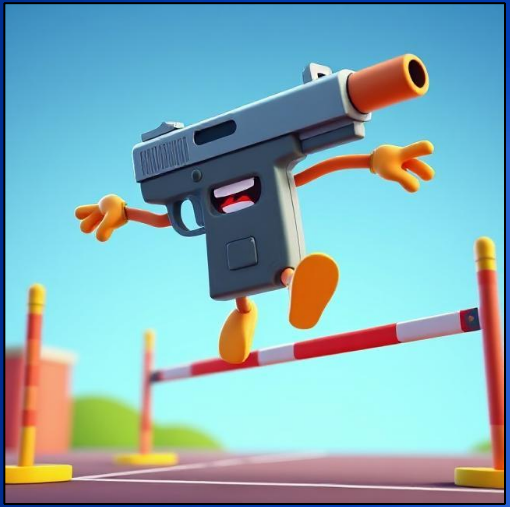
Why digital manufacturing needs to jump the gun



A Quality and QIF perspective

Sam Gambrell
Lockheed Martin, Quality Engineer

GLOBAL PRODUCT DATA
INTEROPERABILITY
SUMMIT 2025

Who is this guy?

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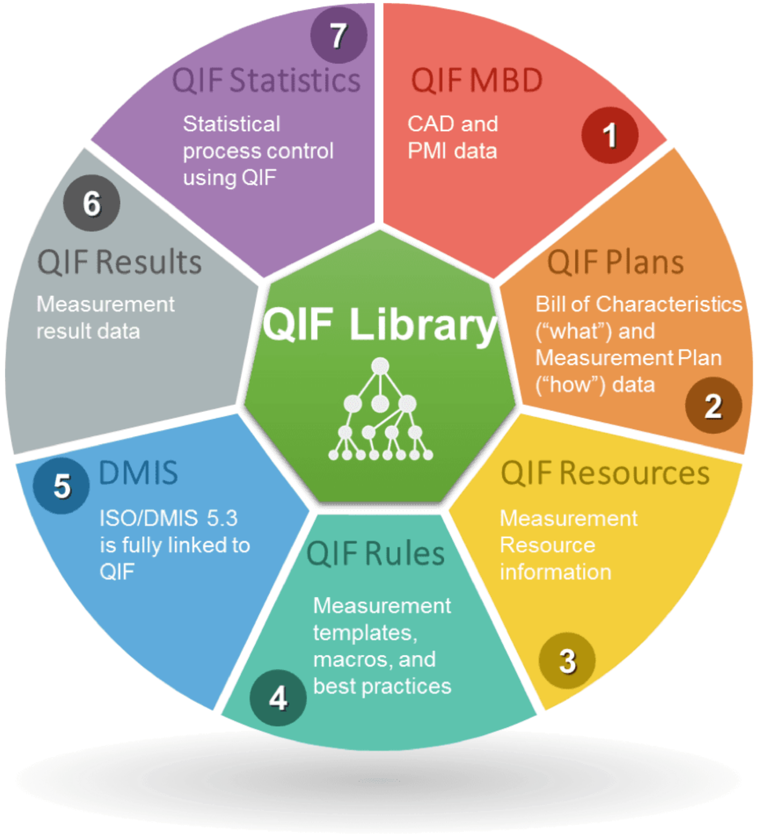
Sam Gambrell is a Quality Project Engineer and has been with Lockheed Martin Rotary and Mission Systems for 19 years. He is working on digital transformation initiatives that will positively impact the quality organization. His primary focus is on how the data we generate, from engineering requirements to shop floor inspections, can be used to improve the quality workflow while also providing information that can be used for data analytics. He is actively involved in the adoption of the Quality Information Framework (QIF) standard at Lockheed Martin along with the development of QIF 4.0 as a Director of the Digital Metrology Standards Consortium

Previously on Model Based Enterprise …

- **Industry 4.0 – cyber physical systems, internet of things, networks**
- **Quality Information Framework (QIF) – model-based language with a strong focus on GD&T and inspection workflow**
- **QIF in the wild – strong adoption of QIF MBD from key metrology software vendors, still struggles with interoperability**

- **Is QIF the end all be all?**
  - **No, but it's a great place to start**
- **Is a cradle to grave QIF workflow ready to be deployed?**
  - **No, but that shouldn't stop us**



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The data on data

- **Machine consumable allows automation**
  - **Clean data doesn’t require manual intervention**
  - **Ride the wave of Engineering MBD**
- **Good data has multiple uses**
  - **Don’t prematurely truncate information to support a single use case**
  - **"The only unitasker allowed in my kitchen is a fire extinguisher“ – Alton Brown**
- **Who are the Data Consumers**
  - **Cost of entry limits consumption to questions identified as high value, effort VS output**
  - **Expanding access, EX: Access to automobiles allowed easier moment for more people**

DATA 1010100010001000
0010101010001000000100
1000000011000100110000
0011000100111010001000
0001010100011010000110
01010010000000110010000
1100001011101000110000
1001000000110111101101
1100010000001100100011
000010111010001100001

Two Roads Diverged in a Yellow Wood

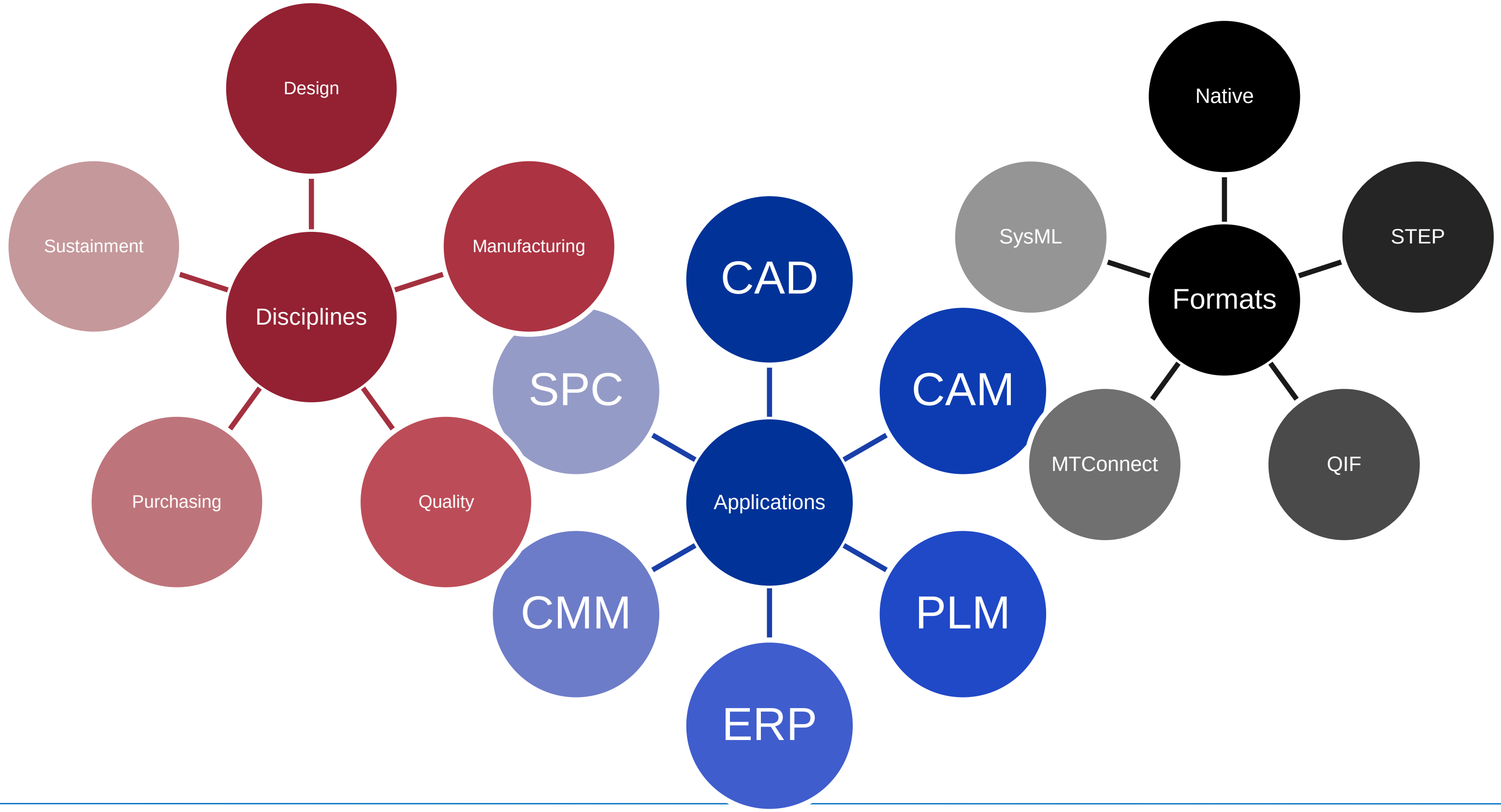
Advocate *caution*. Be *reasonable* and urge your fellow-conferees to be *reasonable* and avoid haste which might result in embarrassments or difficulties later on.
-Simple Sabotage Field Manual, CIA

We have arrived at a stage in digital manufacturing where the theorists are running out of things to talk about while operations wait for a turnkey solution to be dropped in their laps. The concepts must be put into practice if we wish to continue to develop digital manufacturing.

If a thing is worth doing, it's worth doing badly.
- G.K. Chesterton

Why not just fix everything before we use it?

The digital thread is long, complex, and fragile. A single breakage can sever the entire thread.



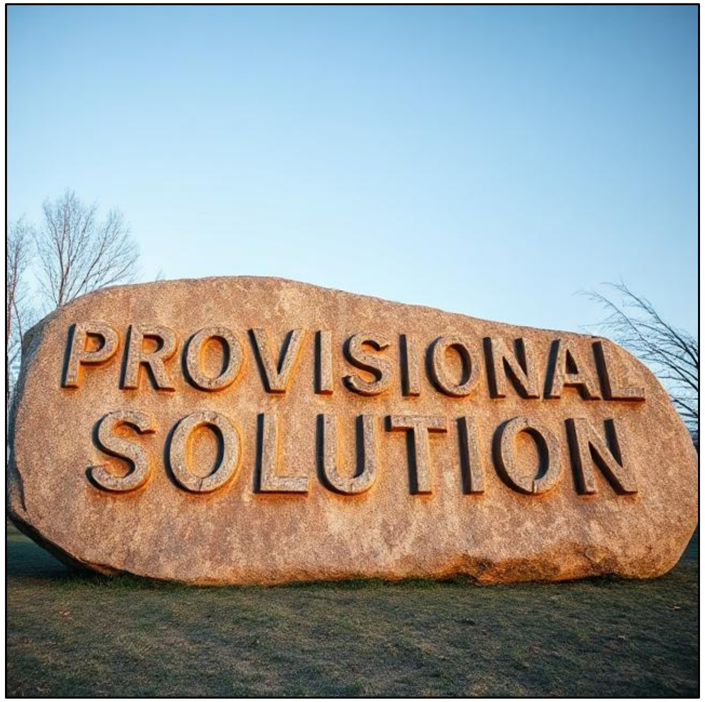
"There are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns—the ones we don't know we don't know."

- Donald Rumsfeld

Iterative VS Big Bang Approaches

- **Software accomplished iterative with an Agile approach**

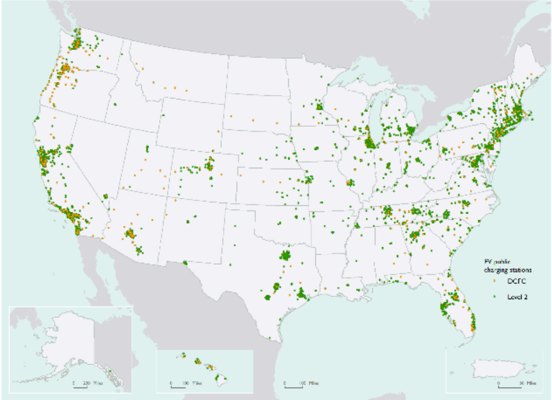
- **Hardware is harder but not impossible**
  - **Aircraft Modernization**
    - **22 different models of the 737, 12 variants of the C-130, 5 variants of the AA-5**
  - **Automotive Over The Air Updates**
    - **Audi, BMW, Ford, General Motors, Honda, Hyundai, Jaguar/Land Rover, Lucid, Mercedes-Benz, Nissan, Polestar, Porsche, Rivian, Stellantis, Tesla, Toyota, Volkswagen, Volvo**
  - **Airworthiness Directives & Vehicle Recalls**
    - **Products in the field are not immune from change when safety is involved**



Reaching Critical Mass – come on in, the water’s fine

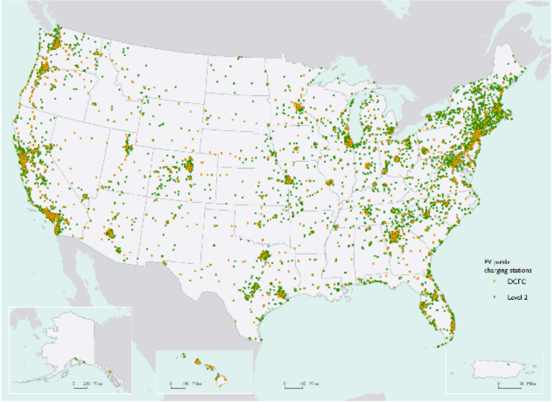
- **Getting past the *chicken or egg***
- **Software vendors react to supplier demand**
- **More software options provide easier entry**
- **More end users means more feedback, fewer unknown unknowns**
- **Benefits manufacturing supply base when in wide use, not just a one off**

Electric Vehicle Public Charging Stations in the United States: 2014



NOTES: DCFC—Direct current fast chargers refers to the voltage that the electric vehicle charger uses (3-phase 480-volt AC electric circuit but delivers direct current (DC) to the vehicle volts). Generally, runs 60-80 miles of driving range per hour of charge. Level 2—Level 2 charging refers to the voltage that the electric vehicle charger uses (240 volts). Generally, runs 10-20 miles of driving range per hour of charge.
SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Atlas Database (NTAD). Alternative Fueling Stations dataset based on Alternative Fuels Data Center, available at https://data-usdot.opendata.arcgis.com/datasets/alternative-fueling-stations as of January 2020.

Electric Vehicle Public Charging Stations in the United States: 2019



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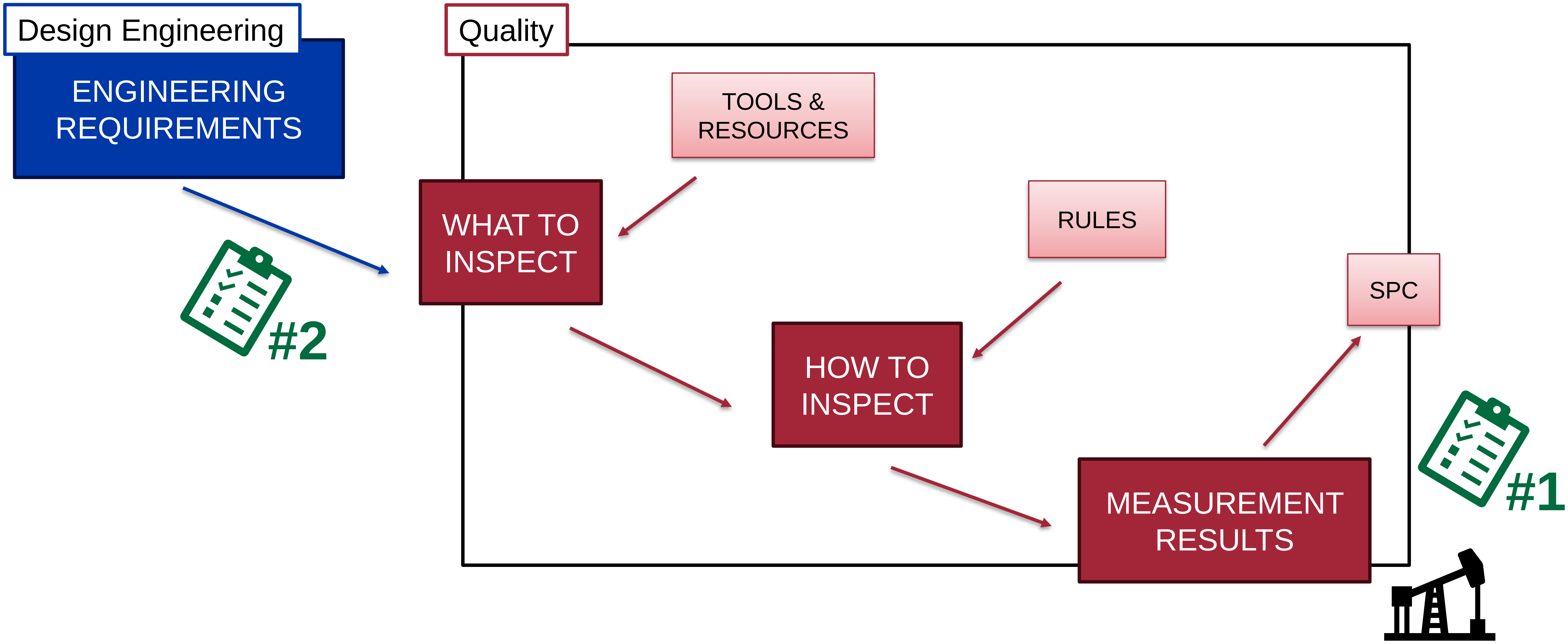
Small Wins Today, Big Wins Tomorrow

- **Immediate Benefits From Partial Implementations**
  - **FAI Form Generation**
  - **PMI import for CMM programming**
  - **3D and Interactive Results**

- **Future Benefits From Early Implementation**
  - **Foundation for Full MBE Workflows**
    - **Ready for Engineering MBD**
  - **Start Building Historical Data**
    - **Feed AI/ML & Digital Twins**
  - **Opportunities for Digitalization**
    - **From FAI Forms to FAI Process**

Focus on Qualities Value Added First, Not on Qualities Needs



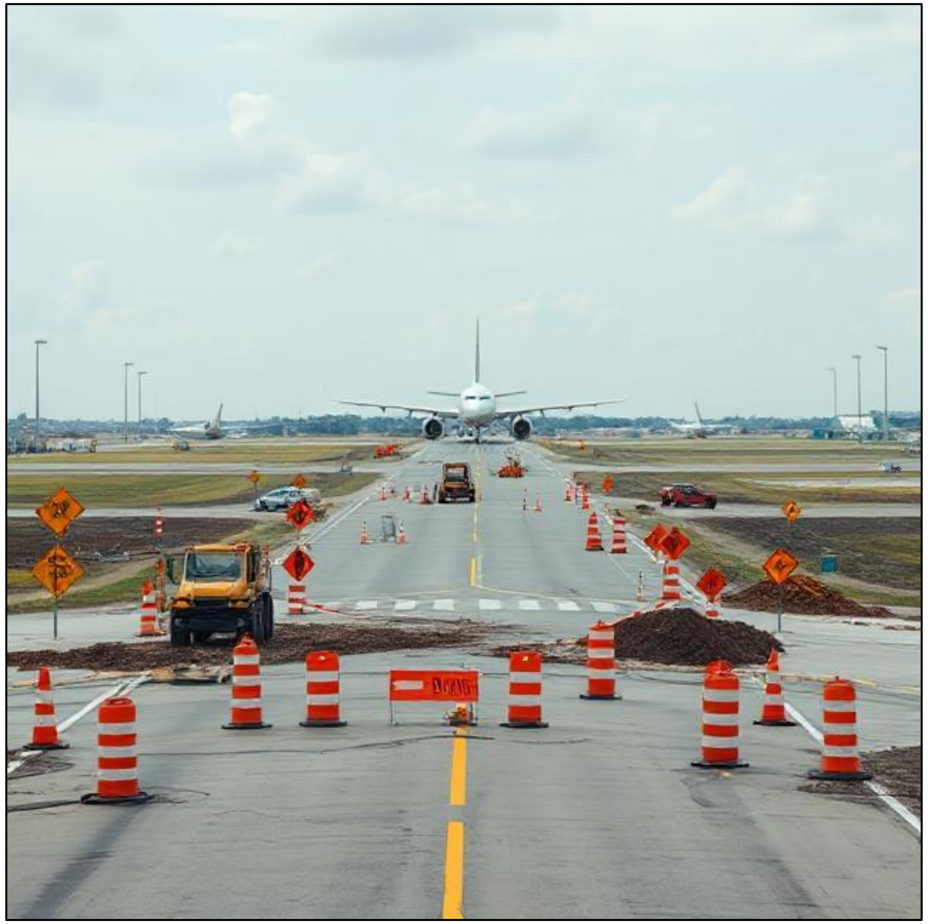
Building the Quality Digital Workflow

- **How does one implement an incomplete workflow**
  - **Build it first, then find work arounds**

- **On Ramp – Engineering data not semantic**
  - **Quality can create a semantic model that will emulate the expected deliverables from design**
  - **Allows us to start pushing this part of the process left**

- **Off Ramp – Limited solutions exist for viewing an analysing QIF results**
  - **Propritary formats current allow some capability of this, create an off ramp to convert QIF to the needed formats**

- **Detour – How will suppliers make use of MBD**
  - **Working to ensure data is consumable internally before brining in external parties**



Next Steps for QIF Adoption

- **DMSC – make sure QIF is universal**
  - **QIF Implementers Forum**
  - **QIF Best Practices**
- **Software Vendors**
  - **QIF Result Viewer**
  - **Better troubleshooting**
- **OEMs**
  - **Start test driving, report back issues and opportunities**
  - **Make data available internally, Discover new use cases**
  - **Uses with external parties, customer and suppliers**

End of the Line

Questions?