ISO 23952 QIF – Enabling Digital Transformation throughout Manufacturing and QualitySystems

Presenter:
Ray Admire

Abstract:
Overview of the QIF ANSI/ISO Standard, demonstrating a digital thread that links engineering, manufacturing, test, and inspection data, enabling organizations to easily share and link MBD and Engineering requirements between different departments and organizations, both internal and external (both supply chain and customers). These artifacts will be key to the enabling of our other DX projects, including the as-built digital twin and statistically driven decision making.

Ray Admire - Bio

- Ray worked for Lockheed Martin and its predecessor companies from 1985 - 2023. Ray is a Quality practitioner serving program quality and supplier quality technical lead at various capacities. Ray is a Coordinate measurement specialist with over thirty-eight years combined experience in the quality organization and recognized SME (subject matter expert) for failure review boards, coordinate metrology, First Article Inspection as well as metrology standards.

- Ray has GD&T Level-4 and Lean Six Sigma Green Belt Certifications. Ray served as the treasurer of the DMSC (Digital Metrology Standards Consortium), has served as representative for Lockheed Martin on several other standardization activities since 2000 (I++, DMIS, QIF & MBC) and is the Chairman of the Standards Committee which oversees progression to ANSI and ISO for all DMSC standards including DMIS, QIF and MBC.

- Ray has also led two global collaborative groups for Lockheed Martin Missiles and Fire Control, CAV/DISCUS-FAI and the CMM Programming teams.

- He served on the board for the Lockheed Martin Management Association many years

- Chaired the Quality Mission Success Golf Tournament for 8 years that brought in over $40,000 for local charities.

- Ray enjoys golfing, traveling, drinking wine, fine cigars and spending time with his family.

What is Digital Transformation

- Digital transformation (DX) is the adoption of digital technology by an organization. Common goals for its implementation are to improve efficiency, value or innovation. (Wikipedia)
  - Digital transformation entails considering how products, processes and organizations can be changed through the use of new, digital technologies.
    - MBD
    - Manufacturing Processes
    - Inspection Plans
    - Measurement results
    - Test Plans
    - Test Results

Any or all requirements can be defined in QIF and Results can be carried within QIF

Moneyball

- Anyone know and understand American Baseball?
  - Baseball is a very statistical and strategic sport.
- Oakland Athletics was one of the biggest underestimated teams in 2002.
  - Ownership was unable to fund the GM enough money to be competitive.
  - During a scouting visit to the Cleveland Indians, Billy Beane (GM of the Oakland Athletics) met Peter Brand.
    - A young Yale economics graduate with radical ideas about how to assess player value.
    - Peter didn't know anything about the game of baseball but he knew economics and statistics.
  - Oakland Athletics won the 2002 division title for 18% what it cost NY Yankees to win the same amount of games. Talk about being affordable.
  - Boston Red Sox owner said "Anybody who's not building a team right and rebuilding it using that model, are dinosaurs."

What was the key ingredient to the success of "Moneyball" concept?

INFORMATION

Which Provides?

Knowledge

Which Provides?

Power

To Make Valuable Decisions

38 Years with No Consistency

- Technology has progressed
  - Migrated from Manual Single Axis Measurements
  - Create Part Program rapidly
  - Measure components with speed and accuracy
  - Automation is affordable
  - Provide Data very quickly

- What's Missing?
  - Interoperability
  - Measurement Plans
    - Software is Proprietary Specific
  - Data is not in a format that allows transfer into corporate database for system analysis

Current Process

- What does the current data from suppliers look like?

- How valuable is that data?

- What type of decisions can you make from this data?

- How can this information help you with your products?

- Here are some actual documentation provided from suppliers.

QIF - Response to 2006 NIST/DMSC Metrology Interoperability Summit

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WHY QIF

- **Mature** ANSI Standard (v3.0) and ISO (2020)
- Solution providers that have **Implemented** QIF
- Realized from Software Scientists and Metrology Experts
- Reflects the **state-of-the-art**
  - Model-Based Definition
  - Feature-Based Tolerancing
  - Characteristic-Centered
  - Quality Planning with Bill of Characteristics (BoC)
  - Robust Measurement Results with Persistent IDs
  - Modern Software Development Techniques
- 500+ Years of **Experience** in Metrology, GD&T, Software Development
- **Value-Added** proposition to Manufacturing and Design
- Energizing the **digital**/dimensional **metrology** development community
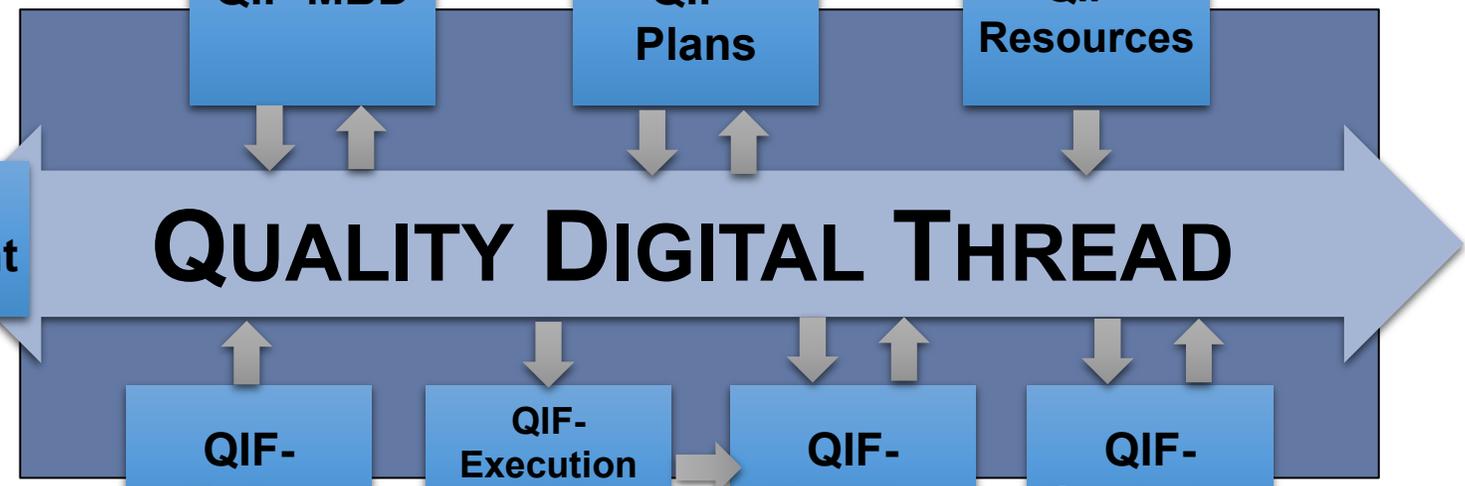
Curtis W. Brown, 2016

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QIF Enables a Quality Digital Thread
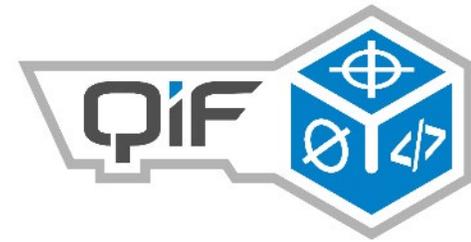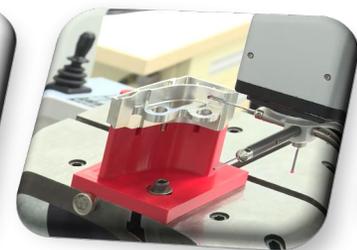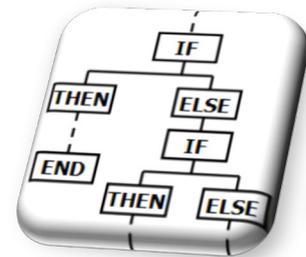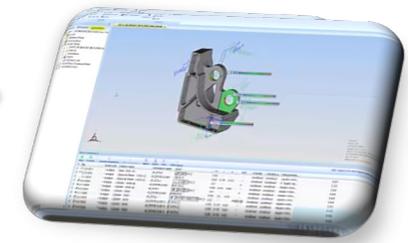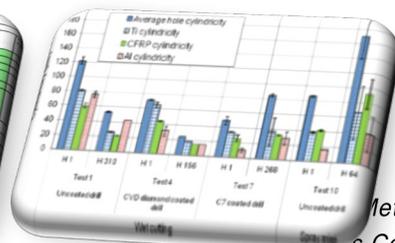
Model-Based Product Characteristics

Persistent Product Characteristic Designators w/ Criticalities

Model-Based Product Characteristics (MBPC): the use of a Model-Based Definition with *persistent product characteristics designations*.
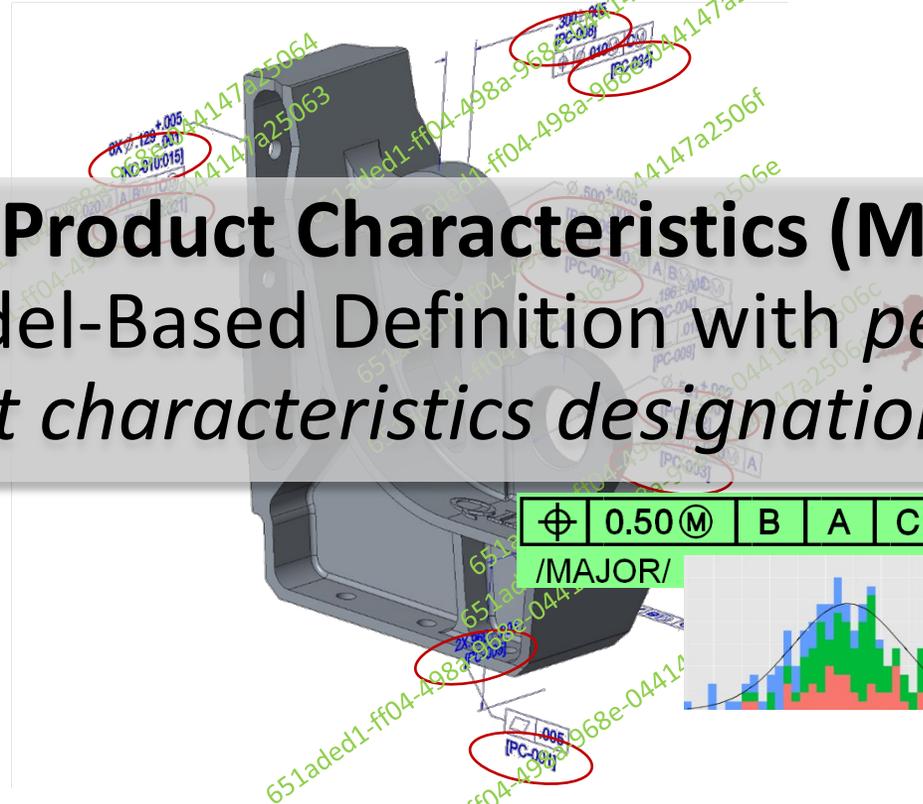
QIF allows Persistent Model-Based Product Characteristics: **Enables** Measurement Results to be Traceable Back to the Model

What is the QIF?
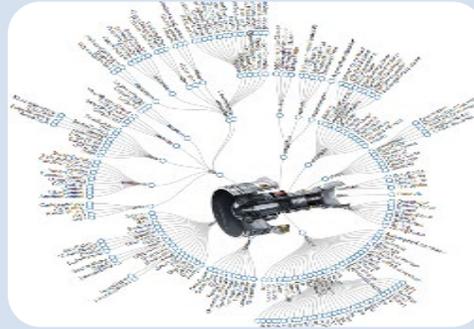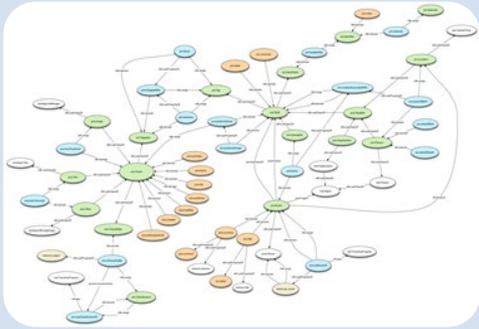
| Feature-Based Characteristic-Centered Ontology of Manufacturing Quality Metadata | XML Technology: Simple Implementation with Built-In Code Validation | Information Semantically Linked to MBD for Full Data Traceability via Persistent IDs (QPId, GUID) | Approved ANSI Digital Interoperability Standard

ISO Harvesting via A-Liaison? |

Developed and Maintained by the Digital Metrology Standards Consortium (DMSC)

QIF Benefits for OEM and Suppliers

QIF offers the following benefits:

- Innovation (New Non-Proprietary Standard)
- Traceability (UUID)
- Better control of supply chain
  - Possible to now monitor suppliers in real time
- Smooth flow of information to/from supply chain
- Increase overall quality of the processes
- Minimize costs
- Elimination of human errors
- Eliminate information loss due to translations
- Creates Agility in Engineering processes and test plans
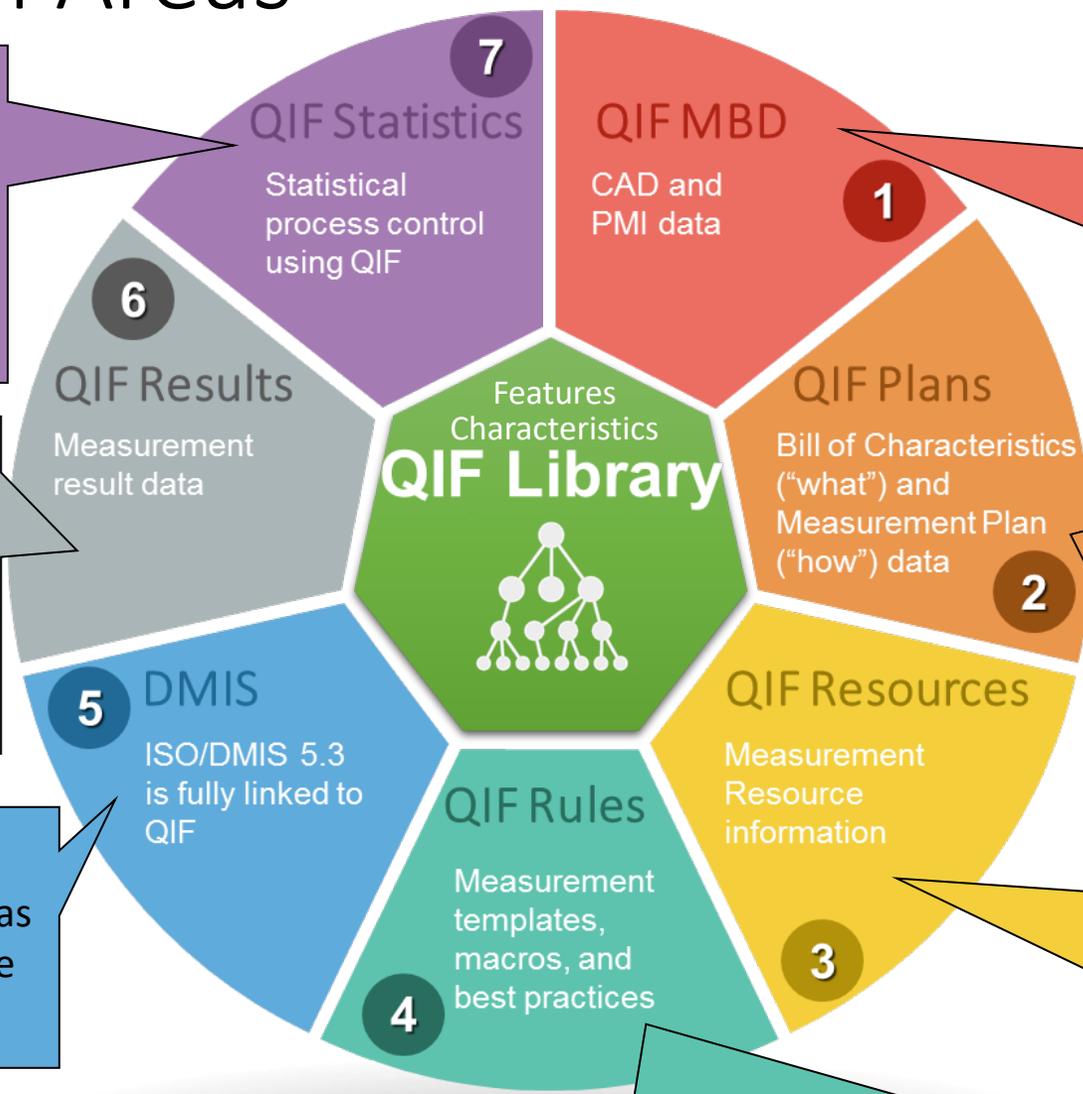- Quality data can help make your products more affordable.

QIF Application Areas

Reference a bundle of QIF Results sets and specify a statistical analysis method to be carried out. Can optionally include the results of the statistical analysis as well

Measurement results data, associated with the MBD! This can be just tolerance evaluation results, and can even include all the point cloud data from the features.

DMIS is not part of QIF, ISO 22093, however the latest ANSI DMIS 5.3 has been updated to harmonize with the data traceability mechanisms in QIF.

7 QIF Statistics — Statistical process control using QIF

6 QIF Results — Measurement result data

Features Characteristics QIF Library

1 QIF MBD — CAD and PMI data

QIF Plans — Bill of Characteristics ("what") and Measurement Plan ("how") data **2**

5 DMIS — ISO/DMIS 5.3 is fully linked to QIF

4 QIF Rules — Measurement templates, macros, and best practices

QIF Resources — Measurement Resource information **3**

QIF MBD is the base for providing traceability to authority CAD data. It is not required for basic QIF use cases. Considered to be the strongest semantic CAD+PMI standard available.

Wide range of optional levels of detail for measurement plans:
- What to Measure: Bill of Characteristics
- How to Measure: Inspection Plan
- Assign measurement resources
- Specify sampling point locations

Specify basic or highly detailed information about available measurement equipment (e.g., CMMs, probes, calipers, gages). As always, this data is contextual and semantic.

Create measurement rule templates. (e.g., *If a Surface Profile tolerance value is less than* **x**, *then use a CMM method with at least* **y** *number of point/sq.in.*)

What about performance Specs and SOR's

When we think of MBD we think of the engineering drawing.

What if we digitized?:

- Performance Specs
- Statement of Requirements (SOR)
- Test ATP Requirements

- Many errors and issues come from designs referencing specs and don't clearly define which requirements are important.

- Industry Specs can be huge and guide many items if they are not for a specific item.

QIF MBD
CAD and PMI data

1

QIF Plans
Bill of Characteristics

tures cteristics

QIF MBD is the base for providing traceability to authority CAD data. It is not required for basic QIF use cases. Considered to be the strongest semantic CAD+PMI standard available.

Workflow Example

QIF
Rules

QIF
Resources

Semantic Link to Authority Model

QIF MBD

QIF
Results

Process Stage 3

(overlapping text) ...generated throughout the entire process is linked to the authority model... ...measurement tasks.
This list of tasks is called a Bill of Characteristics

QIF Plans
BoC

QIF Plans
Meas Plan

DMIS

QIF
Results

QIF
Statistics

Identify Measurement Tasks (Bill of Characteristics)

QIF Definition

The **Quality Information Framework (QIF)** is a unified XML framework standard for computer-aided quality QIF systems, available free to all implementers.

QIF enables the capture, use, and re-use of metrology-related information throughout the Product Lifecycle Management (PLM) and Product Data Management (PDM) domains.

Benefits

- How does QIF, or Quality Information Framework, help organizations with their products throughout the manufacturing and supply chain?

- QIF is a complete Digital Transformation solution for engineering requirements and results to those requirements throughout the development and production processes.

- Overall, QIF contributes to enhanced quality and manufacturing processes, reduced costs, and increased efficiency for companies involved in manufacturing and quality control.

Standardization

- QIF provides a standardized format for sharing quality information, ensuring consistency and compatibility across different systems and processes.

- Large companies can't standardize on proprietary solutions but they can point to an ANSI/ISO standard and ensure the suppliers adhere to the standard for information on the products they produce and procure.

Improved Communication

- It enhances communication between different departments and organizations involved in the manufacturing process, reducing errors and misinterpretations.

Data Accuracy

- QIF helps maintain accurate quality data (datum related requirements, tolerances…), reducing the risk of defects, rework, and non-conformance, ultimately saving costs.

- From a dimensional metrology perspective accuracy of the engineering is key. When the drawings and models don't match it creates havoc across the manufacturing and quality departments. The CMM programs must match the design exactly and when they don't it will cause delays in product acceptance.

Streamlined Processes

- It streamlines quality inspection and measurement processes, making them more efficient and reducing inspection times.

- When manufacturing and inspection are using the same data to produce and qualify products the processes involved throughout the planning and data analysis can be seamless.

- Credibility across multifunctional areas are strengthened

Traceability

- QIF utilizing UUID's enables traceability of quality data, allowing companies to track issues and their resolutions, which is crucial for continuous improvement.

- From the authoritative model to the final data provided to the customer the UUID is a key factor to ensure the same engineering requirements have been used throughout all processes.

Compliance

- It helps companies adhere to industry standards and regulations, ensuring product quality and safety.

- Production Line Validations and other get to production audits are easier to explain when the same engineering requirements are provided in a single requirements document. When requirements come from various places audits become difficult to pass.

Data Analysis

- QIF data can be analyzed to identify trends, patterns, and areas for improvement, leading to better decision-making.

- Regardless of rather production is in your factory or procured from multiple producers QIF can help provide trends of success and areas of concern before it becomes a hindrance on your final assembly line.

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Interoperability

- QIF facilitates interoperability with various software and hardware, making it easier to integrate quality information into existing systems.

- Interoperability (or lack of) has been one of the greatest road blocks in manufacturing and inspection departments for decades.

- Utilization of QIF can allow seamless usage of the same engineering, quality planning, inspection results, SPC analysis from the same authoritative model.

Affordability

- QIF was developed and from the initial concept has meant to be a free standard. What's more affordable than free.

- Drive your engineering to fully annotated models

- Transfer engineering to QIF MBD

- Follow the QIF workflow throughout your supply chain.

QIF in 2D Environment

- Many organizations don't have fully authoritative models, What can we do to utilize QIF

- Need to find multiple organizations willing to develop a 2D solution and test reading in and writing out 2D QIF files to be used as the authoritative model.

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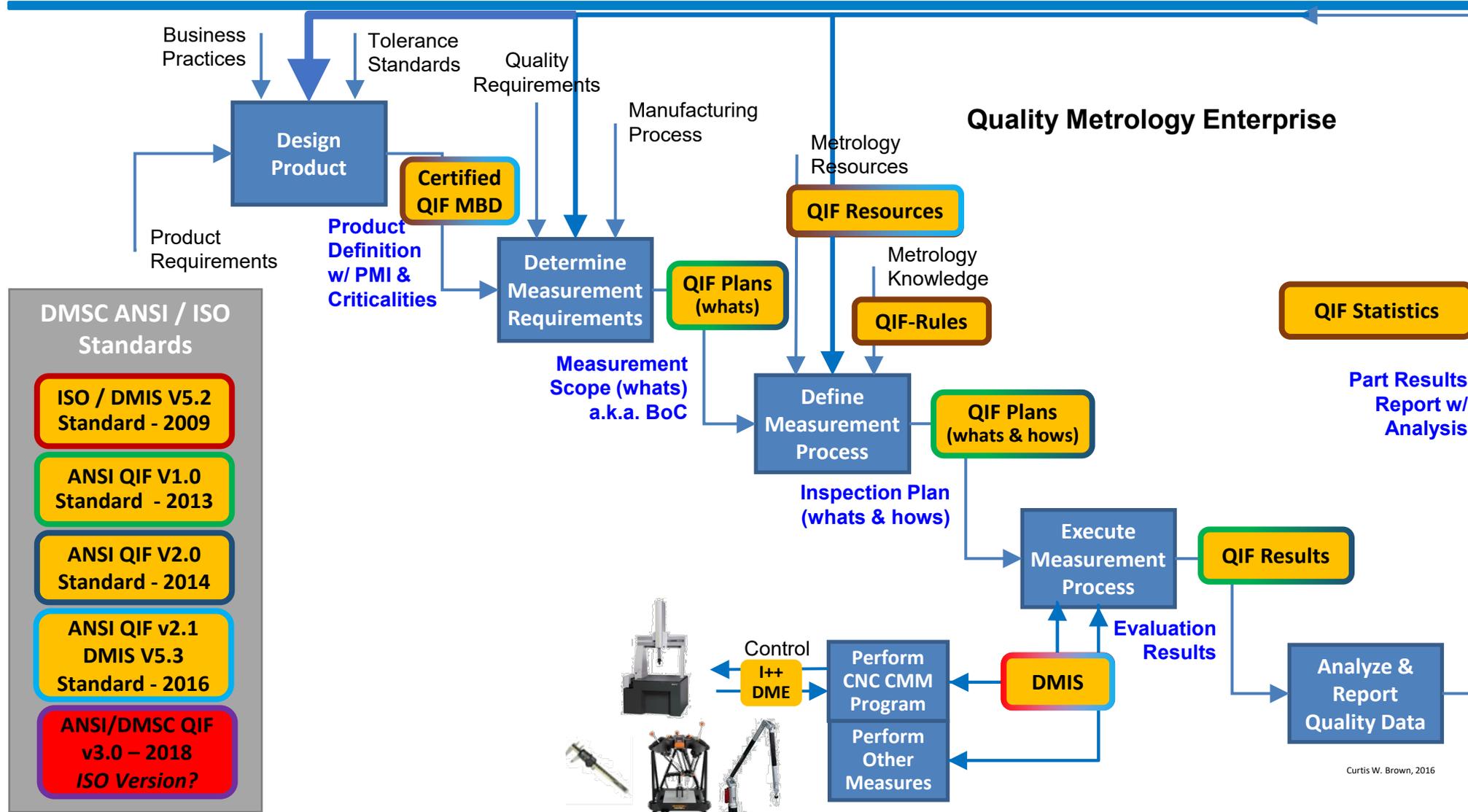*Standards Consortium*

DMSC's Quality Standards Pedigree
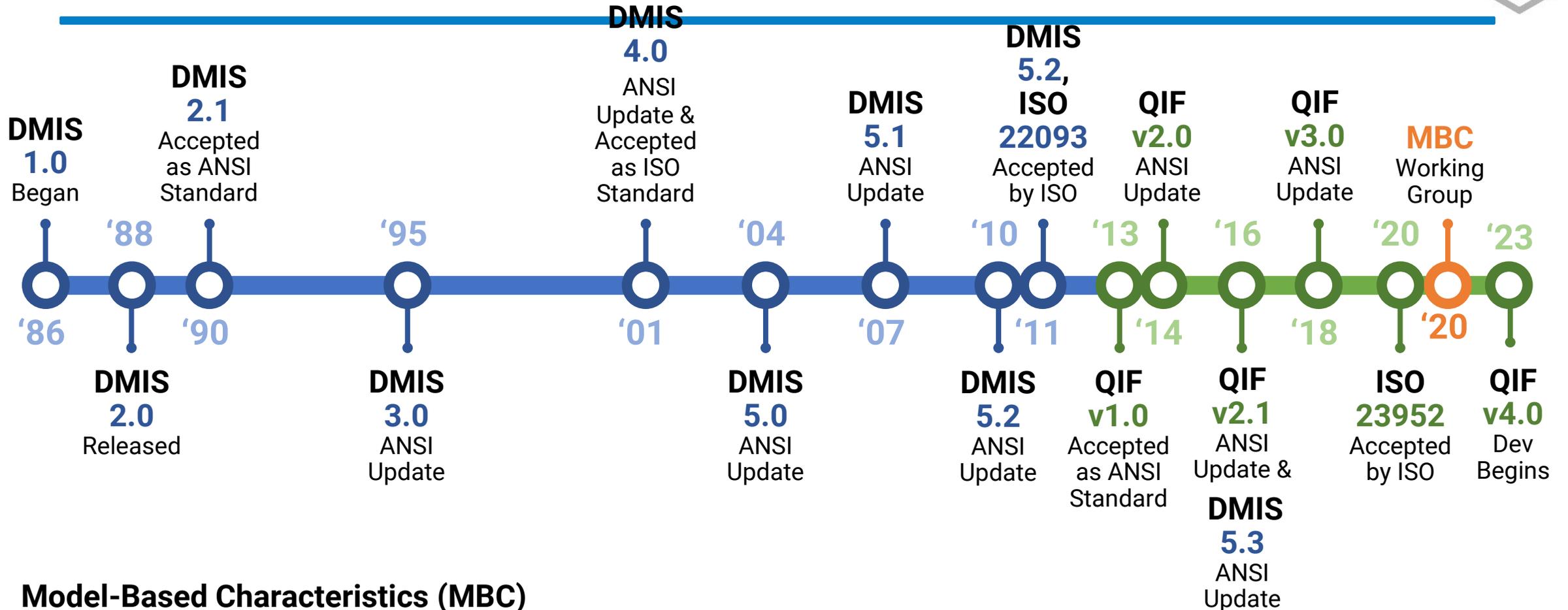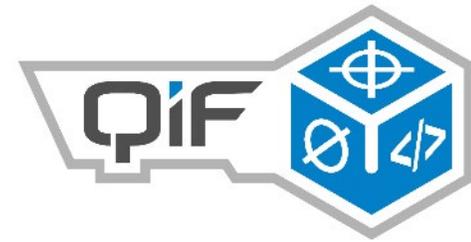
Model-Based Characteristics (MBC)

Quality Information Framework (QIF)

Dimensional Measuring Interface Standard (DMIS)

ISO 22093:2011 – Industrial automation systems and integration – Physical device control – Dimensional Measuring Interface Standard (DMIS)

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Quality Information Activity Workflow

Quality Metrology Enterprise

Business Practices

Tolerance Standards

Quality Requirements

Manufacturing Process

Metrology Resources

Design Product

Certified QIF MBD

QIF Resources

Product Requirements

Product Definition w/ PMI & Criticalities

Determine Measurement Requirements

QIF Plans (whats)

Metrology Knowledge

QIF-Rules

QIF Statistics

DMSC ANSI / ISO Standards

Measurement Scope (whats) a.k.a. BoC

Define Measurement Process

QIF Plans (whats & hows)

Part Results Report w/ Analysis

ISO / DMIS V5.2 Standard - 2009

ANSI QIF V1.0 Standard - 2013

ANSI QIF V2.0 Standard - 2014

Inspection Plan (whats & hows)

Execute Measurement Process

QIF Results

ANSI QIF v2.1 DMIS V5.3 Standard - 2016

ANSI/DMSC QIF v3.0 – 2018 *ISO Version?*

Control

I++ DME

Perform CNC CMM Program

DMIS

Evaluation Results

Analyze & Report Quality Data

**Perform Other Measures**

Curtis W. Brown, 2016

Why good engineering data is key

Almost all information in the workflow builds off of the product definition.

Engineering data that is clean and semantic is essential for the rest of the work flow to work.

Through the use of persistent IDs this will also allow for the linking of Quality data back to design and manufacturing data.

This is the first bridge we need to cross.
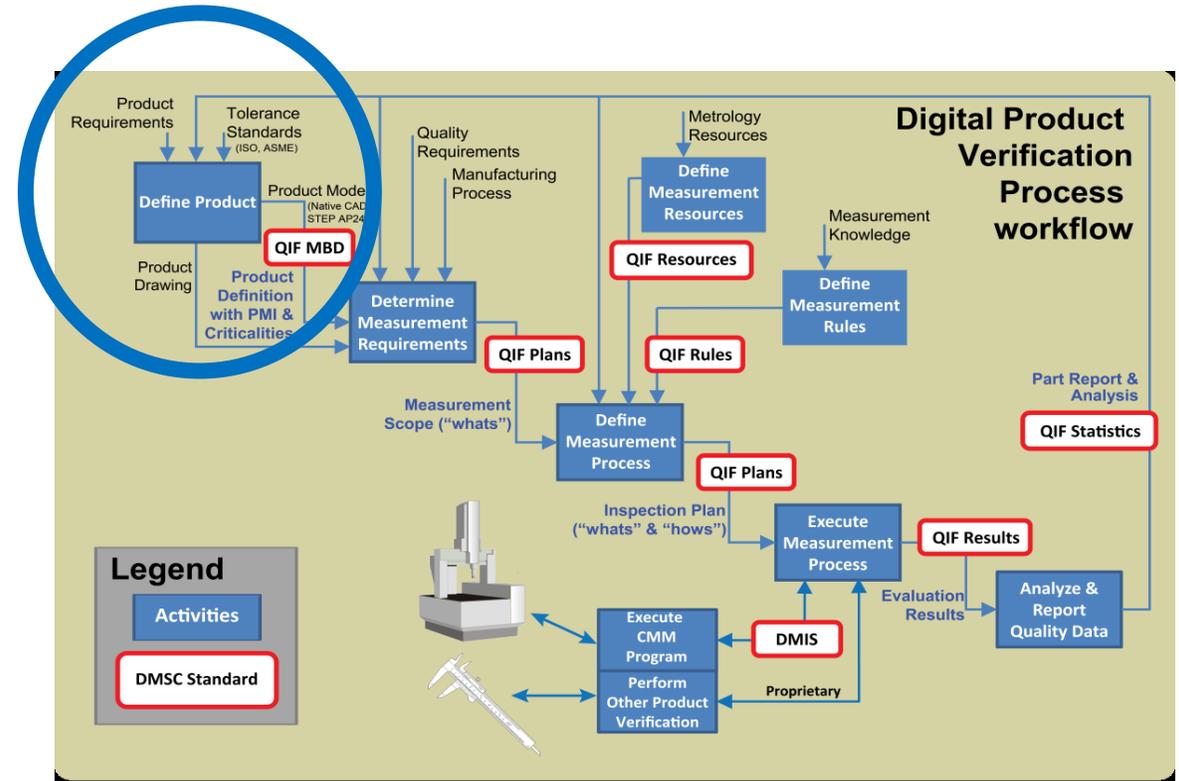
Digital Threads

Threads can be quickly navigated to pull in additional relevant data.

- In what direction was the feature off?
- What was our inspection strategy?
- What tool was used? Did it pass calibration?

Allows for bigger questions, data can be queried.

- What are all the features and parts that this tool was used to inspect?
- Have any tools been used outside their calibration window?
- What is the most common measurement strategy we use for this type of feature?

Threads can be tied together, persistent IDs can be used to tie in Quality data with data from design and manufacturing.

- What tool was used to fabricate the feature? What other features did this tool fabricate? Is it trending?
- Was the feature revised? Does the revision correlate to a change in producibility?

Enables machine learning / AI due to data being machine consumable.

Model-Based Characteristics

- Nomenclature,
- Definitions,
- Designations,
- Symbols,
- Data Structures, and
- Practices for Product Definition
- Augmentations
- Includes Model-Based Definition with Persistent Identification
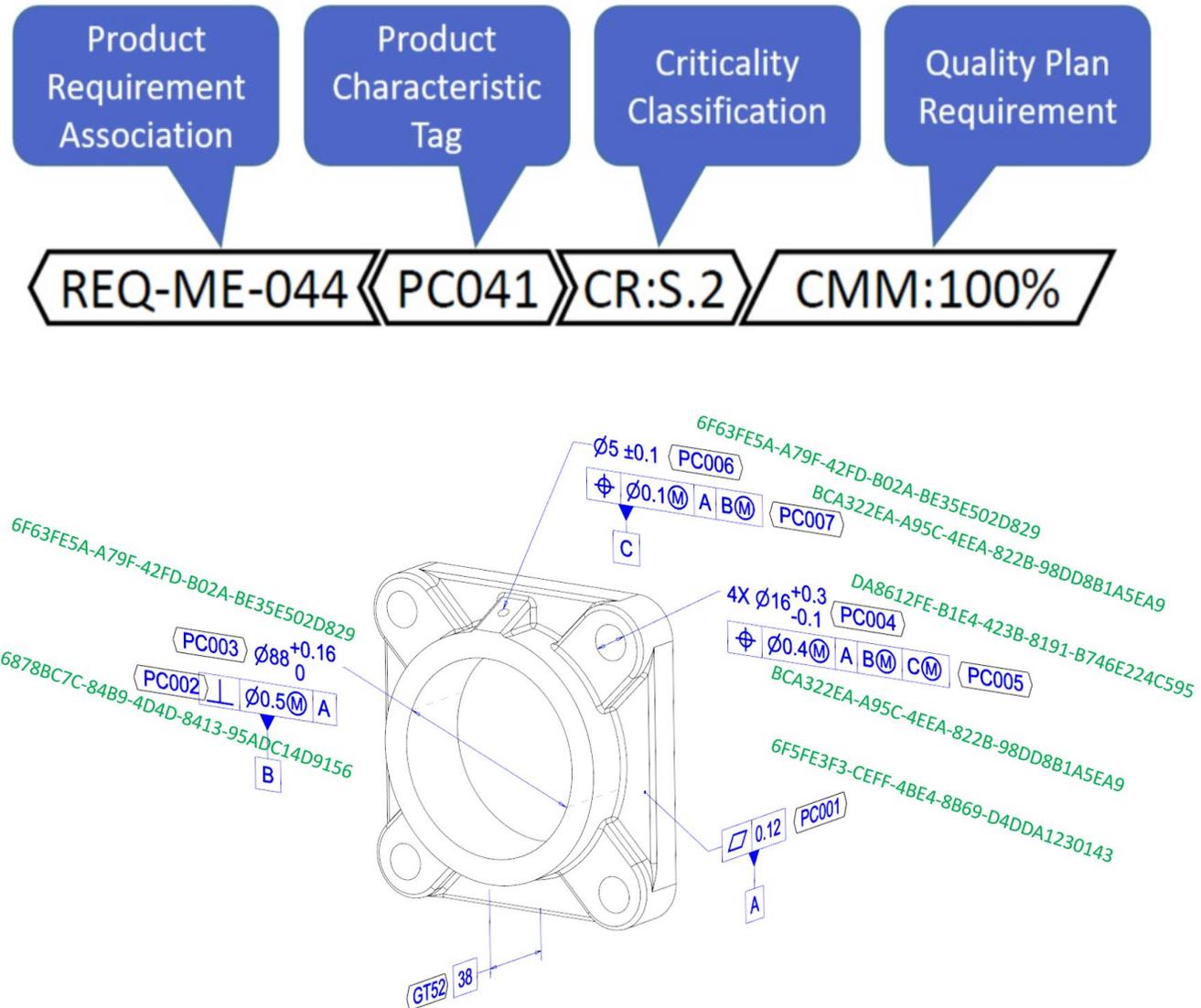
My Prediction

- QIF will allow Metrology systems to automatically create measurement and test plans

- QIF will allow auto-creation of:
  - PPAP (Production Part Approval Process)
  - FAI (A9102 – First Article Inspection)
  - Failure Mode and Effects Analysis (FMEA)

- QIF will provide the "Moneyball" type data for manufacturing/quality systems that gives the knowledge to make breakthrough decisions
  - "Anybody who's not using QIF throughout the supply chain, will be dinosaurs."

- Everyone is part of the problem or solution