AP242 Edition 2, Digital Twins and model based manufacturing

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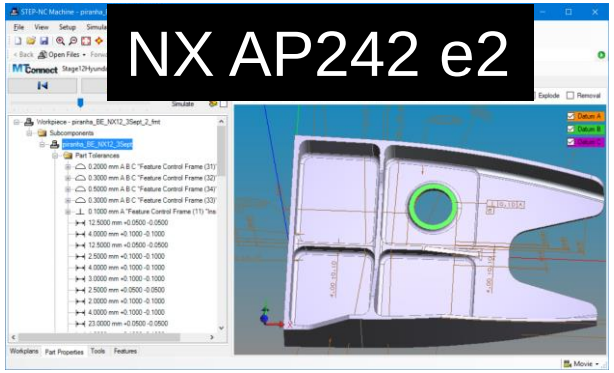
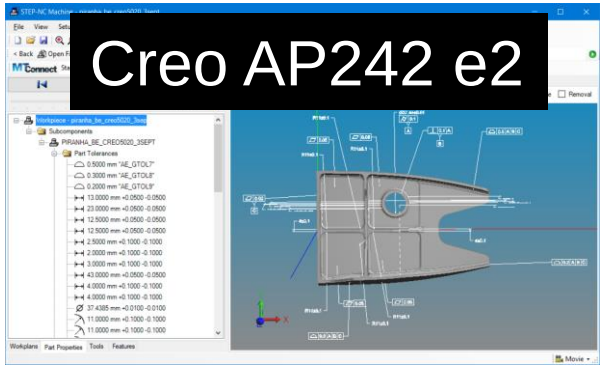
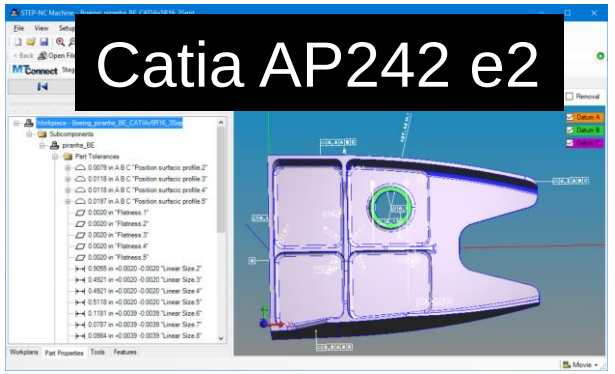
Former Professor of Computer Science, RPI
President STEP Tools, Inc.

STEP is an ISO standard for product models

- **STEP is widely used by industry**
  - **The models are integrated**
  - **Supported by all CAD systems (read and write)**
  - **Seamlessly grows to include new technologies**
- **STEP continues to grow**
  - **Models are coming for composite layup, wire harness and additive manufacturing**
  - **Models are now available for automated tolerances**

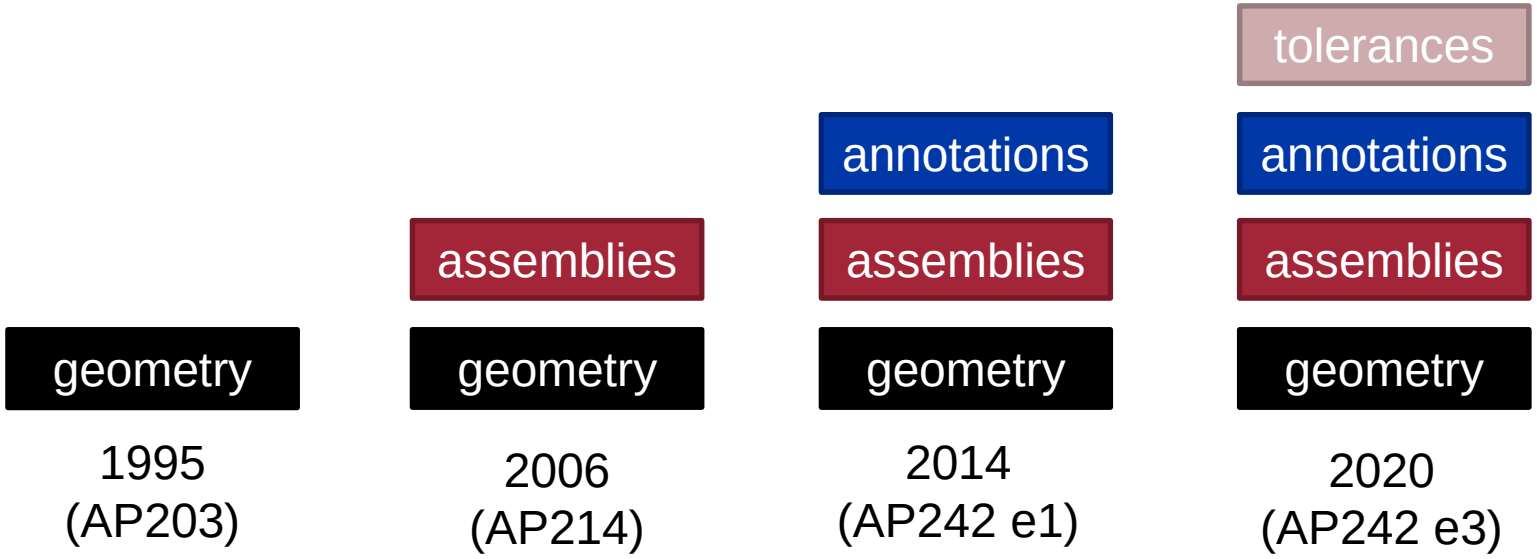






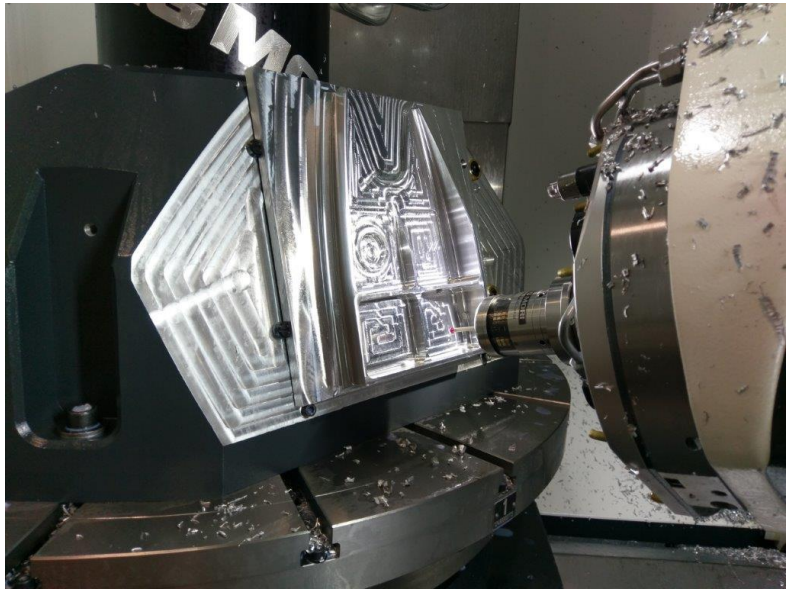
History of STEP

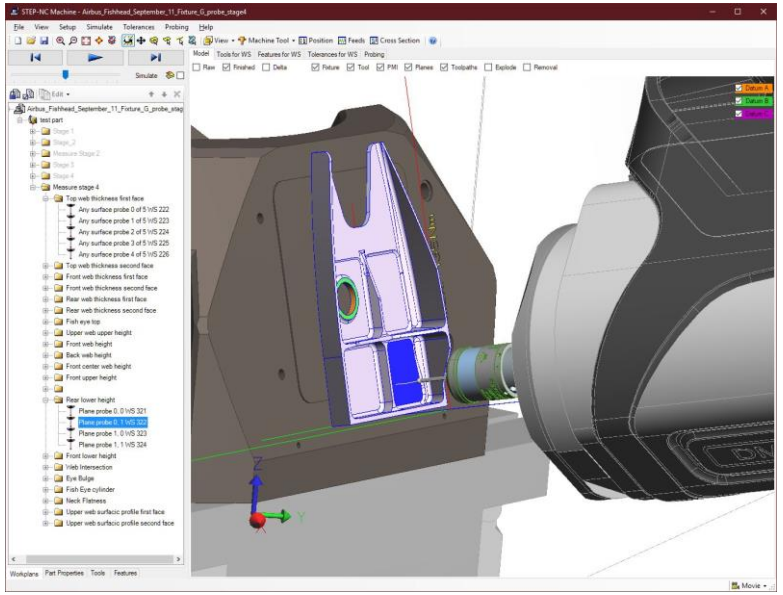
- **Modeling the data found in CAD, CAM, CAE and CNC systems**
  - **And to a lesser extent in PLM and ERP systems**
- **History**
  - **Started to unify three standards: IGES in USA, SET in France, VDAFS in Germany**
  - **In 1991 EXPRESS defined as a universal language for describing 3D geometry**



Digital Twins and STEP

- **STEP 1.0 lets industry communicate requirements using product models**
- **STEP 2.0 lets industry manage manufacturing using digital twins**





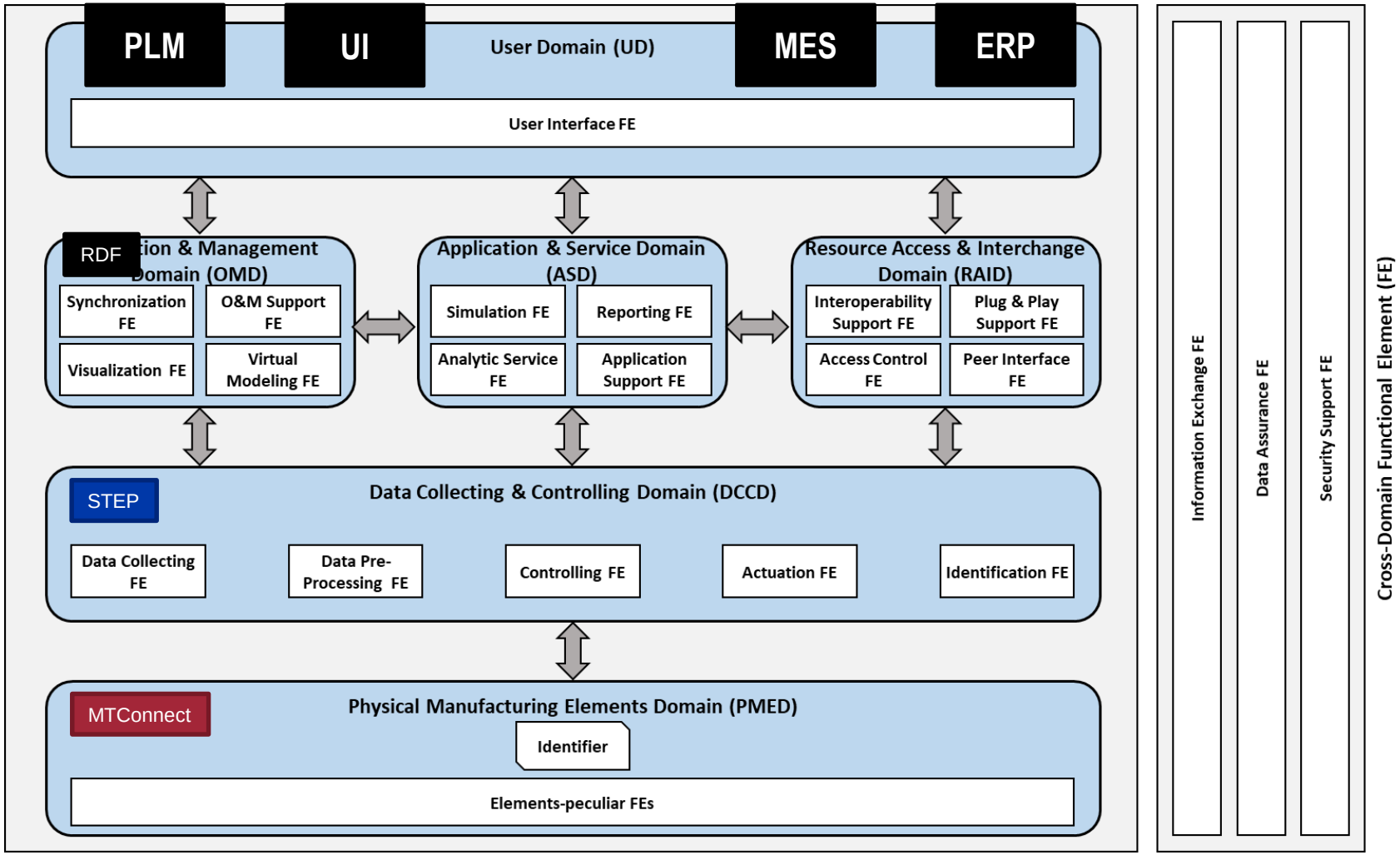
More than one million unique parts were machined using STEP-NC last year

Digital Twin framework for manufacturing

Learning Level

Control Level

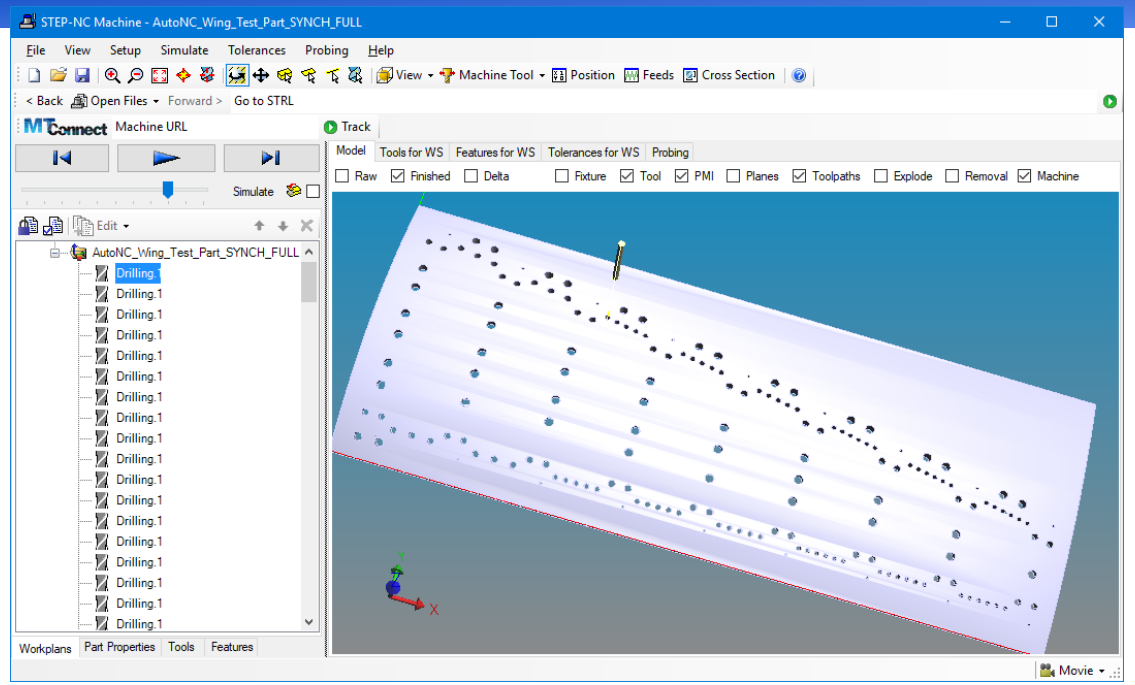
Data Level



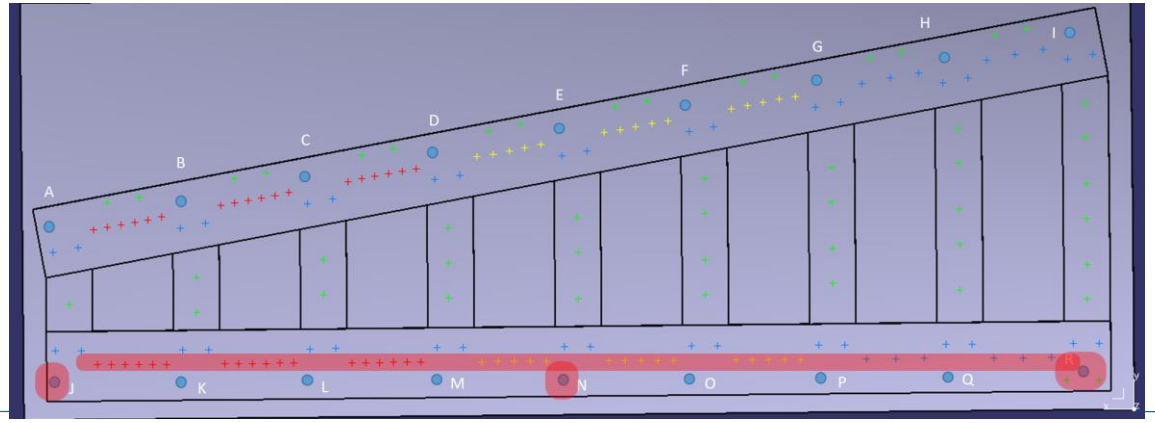
ISO 23247 layered on the IoT architecture ISO 30141

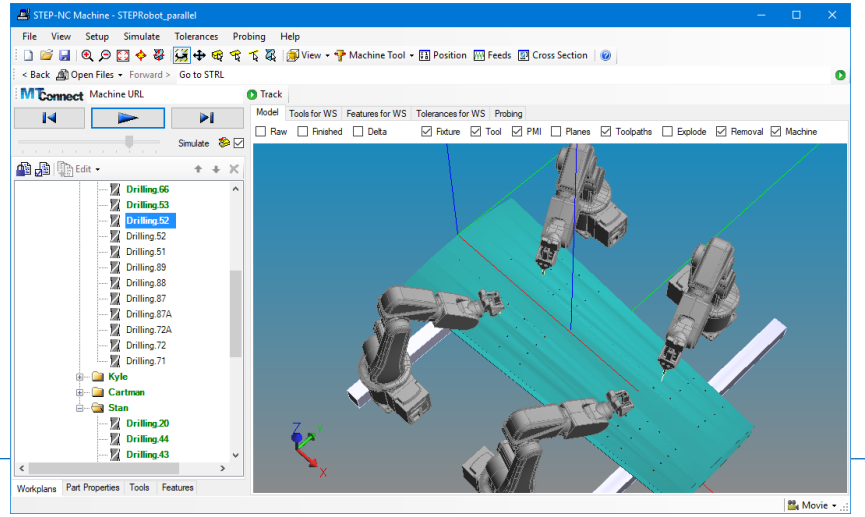
RDF, STEP and MTConnect are example technologies for each level

Use Case 1 – reduce cost of production



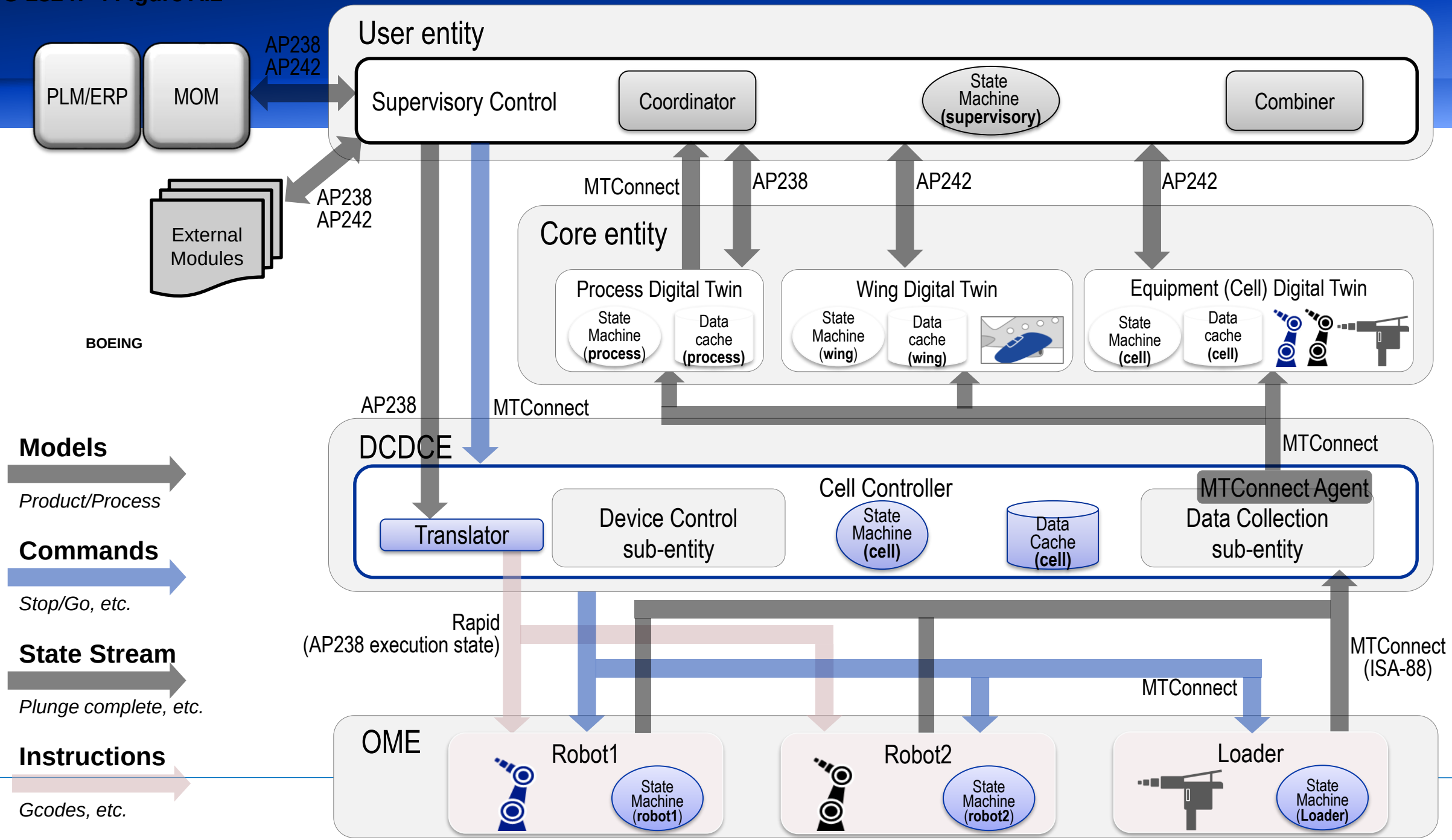
South Park
Kenny,
Cartman,
Kyle,
& Stan



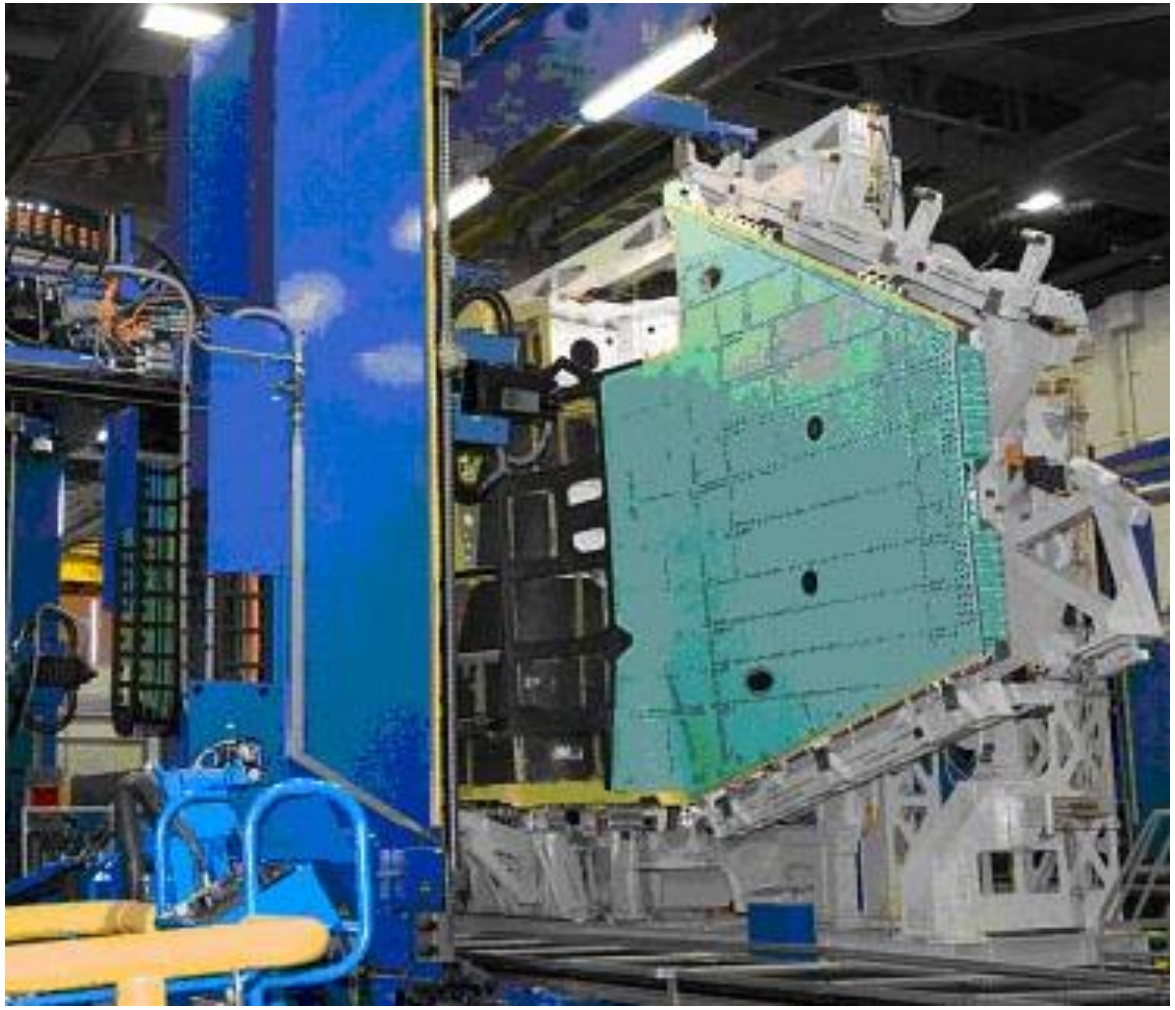


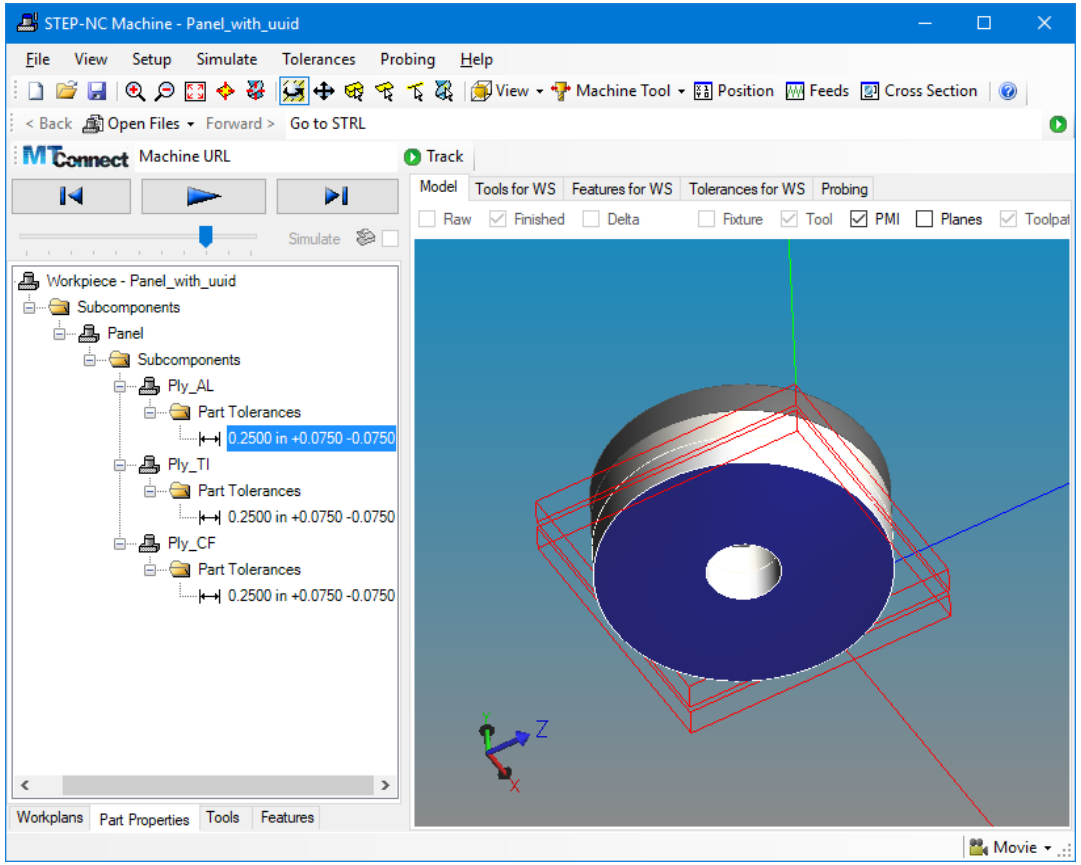
On-shoring increases by 30%

ISO 23247-4 Figure A.2



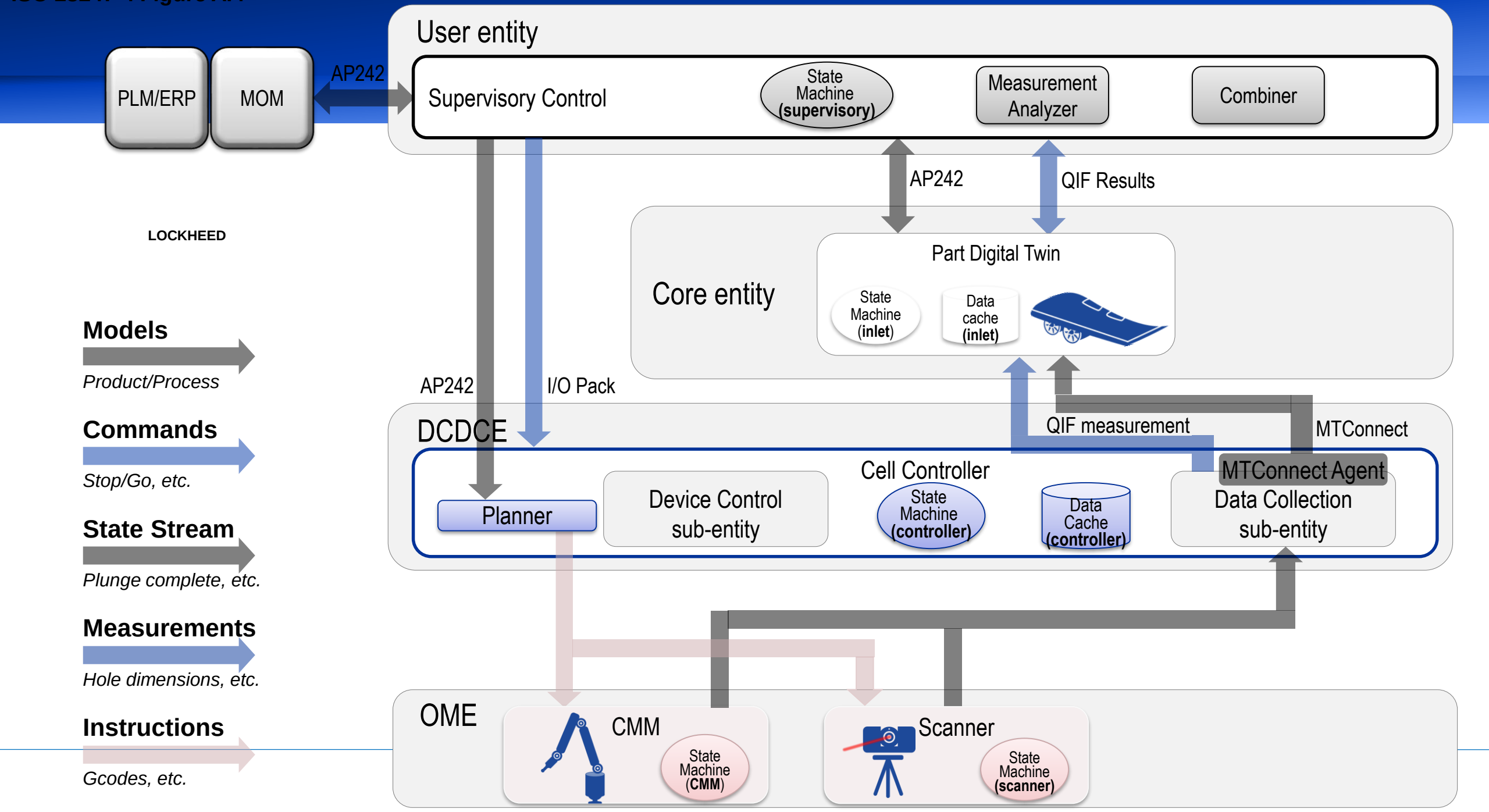
Use Case 2 – enhance material utilization



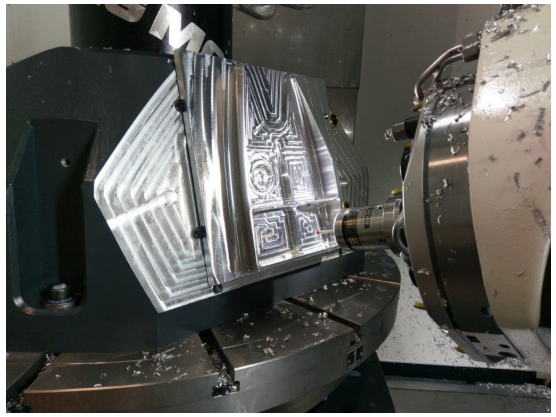


Exact match of fasteners to hole depths reduces weight by 500lb

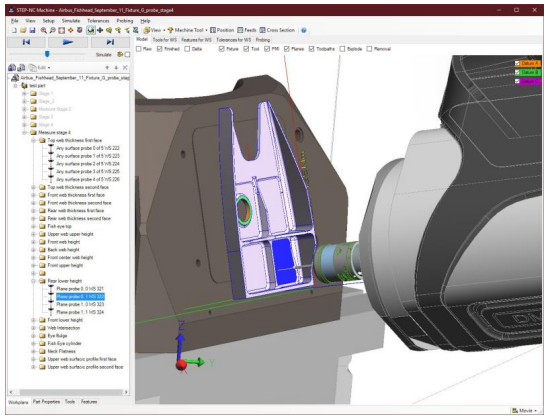
ISO 23247-4 Figure A.4



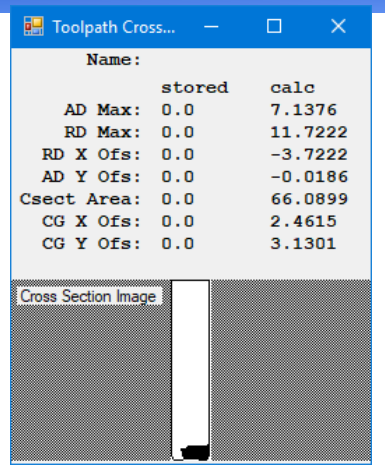
Use Case 3 – increase throughput



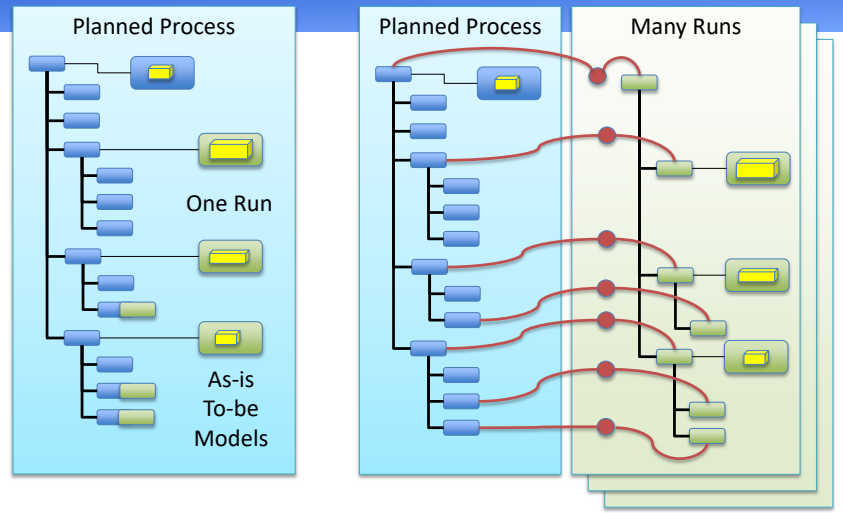
Machine parts



Monitor tool diameter



Compute tool engagement



Store linked data

OMAC

Machining Context Macros

Gcode ops

ANSI

MTConnect

Stream results

STEP Tools

STEP Agent

Apply Results

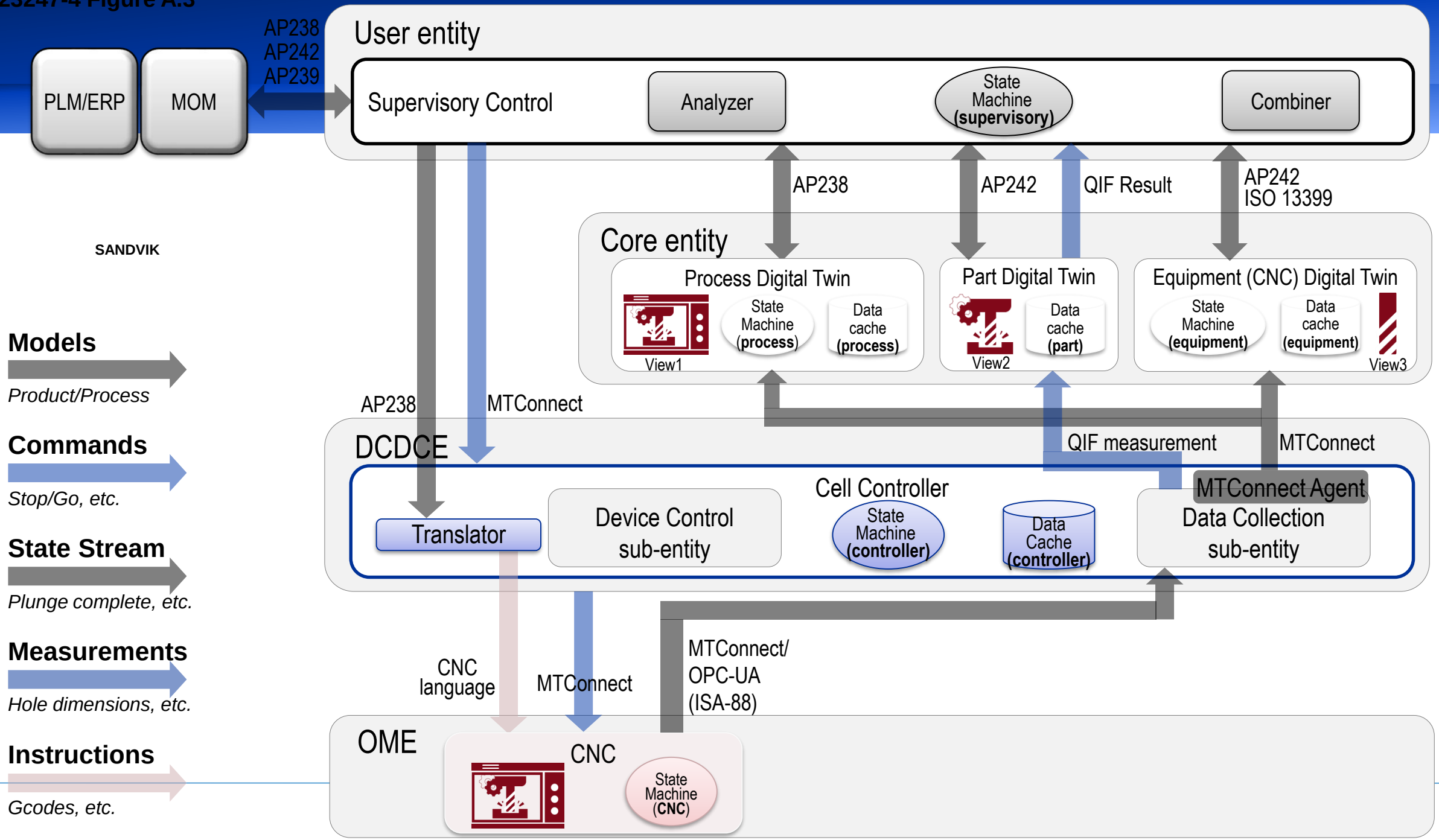
ISO

STEP-NC

Twin model

Tool life increases by 15%

ISO 23247-4 Figure A.3



Use Case Summary

- **10% reduction in cost of production – see use case 1**
- **15% increase in material utilization – see use case 2**
- **15% increase in throughput – see use case 3**
- **10% reduction in defects – all cases**

CAD
Autodesk Inventor
Siemens NX
CATIA v5 and 3DX
SoilidEdge
SolidWorks
Many others

OEMs
Boeing
Lockheed Martin
Raytheon

Machine Tool Builders
Makino
Hyundai Wia

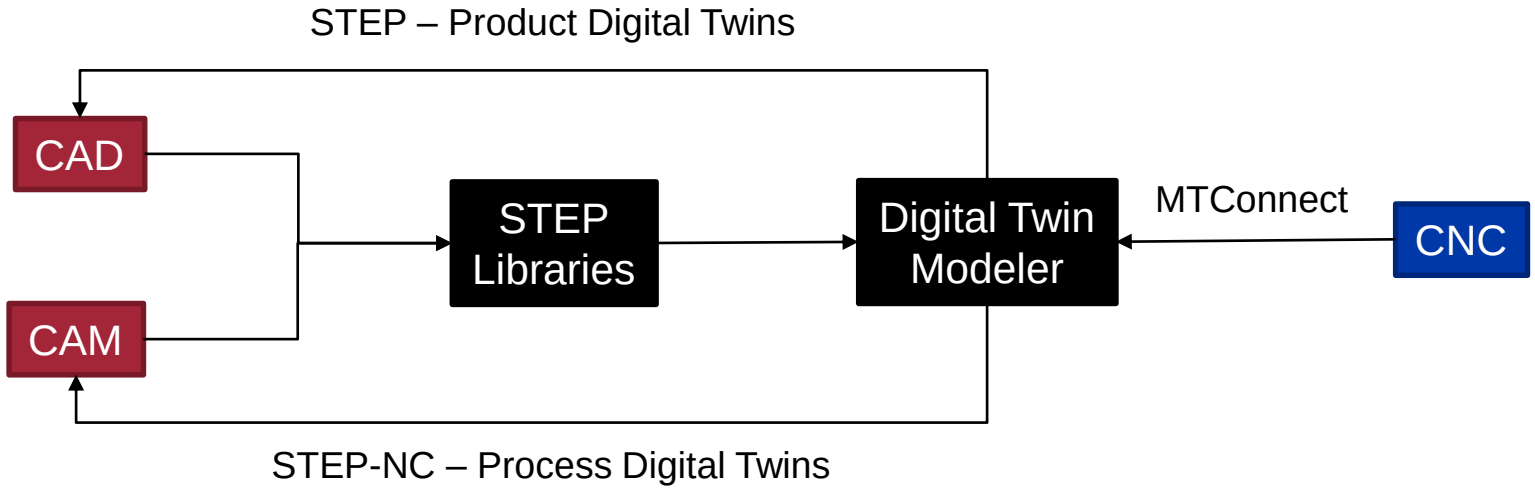
"Contextualizing data makes manufacturing more adaptable"

More information

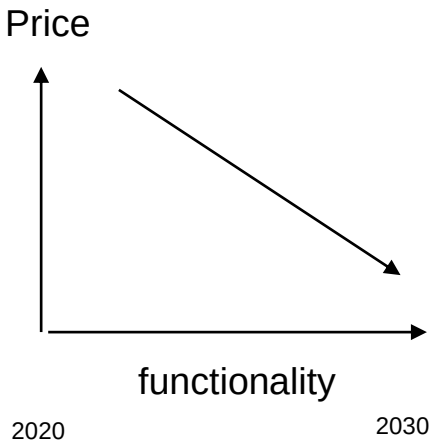
- **Learn about STEP**
  - **Standard at ISO web site: https://www.iso.org/standard/66654.html**
  - **Wiki information: https://en.wikipedia.org/wiki/ISO_10303**
  - **STEP Tools solutions: www.steptools.com**
- **Learn about information content**
  - **Diagrams and web definitions: http://www.steptools.com/stds/stp_expg/arm.html**
  - **Development team: http://www.ap242.org/**
  - **Example data files: http://ap238.org/stepncfiles/**
- **Learn about implementation:**
  - **Demonstrations: http://www.steptools.com/demos/**
  - **Videos: https://www.youtube.com/channel/UClUvqoWURjwHpppFa_dWB_Q**
  - **Definitions: http://www.steptools.com/stds/stp_aim/html/**

How to get started

- **Combine your STEP data with your manufacturing data**
- **Make a manufacturing operation more efficient**
  - **Increase adaptability**
  - **Improve quality**
  - **Reduce costs**



Benefit must exceed cost



STEP Tools, Inc.

- **Founded in 1991 to enable model based manufacturing**
  - **ST-Developer C++ Libraries® used by Autodesk, Siemens NX and many others to read and write STEP and IFC files**
  - **ST-Machine Twin Manager® used by Boeing to machine one million unique parts in 2019**
- **Dr. Martin Hardwick**
  - **Convenor of ISO Digital Manufacturing**
  - **Former Professor of Computer Science at RPI**
- **Dr. David Loffredo**
  - **Convenor of ISO STEP Implementation Methods**
  - **Editor of STEP-NC AP238**

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