GLOBAL PRODUCT DATA
INTEROPERABILITY
SUMMIT
2017

ELYSIUM   Parker Aerospace   NORTHROP GRUMMAN   BOEING

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Presentation Outline

- About CNC Machine Tools

- Traditional Data Connections

- Digital Thread Connections

- Use Cases for Digital Thread

- State of the Thread Segments

- Present/Future Efforts

- Conversation

Boeing

- **1984-1985** Electronics Technician, Rockwell, El Segundo
- **1985-1990** Maintenance Engineer, Rockwell, El Segundo
- **1990-2005** Controls Engineer, Rockwell/Boeing, Tulsa
- **2005-2017** CAD/CAM Development Boeing
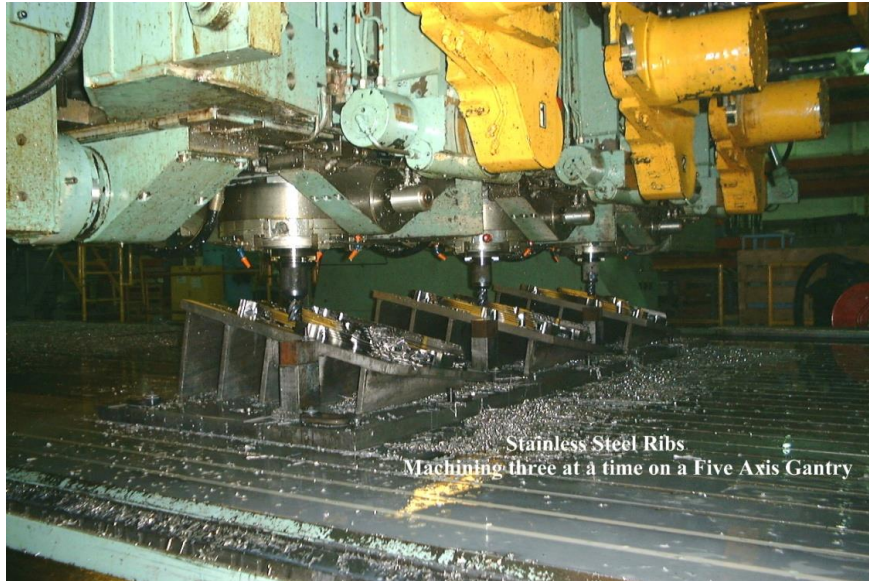- **2011** Associate Technical Fellow, Boeing

External

- ISO TC184/SC4/WG3 (STEP Manufacturing)
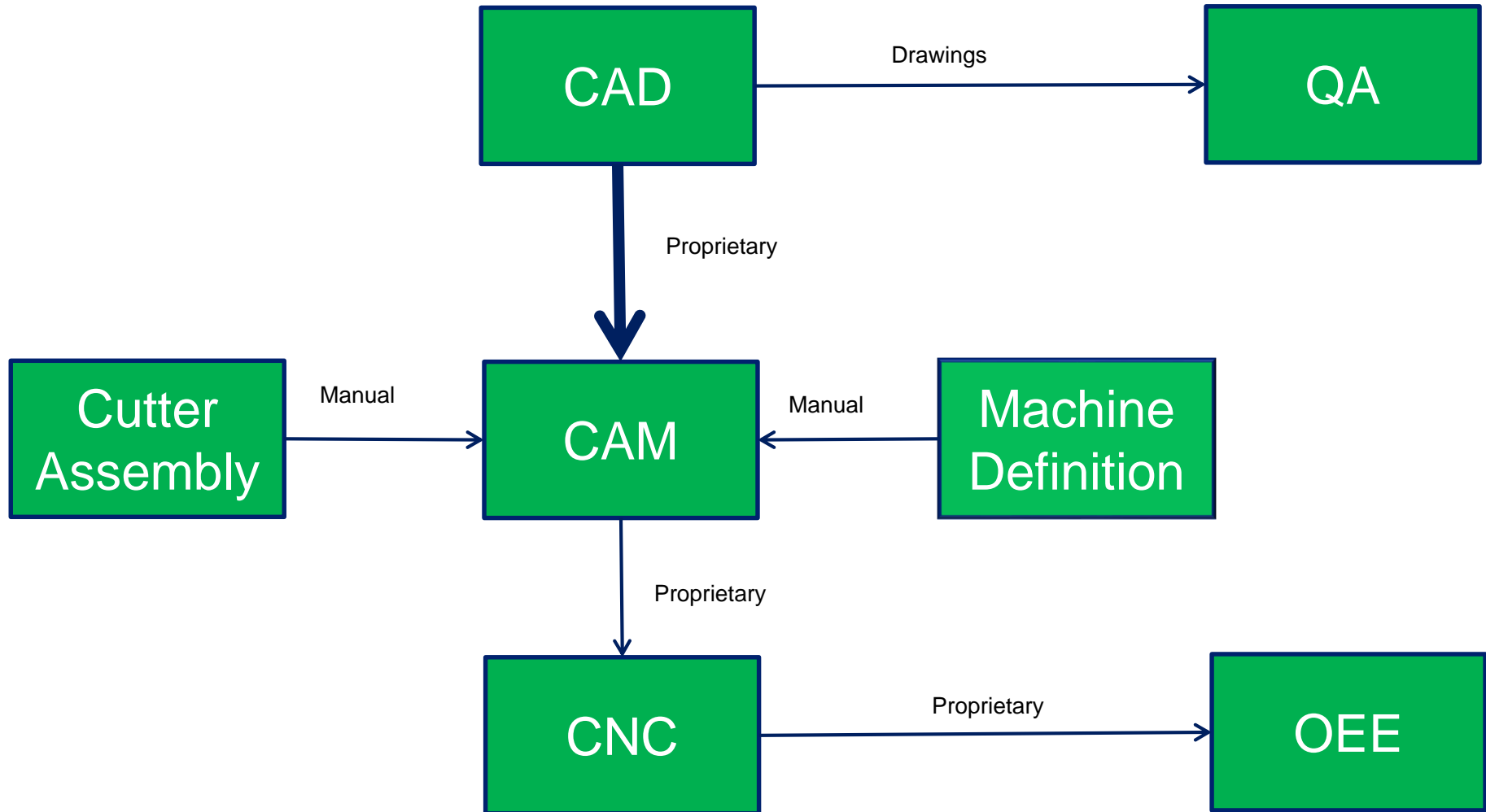- OMAC Machine Tool Workgroup

CNC Machine Tools

Stainless Steel Ribs
Machining three at a time on a Five Axis Gantry

- **Around since 1950s**
- **Ubiquitous in modern manufacturing**
- **Execute simple process data**

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Traditional Data Connections

```
                    ┌─────────┐      Drawings      ┌─────────┐
                    │   CAD   │ ─────────────────► │   QA    │
                    └────┬────┘                    └─────────┘
                         │
                    Proprietary
                         │
                         ▼
┌──────────┐  Manual  ┌─────────┐  Manual  ┌──────────────┐
│  Cutter  │ ───────► │   CAM   │ ◄─────── │   Machine    │
│ Assembly │          └────┬────┘          │  Definition  │
└──────────┘               │               └──────────────┘
                      Proprietary
                           │
                           ▼
                    ┌─────────┐  Proprietary  ┌─────────┐
                    │   CNC   │ ────────────► │   OEE   │
                    └─────────┘               └─────────┘
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Digital Thread Connections
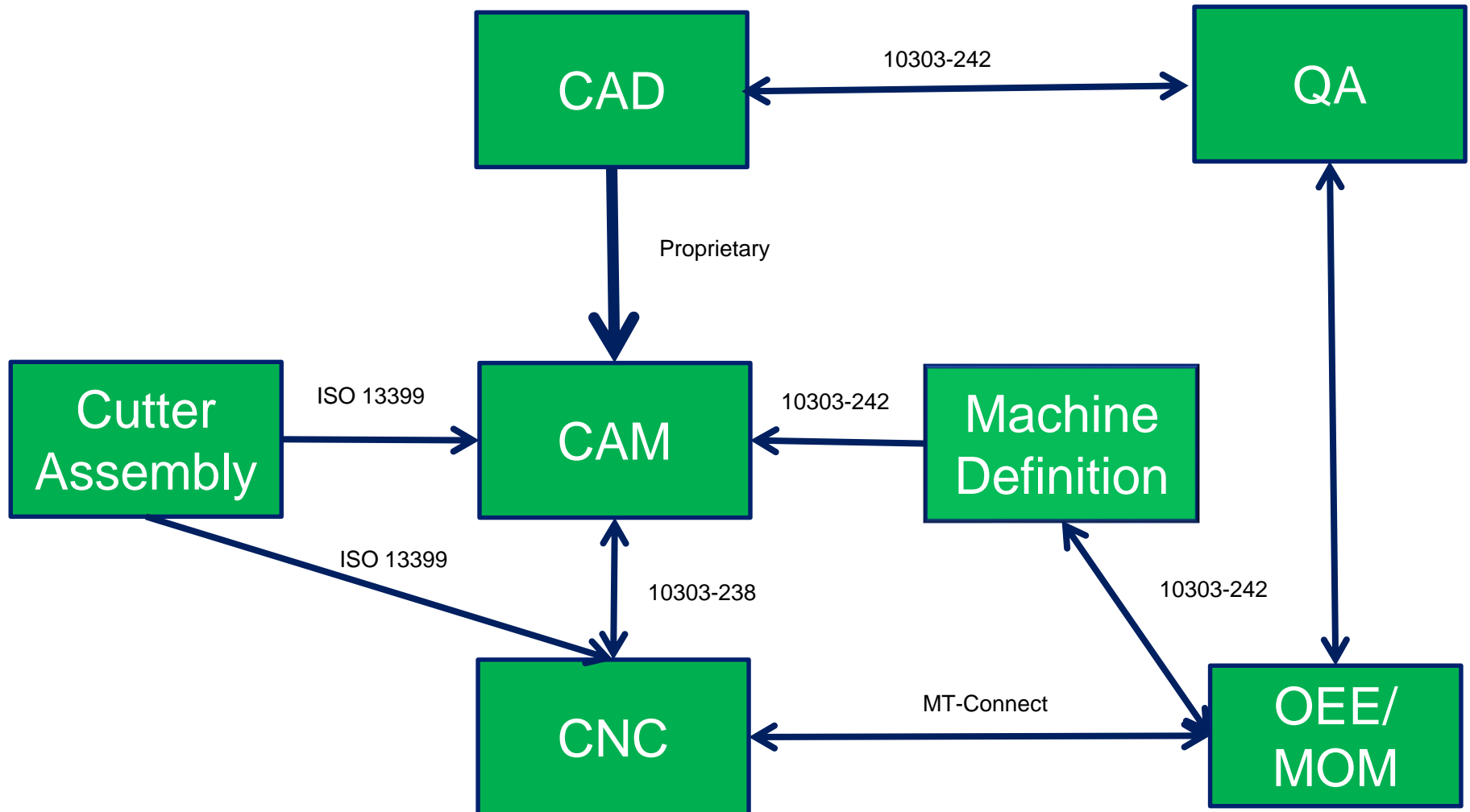
Use Case #1: CAM Data Exchange
(October 2014)

- Live demo at IMTS, Chicago

- CAD/CAM portability/optimization

- Benefits
  - Seamless sharing of CAD/CAM/CNC data
  - Optimized machining processes

- Thread Segments
  - CAD/CAM -> CNC   (STEP 242, 238)
  - Cutter Assembly -> CAM (ISO 13399)
  - CNC -> CAM MT-Connect

- Participants
  - STEP Tools, Boeing, Okuma, Sandvik Cormorant, Iscar

2. Export process as STEP-NC

OEM CAM

STEP-NC File

1. Base process developed by Boeing in CATIA V5

Cutter Supplier

Sandvik Iscar

Job shop

Machine Tool

STEP-NC File

3. Improved process and cutter recommendations generated in MasterCAM

5. Merge processes and machine

4. Export new process as STEP-NC

Use Case #2: Digital Thread & Digital Twin (October 2016)

- DMDII Project 14-02-02 "Mind the Gap"

- Integrated machining, inspection, monitoring, digital twin

- Benefits
  - Process monitoring/optimization
  - Integrated quality assurance

- Thread Segments
  - CAD -> CNC   (STEP 242, 238)
  - CNC -> Virtual CMM (MT-Connect)
  - Virtual CMM -> Report (QIF)

- Participants
  - STEP Tools, Okuma, Boeing, Sandvik Cormorant, Mitutoyo America, Vanderbilt, ITI, Penn State, Vimana
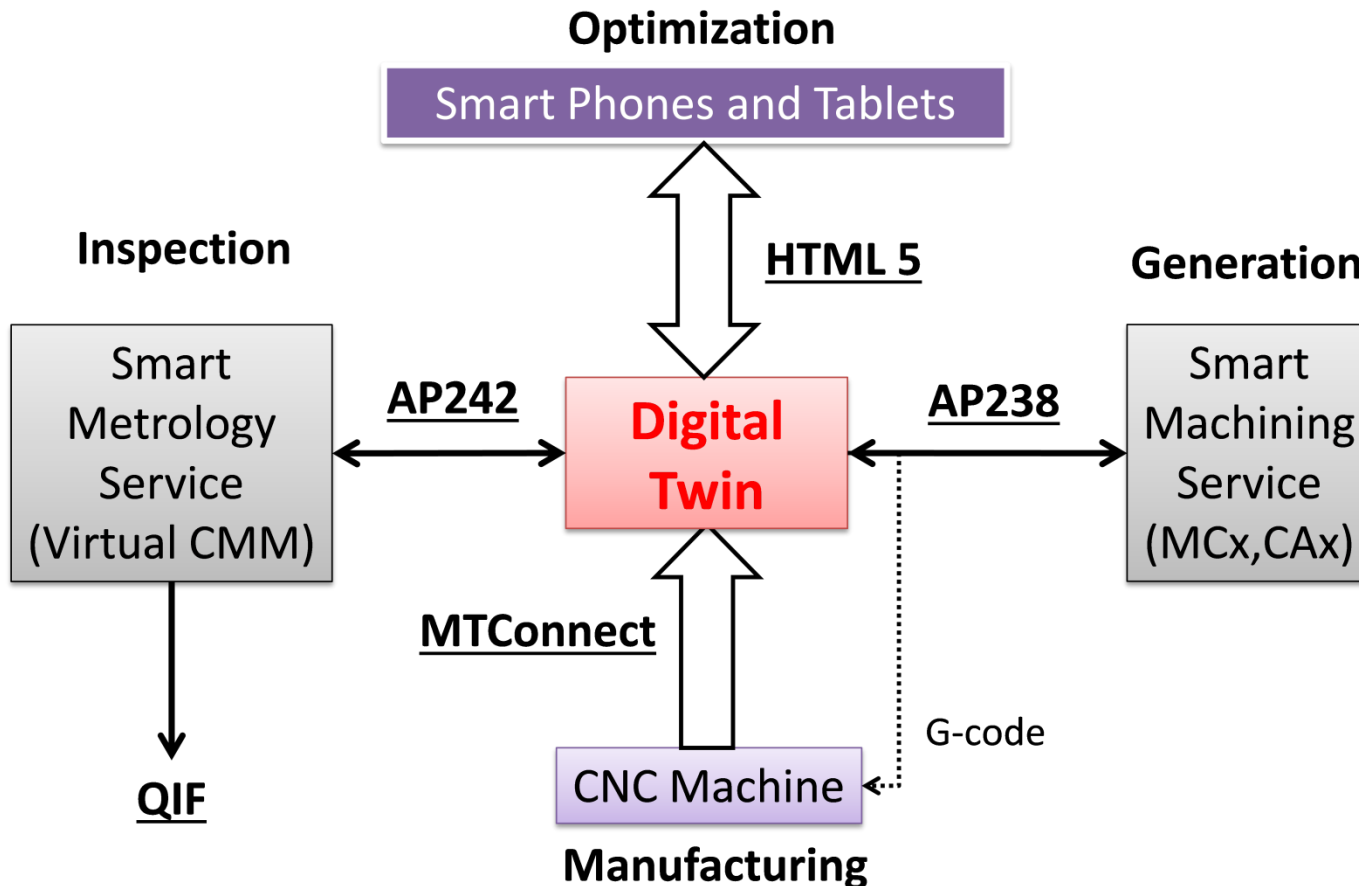
Use Case #3: Integrated Inspection
(July 2017)

- DMDII Project 14-06-05 "Operate, Orchestrate, Originate"

- Integrated machining, on-machine probing, QA evaluation

- Benefits
  - Agile Quality Assurance

- Thread Segments
  - CAD -> CNC   (STEP 242, 238)
  - CNC -> Metrology Services (MT-Connect)
  - CNC -> Web monitoring (HTML5)
  - Cutter Assembly -> CAM (ISO 13399)
  - Metrology Services -> Report (QIF)

- Participants
  - STEP Tools, Mitutoyo America, Boeing, Hyundai, Vimana

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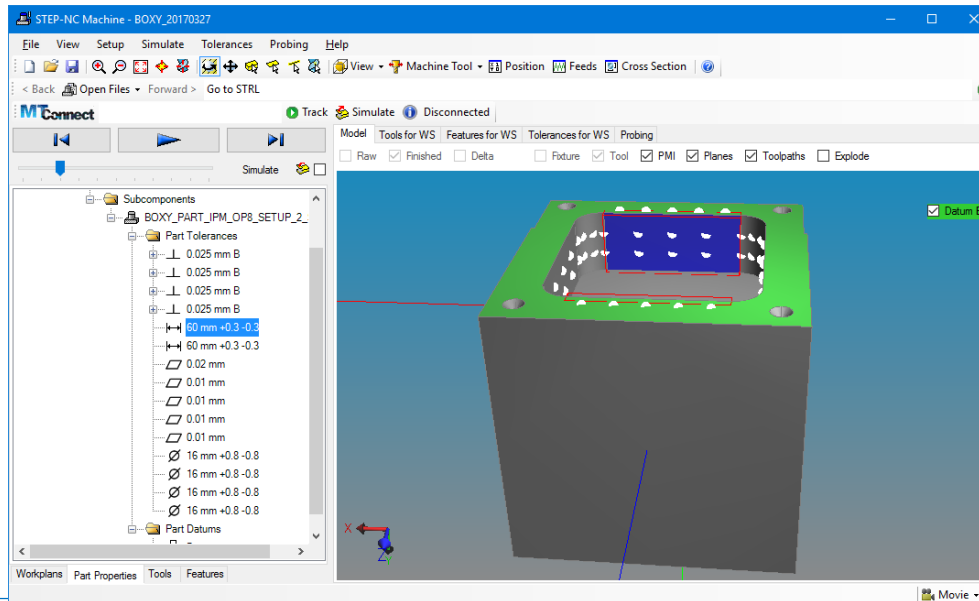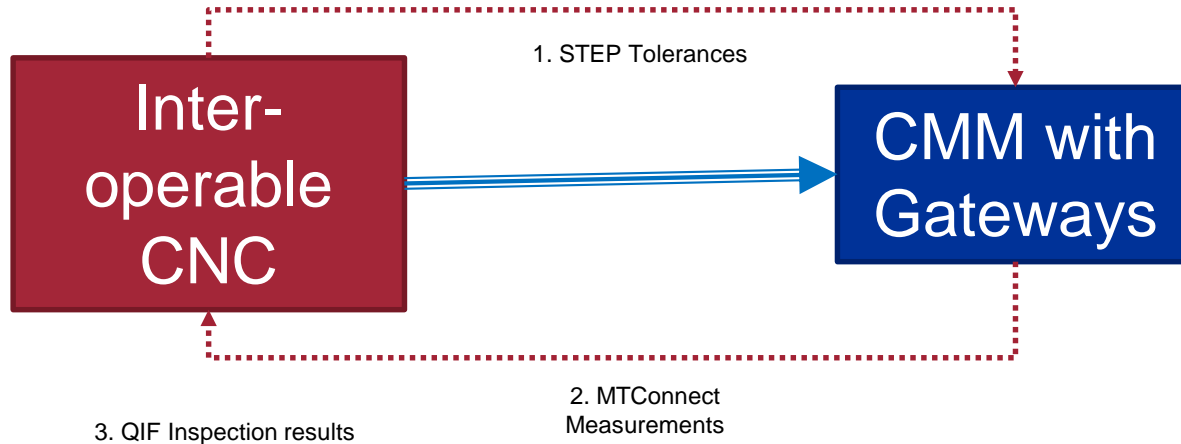
Thread Segment: Cutter Assembly Definition (ISO 13399)

- Goal: Seamless communication of cutter assembly parameters

- Found Issues: None

- Workarounds: N/A

- Present Availability
  - ISCAR and Sandvik Cormorant support 13399 in their on line catalogs
  - Dassault CATIA 3DX, Siemens NX

- Production Status
  - In Production

- Future
  - Integrated 3D modeling
  - Capability parameters

- Goal: Seamless communication of product information, including tolerancing

- Found Issues:
  - Existing capabilities for export/import from CAD is presently limited
  - Undefined representation methods

- Workarounds:
  - Converters developed, manual entry

- Present Availability
  - Various viewers
  - Most major CAD systems allow limited export/import

- Production Status
  - In Production

- Future
  - Standardized representation methods
  - Native import/export

- Goal: Seamless, complete communication of CAM/CNC process definitions

- Found Issues:
  - Export/Import not supported by CAM vendors
  - Not supported by CNC suppliers

- Workarounds:
  - Converters developed (CAM/CNC)
  - State tags for CNCs
  - UUIDs for features

- Present Availability
  - STEP Tools ST-Machine

- Production Status
  - In Production (Boeing)

- Future
  - Edition 2

Thread Segment: (MT-Connect)

- Goal: Seamless, complete communication of Quality/State parameters

- Found Issues:
  - Typical transfer rate too low
  - Cultural issues between CNC/CMM worlds
  - Tags not formally defined

- Workarounds:
  - MT-Connect adapters developed with improved throughput
  - Informal agreements between CNC/CMM
  - Interim tags developed

- Present Availability
  - MT-Connect infrastructure is ubiquitous

- Production Status
  - MT-Connect In Production

- Future
  - Continue to upgrade adapter expectations
  - Define standard tags
  - Formalize data/axis system definitions

Upcoming Opportunities For Participation

- "The Grand Challenge: *Build it Here, Build it Now, Build it Right with the Digital Thread*"   IMTS and JIMTOF 2018

- ISO STEP 10303 238, 242

- Boeing-Only Session

On Line Resources

- AP238.org http://ap238.org/

- Use Case #1:
  https://www.youtube.com/watch?v=n_syXtpyxgM

- Use Case #2:
  https://www.youtube.com/watch?v=Mjzg5nku5Lg

- Use Case #3:
  http://www.steptools.com/blog/20140914_imts/