximize leverage of industry standards to enable offeror's readiness to respond to RFPs
4. Use contract clauses to clarify details related to AS9100

Move standard clauses and DRDs into industry standards

5. Leverage the LCR process[1] by defining look-ahead QA deliverables
6. Use standardized DRDs that generate LCR deliverables

Use DRD products to populate safety case

7. Use Safety Case Model to track and visualize SMA program status, risk status, and satisfaction of conditions for the CoFR



1. See NPR 7120.5, NASA Space Flight Program and Project Management Requirements

Rich content in the policies and SDO documents are not getting into RFPs and contracts.

Other IAQG Standards	Clauses in the 9100 Standard					
	4	5	6	7	8	9
9101	4.4					9.2
9102					8.4.2, 8.5.1.3	
9103					8.1, 8.3.5, 8.4.3, 8.5.1	
9107					8.6	
9114					8.6	
9115	All	All	All	All	All	All
9116					8.3.6, 8.4.3, 8.5.6	
9131					8.7	
9132					8.5.2	
9133					8.4.2, 8.6	
9134					8.4.1	
9162					8.5.1, 8.6	

NOTE: "All" indicates that all the sub-clauses in the specific clause of the 9100 stand related to the other IAQG standard.

Current list of related STDs for AS9100

Document Number	Title
NASA-STD-5009	Nondestructive Evaluation Requirements for Fracture Critical Metallic Components
NASA-STD-6016	Standard Materials and Processes for Spacecraft
NASA-STD-8739.6	Implementation Requirements for NASA Workmanship Standards
NASA-STD-8739.10	Electrical, Electronic, and Electromechanical (EEE) Parts Assurance Standard
NASA-STD-8739.12	Metrology and Calibration
NASA-STD-8739.14	NASA Fastener Procurement, Receiving Inspection, and Storage Practices for NASA Mission Hardware
NAS 412 Revision 1	Foreign Object Damage/Foreign Object Debris (FOD) Prevention
SAE GEIA-STD-0005-1A	Performance Standard for Aerospace and High-Performance Electronic Systems Containing Lead-free Solder
SAE GEIA-STD-0005-2A	Standard for Mitigating the Effects of Tin Whiskers in Aerospace and High-Performance Electronic Systems
SAE AS5553C	Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition.
SAE AS6174A	Counterfeit Materiel, Assuring Acquisition of Authentic and Conforming Materiel

STDs Invoked by NASA Quality Policy

OSMA/QA Leveraging the STDs approach……..

Other IAQG/AAQG Standards		
9101	9116	**9136**
9102	9117	**9137**
9103	**91TBD**	**9138**
9107	9131	**9145**
9018	9132	**9146**
9114	9133	**9147**
9115	9134	9162
		9163

Potential list of related STDs for IA9100

9018 Customer Identified Major Quality Management System Nonconformity Other Party Collaborative Corrective Action Process

91TBD [Integration into ICOP for Aerospace Product Suppliers Without Design Authority]

9145 Aerospace Series – Requirements for Advanced Product Quality Planning and Production Part Approval Process

9146 Foreign Object Damage (FOD) Prevention Program - Requirements for Aviation, Space, and Defense Organizations

Formulation: QA Not Present
Mission Success Objectives
Program/Project Management Framework
Budget, Schedule
Acquisition Strategy: Contract Type, Likely Prime Offerors, Innovations

First Half of Lifecycle: Low Awareness of QA Program and QA Program Contributions
Risk Posture
Industrial base, SCRM
Critical Items/Attributes
Manufacturability
Flowdown: PQA
Data Management
Risk Characterization and Management

New Standard Clauses for NPR 8735.2C, Standard DRDs

Red indicates content to be addressed in SAE ARP9009, *Aerospace Contract Clauses*

Required QA Training and Certification Credentials	QA Implementation Plan (std DRD)
Custom Operator and Inspector Training	Handling Government Furnished Equipment (GFE)
Approach for Determining Criticality	Parts and Materials Certification
Data Capture General * (new DRD)	Production Readiness Review (PRR) Planning
Baseline Technical Standards *	First Party Verifications
Counterfeit Avoidance * (new NFS clause for EEEE parts)	Coordinating Inspections or Tests Performed by the Govt
Product, Process, and Verification Attributes Captured in Engineering Documents	Second Party QA General
Product, Process, and Verification Attributes Flowdown *	I&T Quality Assurance
QA Factors for Design Reviews (MRL, SCRM)	Notice of Suspect Items and Recalls
Reporting Manufacturability Risks in Design Reviews	Launch Preparation and Execution Assurance
SCRM Research	Mission Operations Assurance
Approval to Transfer Hardware Between Subtiers and Use of DD250	Change Management *
Flow Down Assurance	Review Boards (Closed Loop System for NCs) * (new DRD)
QMS Standards by Supply Chain Tier and Risk *	NASA Technical Authority (TA) Concurrence for MRB Dispositions
Supply Chain Map (new DRD)	CAR and OASIS Reporting *
GIDEP * (new FAR clause, std DRD)	Reporting Fraud, Malpractice, and Serious Misconduct

Calibration, Electronic Data Submission, FOD, CoC, FAI, APQP, Maintenance and Repair……and more.

SCRM: Supply Chain Risk Management
CUI: Controlled Unclassified Information
WBS: Work breakdown structure

Leveraging Standard DRDs

Revised 2-2-23 – DRAFT

1. DRD Title: Supply Chain Visibility (SCV) Reporting for NASA Mission Project Procurements		
2. DRD No.: DRD Number TBD	**3. Data Type:** Type 1	**4. OPR:** NASA Office of

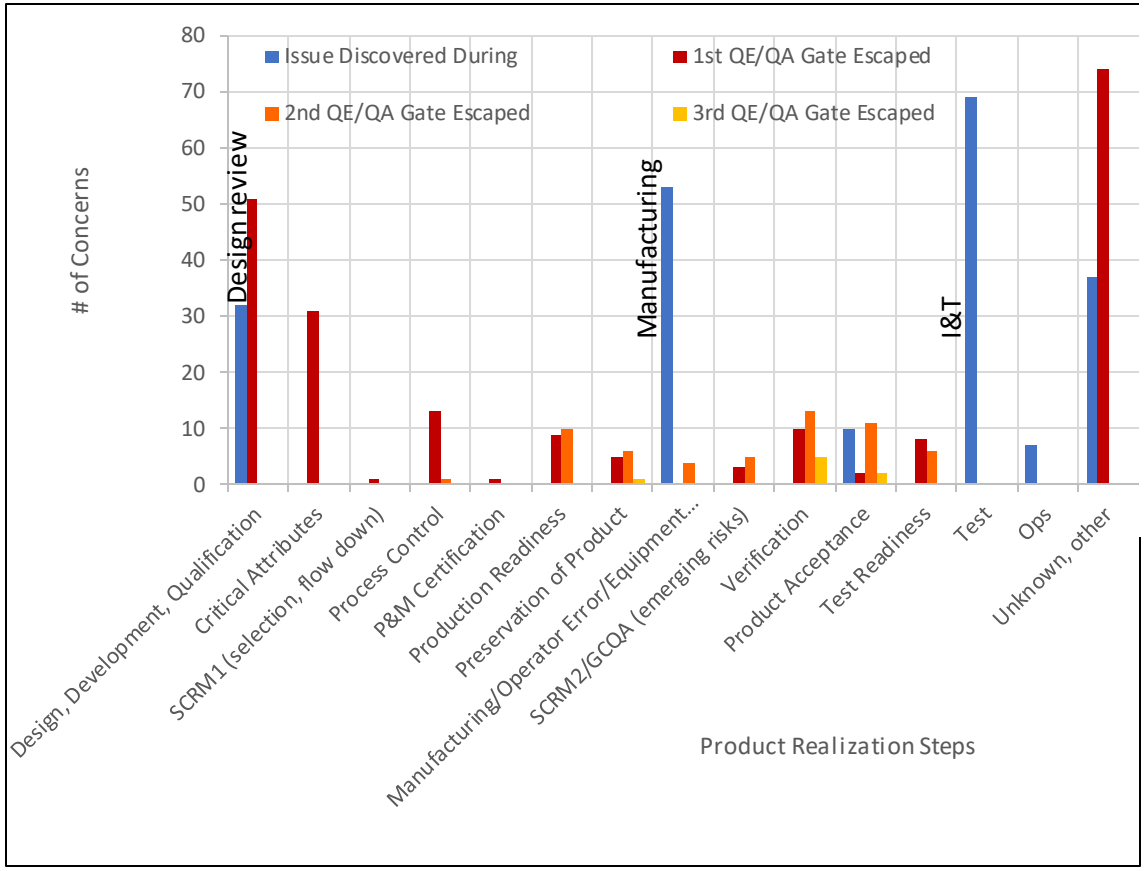
- Continuously **build supply chain map** for NASA programs/projects
- Like the emerging requirements related to cyber
- Data will reside in NASA's Supply Chain Insight Central SCRM database (internal only, CUI, restricted access)
- Reporting starts within 60 days of contract award and at least biannually thereafter.
- Supplier meta data (e.g., name, address, Cage Code)
- Contract meta data
- Relevant product or service and association to WBS or hardware element
- Flow down requirement four tiers

DRD No.	Data Requirement Title
001	Quality Assurance Implementation Plan
002	Government Industry Data Exchange Program (GIDEP) and NASA Advisories/ and Alerts
003	NC Reporting and Review Board Status
004	Foreign Object Debris (FOD) Control Program Plan
005	Electrostatic Discharge (ESD) Control Program Plan
006	Counterfeit Avoidance Program Plan
007	Lead-Free (Pb-free) Tin Control Plan
008	QA Metrics

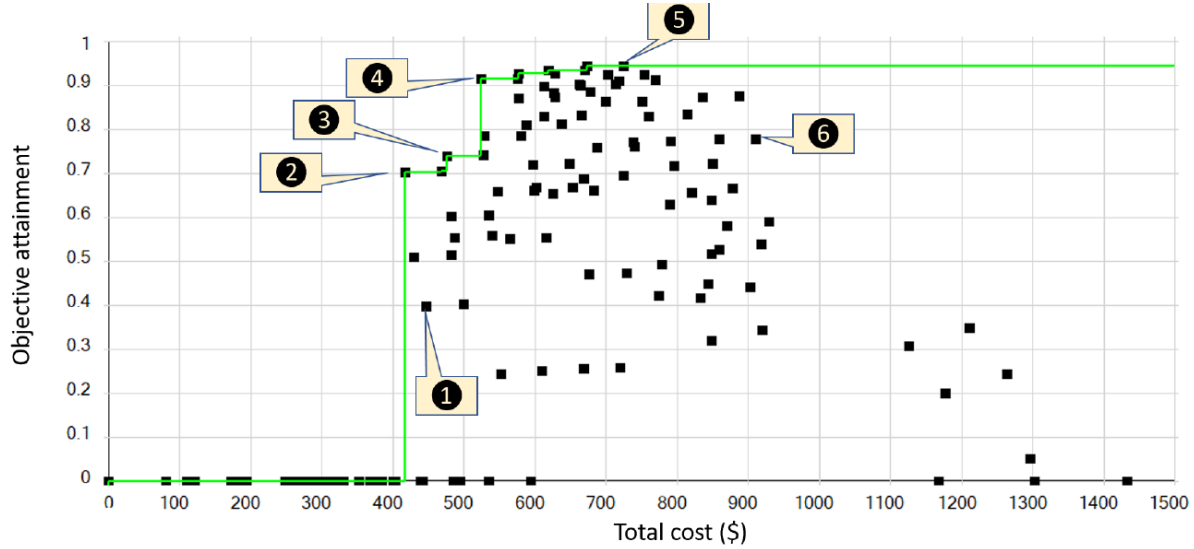
Automate Insight: Data Acquisition, FAIR, Data Analytics, MBQA

How can we leverage IT to exploit what we already know, absorb what we've learned, visualize current state?

MRB Analyses: Insight into QC escapes found at test



GMIP Effectiveness and Cost



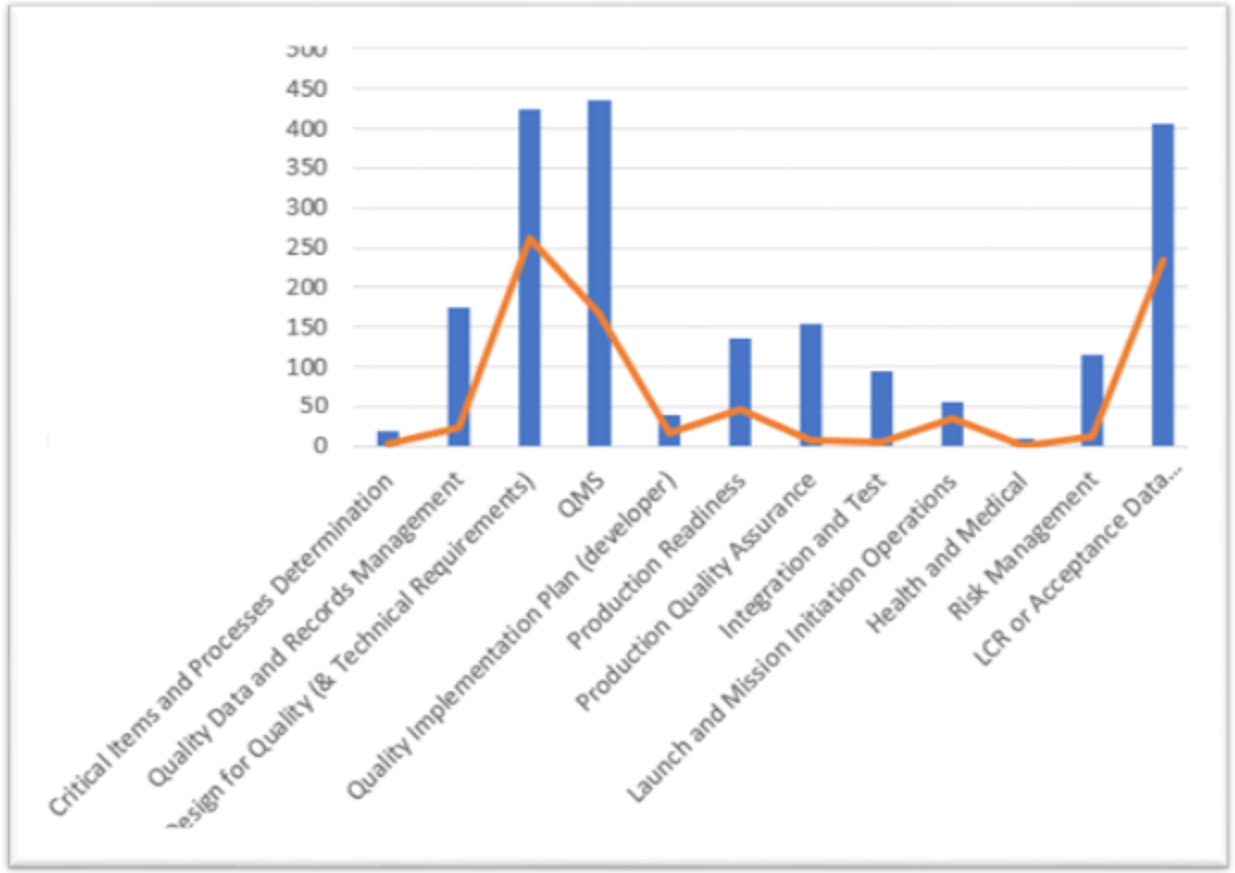
S. L. Cornford, A. Wheeler, M. S. Feather and J. F. Plante, "Assurance Equations: A Cost and Criticality Model for Optimizing Quality Assurance Surveillance," *2022 IEEE Aerospace Conference (AERO)*, Big Sky, MT, USA, 2022, pp. 1-13, doi: 10.1109/AERO53065.2022.9843807.

MBQA: Model Based Quality Assurance
FAIR: Findable, Accessible, Interoperable, Reusable

Topic Takeaway: Requirements Development

- Learn about additional **standards that reduce custom SOW clauses**
- Research the **supply chain and understand the QMS and technical standards** that are going to be a good fit
- **Push for a QA plan earlier**. This is the way to introduce value-added research and planning work
- **Use DRDs to pull in early indications** of Manufacturability, Supply chain capability, industrial base risk, data/metrics that will be available.
- Contribute to the **maturation of standard SOW clauses**

Traceability Analysis: Policy vs Contracts



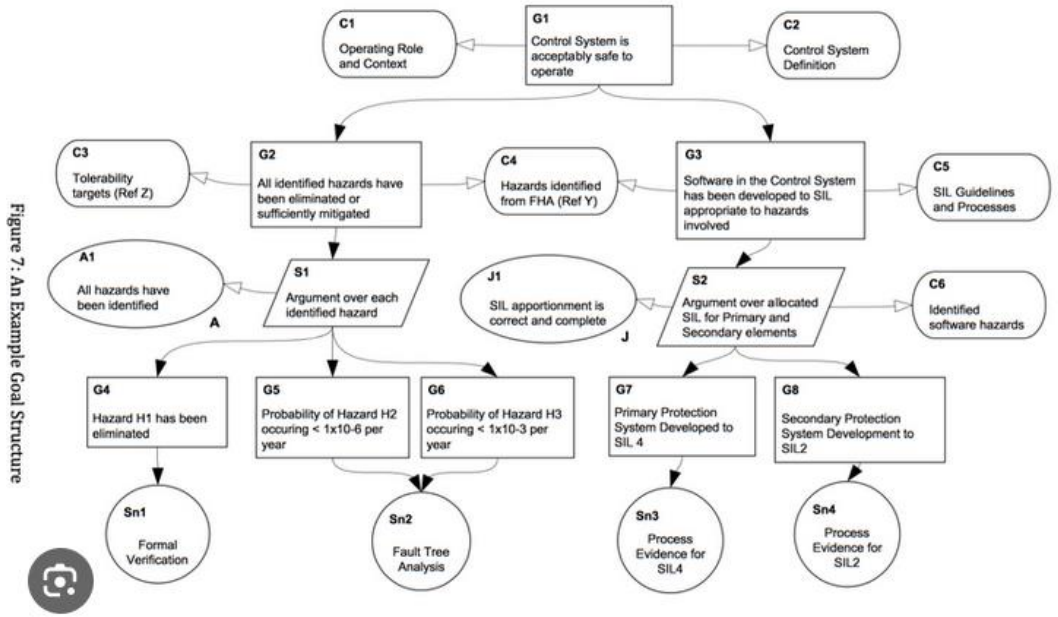


Figure 7: An Example Goal Structure

GSN Community Standard. Version 2. January 2018

Modeling the Safety Case using Goal Structured Notation

- NASA's Assurance Program Plan Generator (APPG)
- Machine Readable Technical Standards: SAE ITC Digital Standards Alliance

Automate Insight: Data Acquisition, FAIR, Data Analytics, MBQA

Needs:

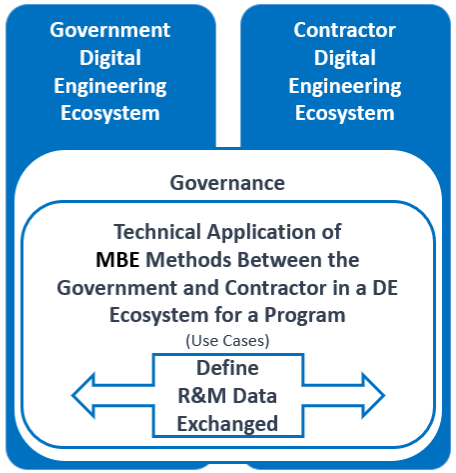
- Digital tools automating data acquisition: QR codes, Bar codes, Apps and Workflows, User profiles, MTConnect, MB/digital data deliverables.
- Ability to access and combine data sets (one system will *not* rule them all)
  - Common taxonomies for suppliers, hardware, processes, defects, technical requirements
  - MBQA safety case built on AS9100 framework (NASA Quality Policy aligned with AS9100 framework)
- Ability to design and manipulate analyses (views)

MTConnect: see MTConnect.org

DRD → MBx Inputs → MBAssessment → Decisions → LCR

Introduction – MBE FMECA Effort

- Established three working groups at the August 2019 DoD-Industry R&M Roundtable
  - ✓ Define the R&M Data Exchanged (Elements)
  - ✓ Governance - Defense Standardization Program Office (DSPO)
  - ✓ Technical Application in an Digital Engineering (DE) Ecosystem



AIA Joint Strategic Quality Council (JSQC)

Model Based Mission/Quality Assurance MBM/QA Team

Government

- DCMA – Craig Bennett (core)
- DLA(R&D) – Dr. Senthil Arul
- FAA – Steve Roomes
  - TBD
- NASA – Jeannette Plante (core)
  - Don Brandl – NASA Safety Center, Cleveland, OH
  - Robert Lange – Kennedy Space Center, FL
- OUSD(R&E) – Mr. Chris DeLuca, Director, Specialty Engineering
  - Mr. Albert Ismailov (Specialty Engineering-QA Lead)
  - Casey DeCarlis
- AIA QAC – Gery Mras (core)

Industry

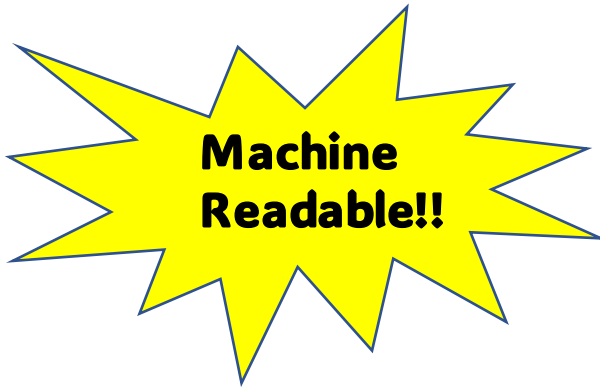
- BAE Systems – Brian Svoboda
- Ball Aerospace – Rick Roelecke (core)
- Boeing – Mike Best
- Elbit Systems – Ashley Dunn (lead/core), Jennifer Marsh (alt)
- General Dynamics – TBD
- L3 Harris – April Tidwell
- Lockheed Martin – Hannah Ensor (core), Brian Tenney (alt)
- Northrop Grumman – Lisa Fenton
  - Doug Cartney, Laura Lam (alt)
- Raytheon Technologies – John Fordyce (lead/core)
  - Hermitt Vega (PW), Logan Brooks (RAY), Cindee Cognetta (alt), Lindsey Shaw (alt)
- Rolls Royce – Tracy Lockhart (core)
  - Carley Sawyer, Elizabeth Watts
- Textron Bell – Keith Danel
- Triumph Group – Alma Palmer

* Specialty Engineering, Office of Systems Engineering and Architecture, Office of the Under Secretary of Defense for Research and Engineering

AIA: Aerospace Industries Association
MBQA: Model Based Quality Assurance
FMEA: Failure Modes and Effects Analysis
FAI: First Article Inspection
R&M: Reliability and Maintainability
MBE: Model Based Engineering

Topic Takeaway: Digital Transformation

- ✓ Urgent need for **digital infrastructure** for:
  - QA to enter and coexist in the Digital Engineering ecosystem
  - To streamline data acquisition and FAIR storage
- ✓ **Quality data** can feed MBQA Views
  - Evolving insight for decision-making
  - Breakdown communication barriers
- ✓ Think **FAIR** rather than Same. Enable custom analyses.
- ✓ Use **DRDs to drive communicating** via data sets and models.



>> Thank You <<

MBQA: Model Based Quality Assurance
FAIR: Findable, Accessible, Interoperable, Reusable
DRD: Data Requirements Description


Thank You
Merci
Grazie
Danke
Gracias