Enabling MBD in Aerospace Part Supplier Systems

Rapid Expansion of High QA Manufacturing Quality Management Software to Support Model-Based Definition Inspection Planning in a Web Environment

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GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2024

BOEING ELYSIUM NORTHROP GRUMMAN Parker PDES, Inc.® Connecting the Digital Enterprise

Presenters Bio

John Wright McCullough

General Manager Marketing, Kubotek Kosmos

- **BSME, started in MCAD in the DOS era**
- **Experience**
  - **Baystate Technologies - Software Developer**
  - **CADKEY – Reseller Channel Management**
  - **Kubotek – Product Management**
  - **Onshape – Quality Assurance**

Kubotek Kosmos

Modeling & Translation Kernel ::: 3D Framework

Cloud-ready, high-performance 3D geometry kernel licensed to other specialized engineering developers

MBD / CAD File Utilities

Specialized multi-device utilities focused on aerospace manufacturing, MBD workflows (built on Framework)

Direct CAD ::: KeyCreator

Full professional CAD favored in manufacturing & concept design settings (Framework translators)

Presentation Outline

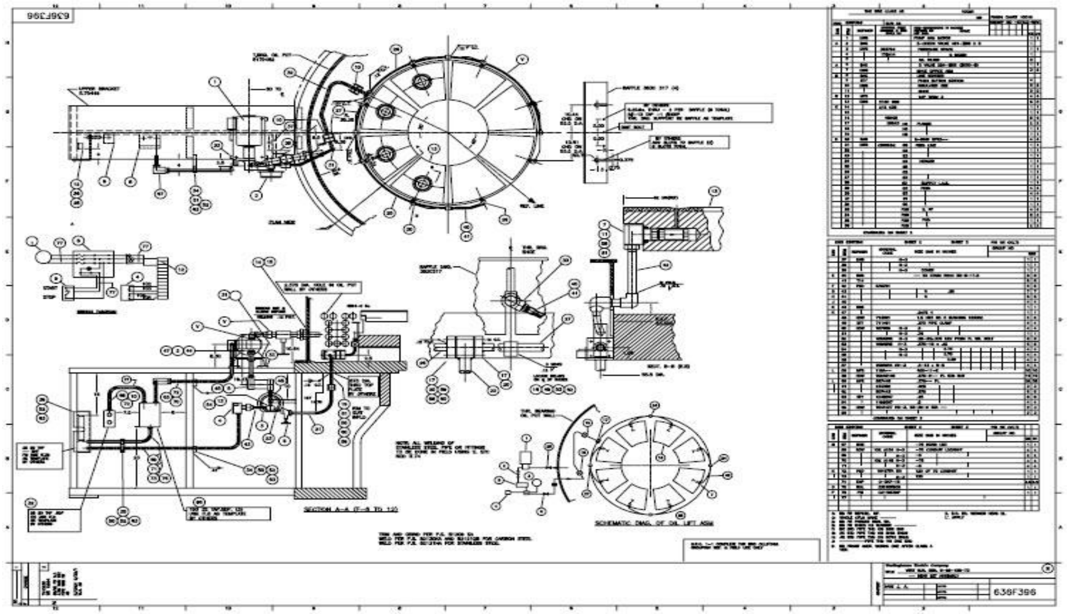
- **Context**
- **Objective**
- **Methods**
- **Results**

Context Section

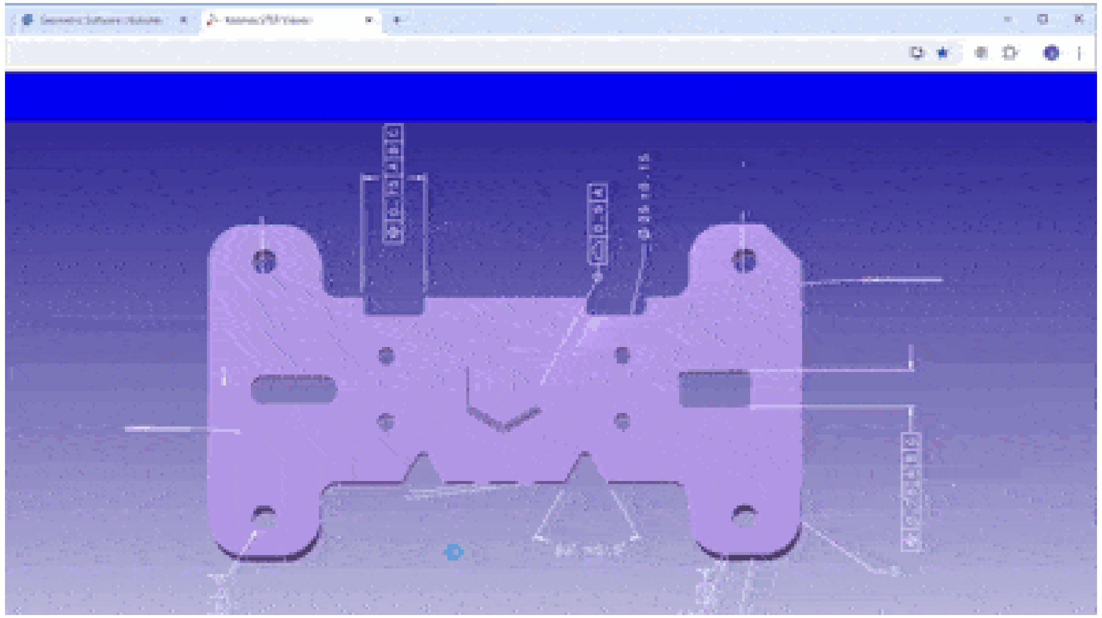
- **Context**

Unambiguous Product Definition

Drawing



MBD



Product Definition Differences

Drawing

- Physical & digital
- Structured for human readability
  - All key measurements called out
  - Breaks digital thread
- Since ~5,000 BCE

MBD

- Digital (digital twin)
- Structured for machine readability
  - B-Rep precise nominal model
  - Maintains digital thread
- Human readable with software*
- Since ~2,000 CE

Why Use MBD?

- **Efficiently share critical data across teams/systems**
  - **Digitally connect the "enterprise" (break down silos)**
    - **Increase traceability of results**
      - **As-built, As-processed and As-tested**
    - **Support AI**
  - **Reduce human interpretation**
- **Reduce Errors**
  - **Manual data re-entry errors**
  - **Errors in understanding**
- **Eliminate 3D->2D conversion documentation**
  - **Out-of-sync errors**
  - **Communication delay**
  - **Time investment**

MBD Use by Manufacturing Industry

- **Aerospace & Defense**
- **Automotive**
- **Agriculture**
- **Medical Device**
- **Computer/Electrical**
- **Appliances**
- **Machinery**
- **Metals**
- **Plastics**

DOD Data Strategy

"DoD is a data-centric organization that uses data at speed and scale for operational advantage and increased efficiency"

- **Guiding Principles**
  - **Enterprise-Wide Data Access and Availability- "available for use by all authorized individuals" [CLOUD]**
  - **Data for Artificial Intelligence Training – "increasingly become the DoD's most valuable digital assets" [MBD]**
  - **Data Fit for Purpose – "minimization of any sources of unintended bias" [STANDARDS]**
  - **Design for Compliance – "maintain end-to-end records management"- [STANDARDS, PLM, LOTAR]**
- **Standards**
  - **"standards should be applied at the earliest practical point in the data lifecycle"**
  - **"industry standards for an open data architecture should be used wherever practical"**
  - **"enabling data and information to be readily and securely utilized and exchanged" [STEP]**
- **Goals**
  - **Make data understandable, interoperable**
  - **"DoD utilizes a common data syntax for the same data types and includes semantic metadata with data assets" [XML?]**

DOD Competition Strategy

"When markets are competitive, the Department reaps the benefits through improved cost, schedule, and performance for the products and services needed to support national defense."

- **Seeking expansion of small business participation**
  - **A rating from Small Business Administration**
  - **Procurement Technical Assistance Program**
- **Modular open systems architecture (MOSA)**
- **Federal Acquisition Streamlining Act (FASA)**
  - **Commercial off the Shelf**

DOD Digital Engineering Instruction 5000.97

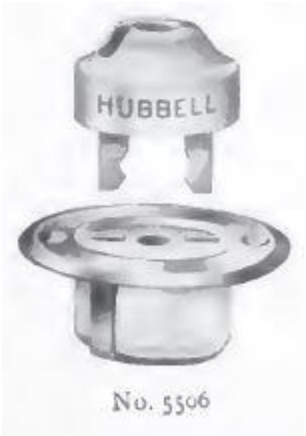
"Digital models become ubiquitous and central to how engineering activities are performed."

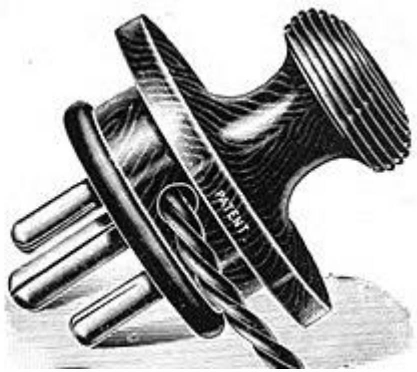
- **Digital Model Requirements**
  - **Maximize interoperability**
  - **Existing modeling standards and approaches**
  - **Accurate, complete, trusted, and reusable**
- **Model Type Examples**
  - **Requirements, Structural, Functional**
  - **Business process, Architecture, Enterprise**
  - **Physics-based, Human performance**
  - **Threat, Product life cycle**

Lockheed Martin’s MBE Playbook for Suppliers

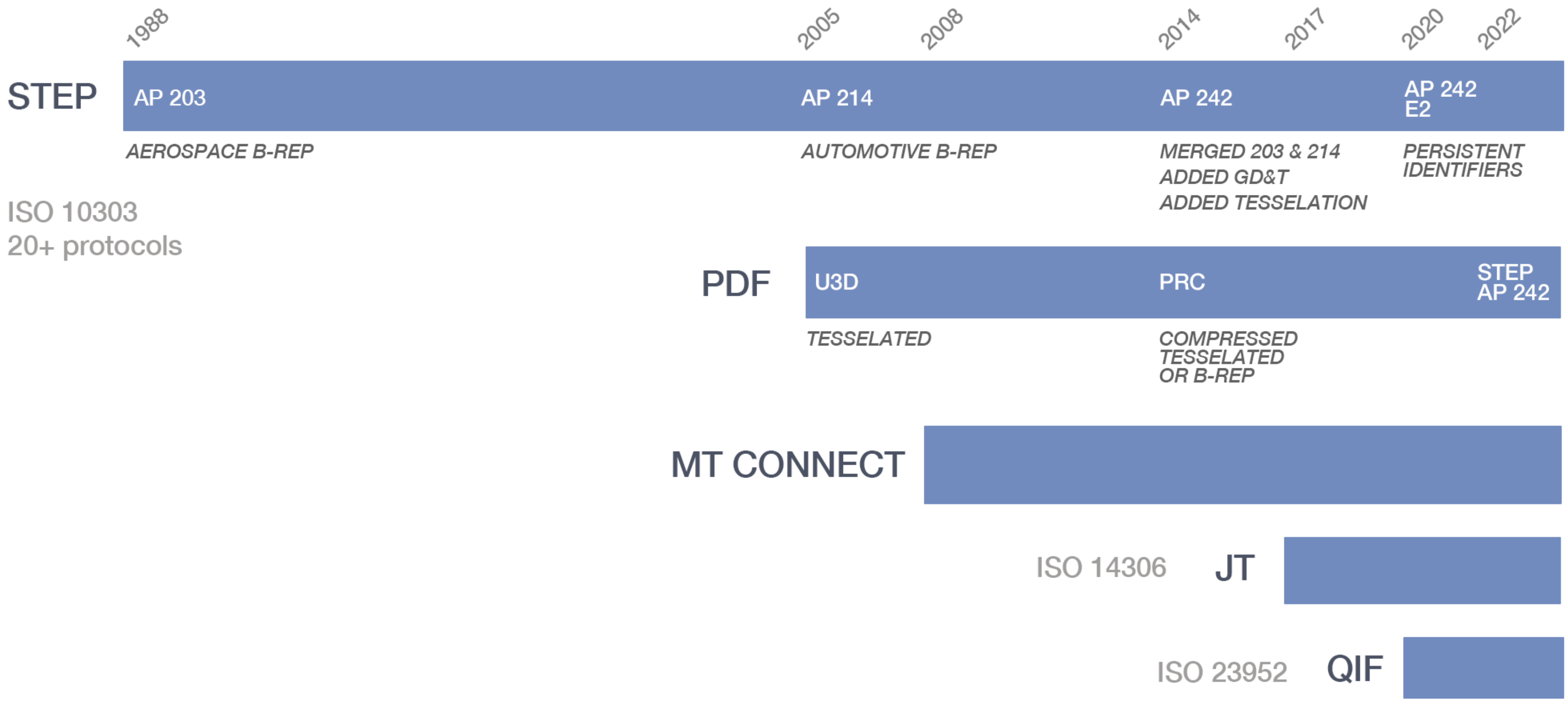
- **“Incredible potential to produce quality products faster and more affordably”**
  - **75%-90% time savings on programing machining and inspection**
  - **2-3x faster design and engineering**
  - **Automated First Article Inspection reporting (AS9102 forms)**
- **1st edition published in late 2023, a 5-year transition plan**
  - **Readiness surveys showed many suppliers will still create drawings for mfg/inspection**
  - **Legacy programs may operate as partial MBE**
  - **Non-MBD suppliers will be at competitive disadvantage**
  - **MBE needed to “continue to secure work on future USG DOD programs”**
- **File Formats**
  - **Driving model files toward STEP AP242 and 3D PDF**
  - **Data sets expected with physical parts**
    - **QIF is preferred format for As-Tested data**
    - **MTConnect for As-Processed data**

Why So Many "Standards"!?





Timeline of 3D Standards for Engineering/Manufacturing



MBD Contents

- **Boundary representation geometric model (B-rep)**
  - **Precise 3D solids and surfaces**
- **Tolerance annotations**
  - **ASME Y14.5 or ISO GPS**
- **Manufacturing instruction notes**
- **Metadata**
  - **Material properties, etc.**

Commercial & Standard B-Rep Databases

Organization	Database	File Format	Broad CAD Support	Full MBD	Published Standard
Dassault Systemes	*CATIA V4 (2011)*				
	CGM				
	ACIS	SAT	X		
Siemens	Parasolid	X_T	X		
PTC	Granite	G			
Autodesk	ShapeManager	SMT			
Capgemini	Open Cascade	XDE		X	
Kubotek	Kosmos	KCM		X	
ISO	10303	STP	X	X	X
	14739	PRC			X
	23952	QIF		X	X

ISO/Siemens	JT Open/Parasolid	JT (X_T)	X	X	X*

Objective Section

- **Objective**

Networked MBD Inspection Planning

- **Read full MBD from STEP AP242 and major CAD formats**
- **Convert definition into inspection characteristics/operations**
- **Include clear graphics & annotations of each characteristic**
- **Link tightly to quality systems and teams**
- **Maintain digital thread associativity to MBD**
- **Output STEP to 3D PDF**
- **CMMC security compliance**

Aggressive Timeline

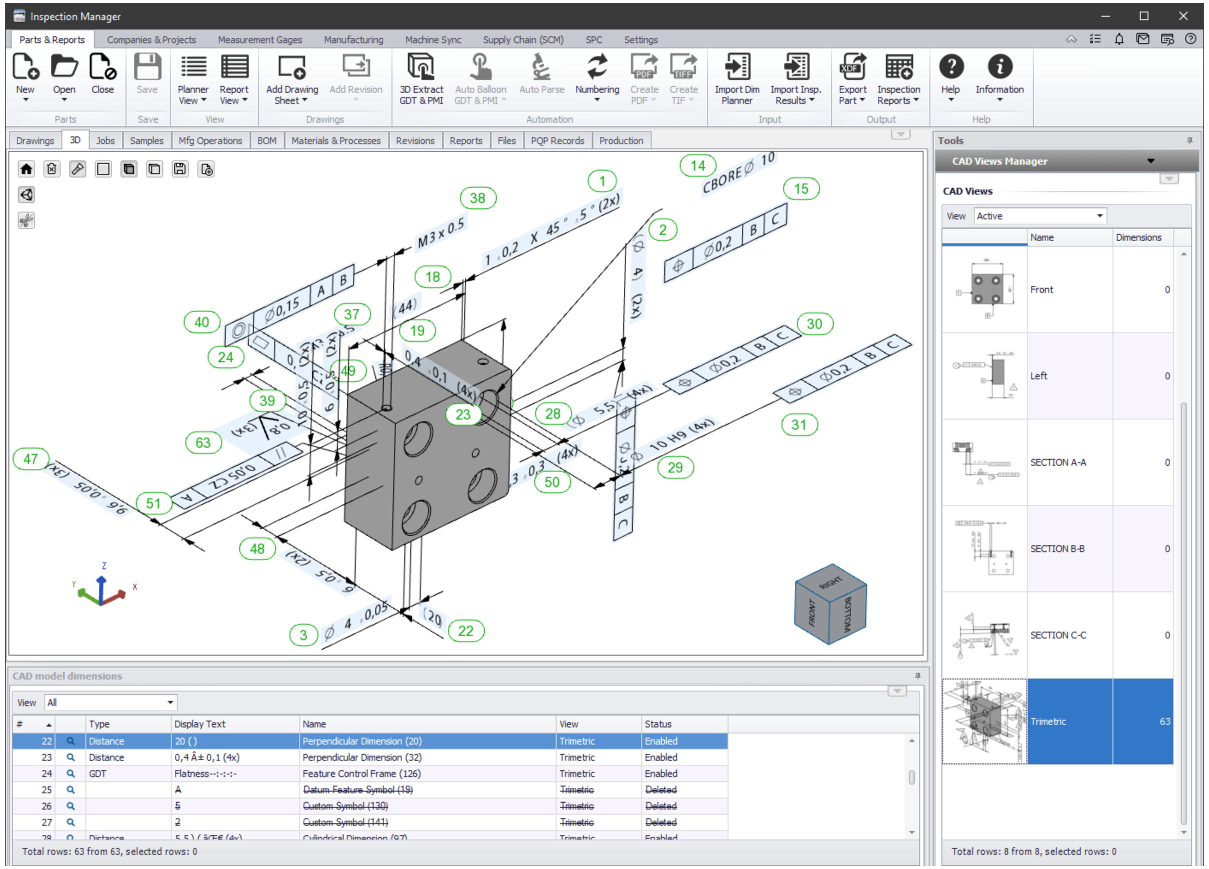
- **Project Start: July 2022**
- **Target Release: June 2024**

Methods Section

- **Methods**

Move HQA “Inspection Manager” to the Web

- **Centralize data with client-server architecture**
  - **On-premises or private server**
- **Support new platforms/devices**
- **Support value added changes to STEP data**



Utilize Kubotek Kosmos 3D Framework

- **Single API**
  - **Read MBD**
    - **STEP, CATIA, NX, Creo, SolidWorks**
  - **Geometric queries**
  - **WebGL display**
  - **Create views and reference geometry**
  - **Create and edit annotations**
  - **Write additions as STEP**
- **Performance**
  - **Small library footprint for client (WebAssembly)**
- **Support**
  - **Developer resource contracting**

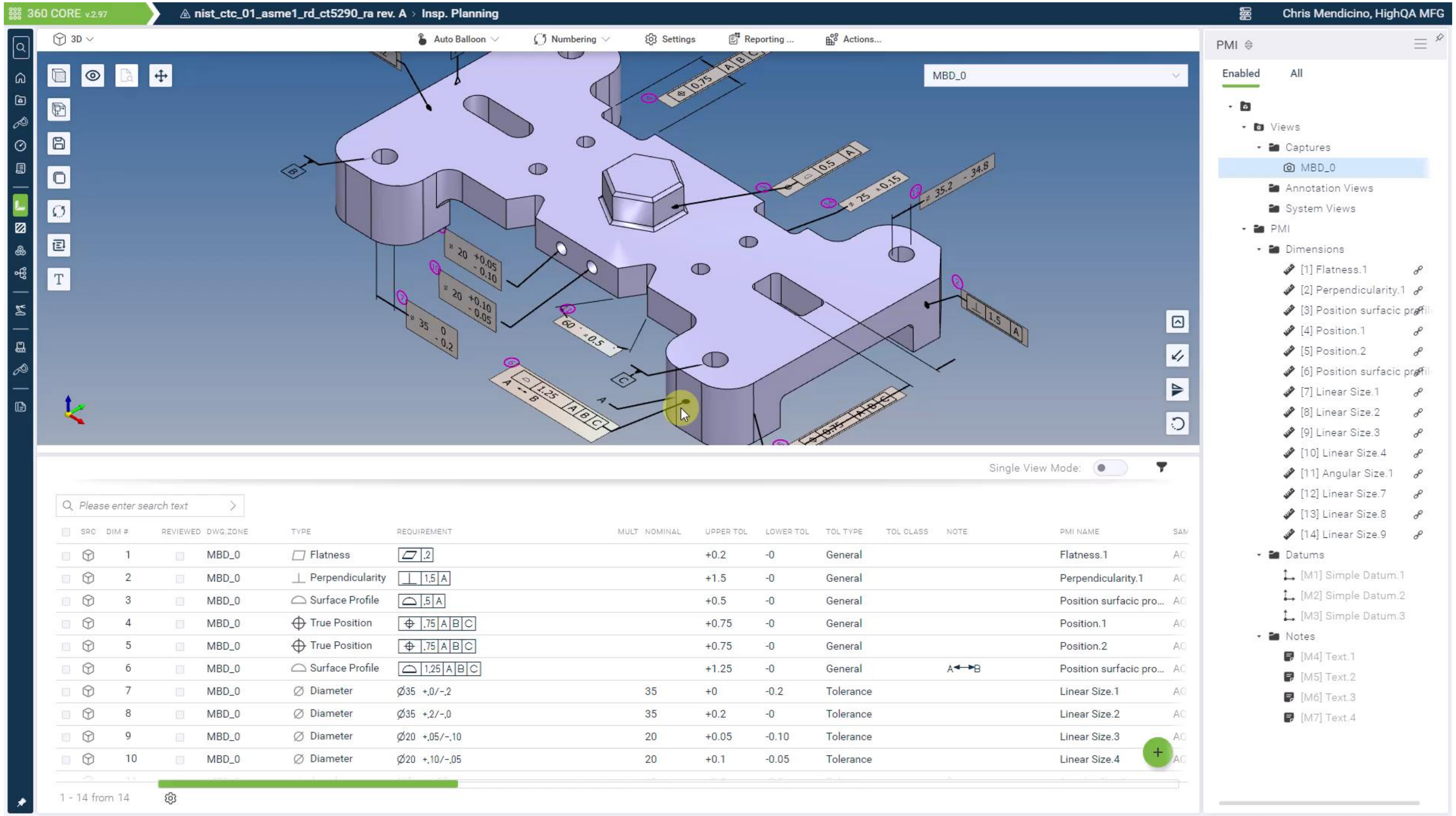
Results Section

- **Results**

Web Version of High QA 360 Core/Hub

- **Piloted with major aerospace & other industry OEMs**
- **Launched 2-weeks ago at IMTS 2024**
- **Converts MBD to Bill of Characteristics for supplier**
  - **Shared by Manufacturing and Quality**
  - **Universal ID for each feature**
- **3D Views provide drawing-type graphics**
  - **Preserves digital thread**
- **Web architecture provides real-time data connection**
  - **Visibility of supplier activity**
  - **Single source of truth**

Quick Demonstration of High QA MBD Web Interface



Front End for Complete High QA Solution

Lessons