FAIR - Additive Mfg. Data - ***Interoperability***

ASM International Data Ecosystem Initiative

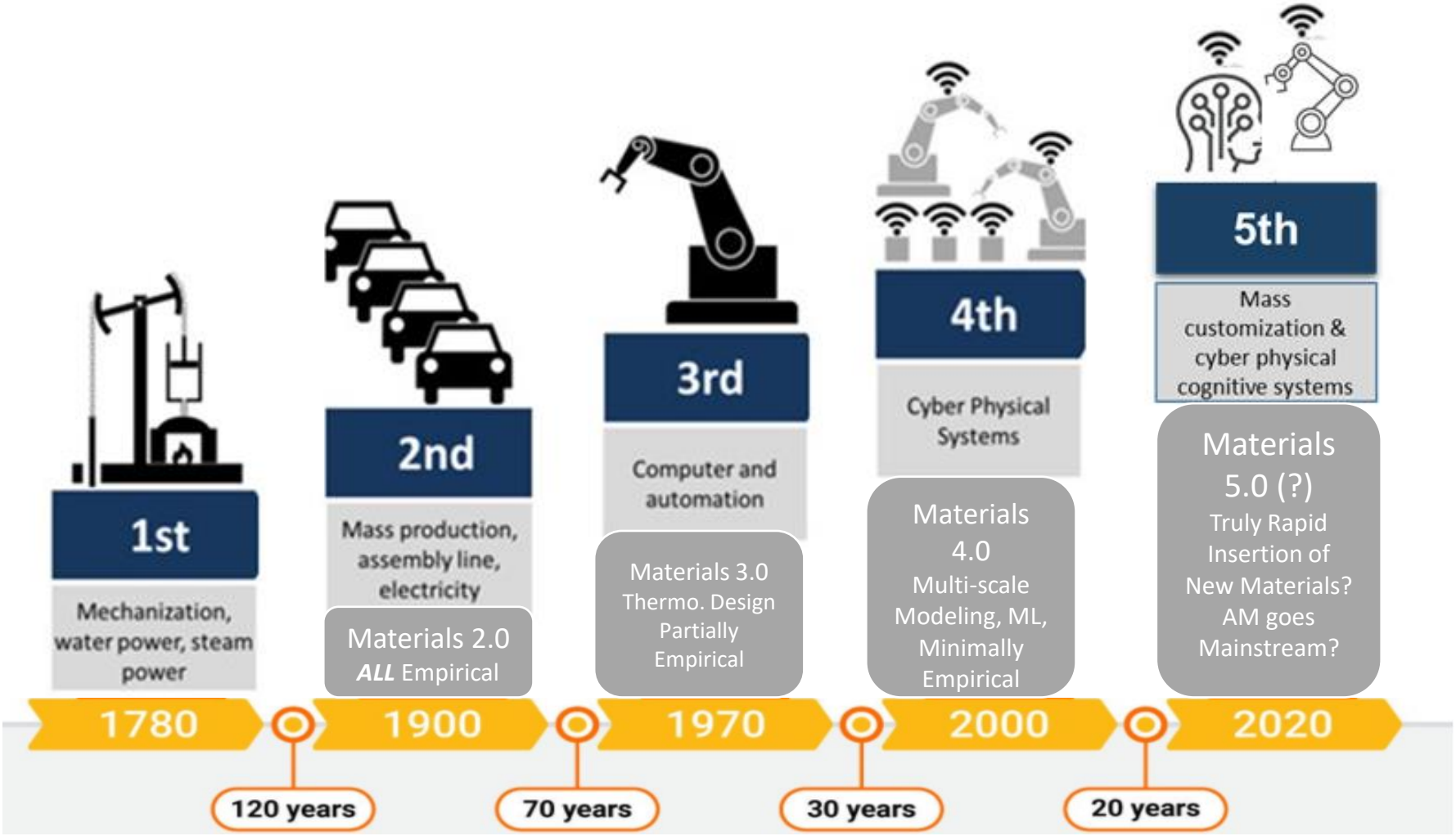
Oct 28, 2020

Ray Fryan, Executive Director – New Product Development

Outline

- Interoperability Intro & Context
- ASM Data Ecosystem intro
- ASM Interoperability Engagement
  - Example Use Case Projects
- Interoperability – Fair Principles

The World is Changing!



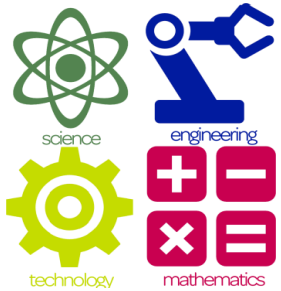
ASM Burning Platform → Enable Materials 4.0

ASM's Place – Enabling Discovery to Become Application

Science
Discovery
Inductive Reasoning

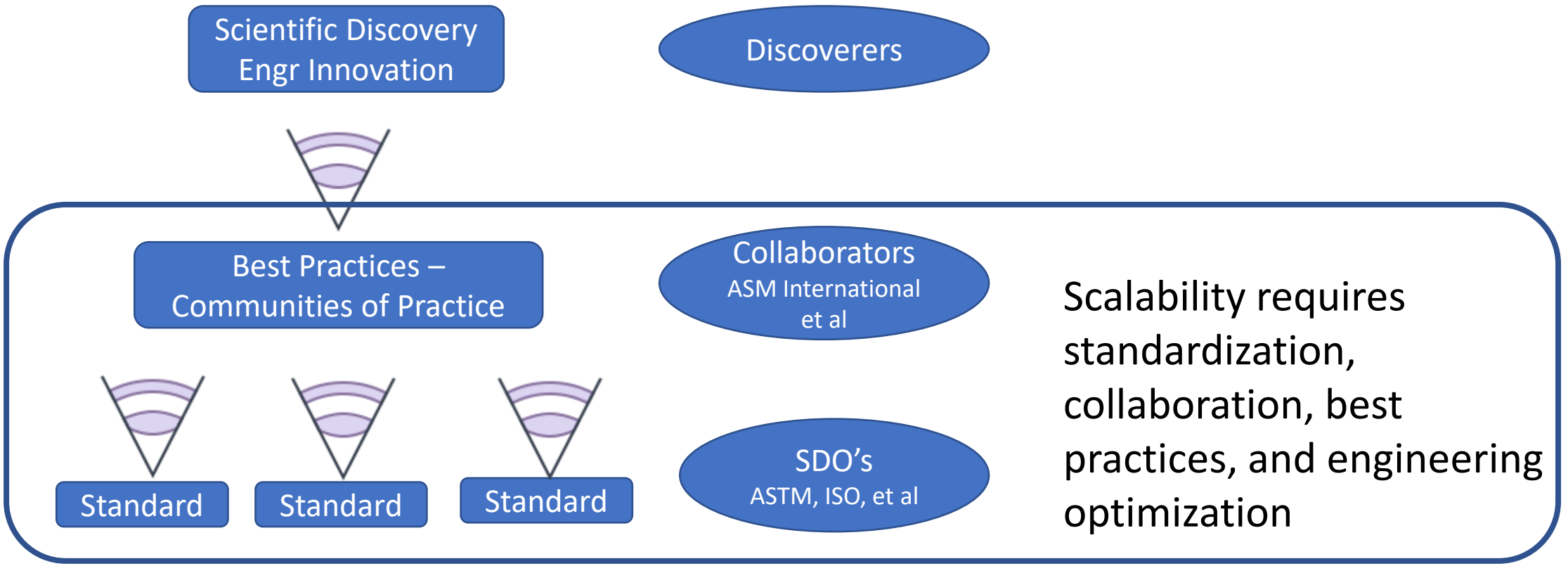
Invention
Innovation
Improvement

Engineering
Application
Deductive Reasoning



ASM - Enabling Materials 4.0 Competency in Industry

Thoughts on Progress – a Simple Model



ASM – Collaboratively Building a Materials and Data Ecosystem

ASM International Data Ecosystem Concept

Note – examples only

Thermo-Calc Software
PANDAT
ANSYS
GRANTA
QuesTek

Public Data
Private Data
Government Data

Oak Ridge National Lab
Center for Materials Processing Data
ASM
CALPHAD
GRANTA

Note – examples only

Materials Data Management "School"

ASM – Leading COP on Materials Data to Enable Materials 4.0

Additive Manufacturing Interoperability Connection

Materials Data Management "School"

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Public Data
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MOBI - CDD
Hyper Thought - CDD

Findable
Accessible
Interoperable
Reusable

CDD IS For AM Community! – Less Machine, Process or Company Specific

ASM International – Interoperability History

- Materials Properties Database Committee (MPDC) work on data sharing formats:
  - .xml, Matml, .xsd, RDF/OWL

Many Viewpoints and Perspectives!
(emerging consensus)

- International Projects – Data Sharing Formats:
  - FATEDA (Fatigue Testing Data)/ .xml
  - METEDA (Mechanical Testing Data – Tensile, Creep-Fatigue)/ .xml; RDF/OWL
  - NATEDA (Nano Testing Data)/.xml, Express

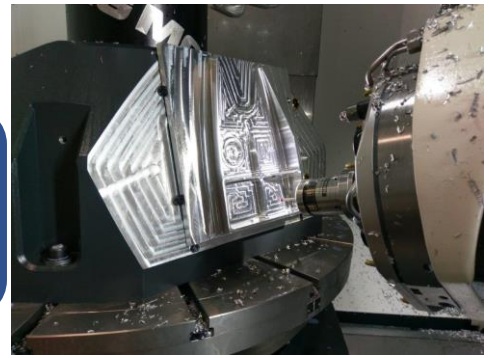
More Viewpoints and Perspectives – Test Specific!

Data Interoperability "Best Practices" Are Emerging…Consensus Achieved Slowly!

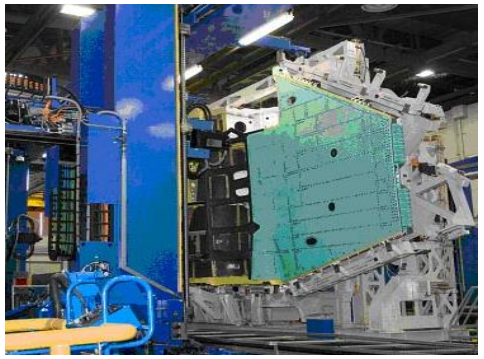
ASM Engagement - Smart Manufacturing - Digital Twin/ISO Project

- **Robot scheduling** - David Odendahl, Boeing
  - Flexible Schedule for robot fill and drill
  - ASM Int./AFRL Interoperability Project
    - Alignment with ISO 10303 & ISO 23247
    - Interoperability Files
      - Express/STEP to RDF/OWL translation
        - Including Hardness/ML Evaluation

- **Tool life optimization (Tool life increase of 15%)**
  - Bengt Olsson, Sandvik
  - ASM Int. – Materials Properties Implementation
    - Alignment with ISO 10303 & ISO 23247
    - Spikey Project for Microstructural Evaluation

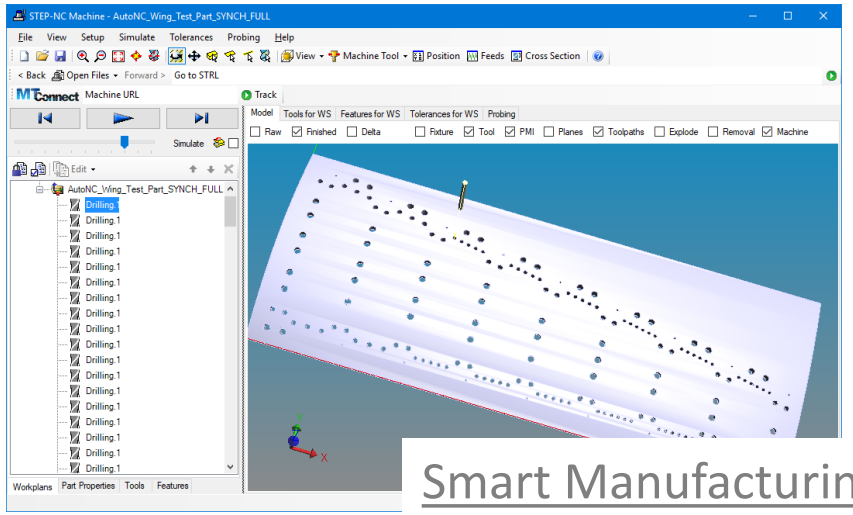


- **Advanced metrology (Reduce weight by 500lb)**
  - Jan De Nijs, Lockheed
  - Exact Match of Fastener to Hole

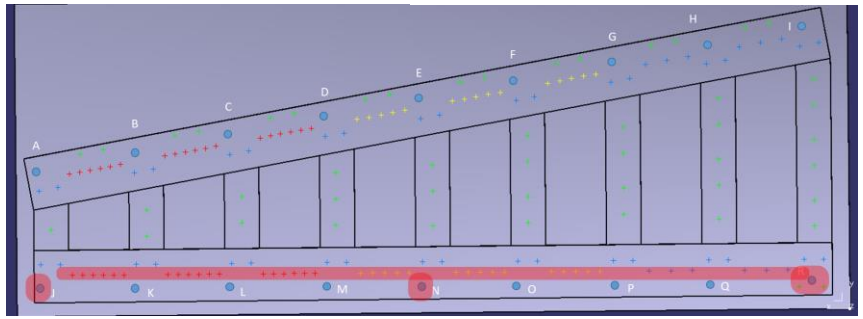


Engagement in Digital Twin ISO Activities!

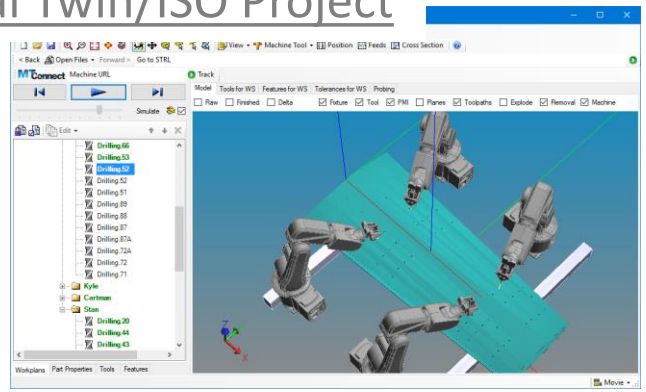
Use Case 1/Boeing – Flexible Schedule for Robot Drill & Fill



Smart Manufacturing - Digital Twin/ISO Project

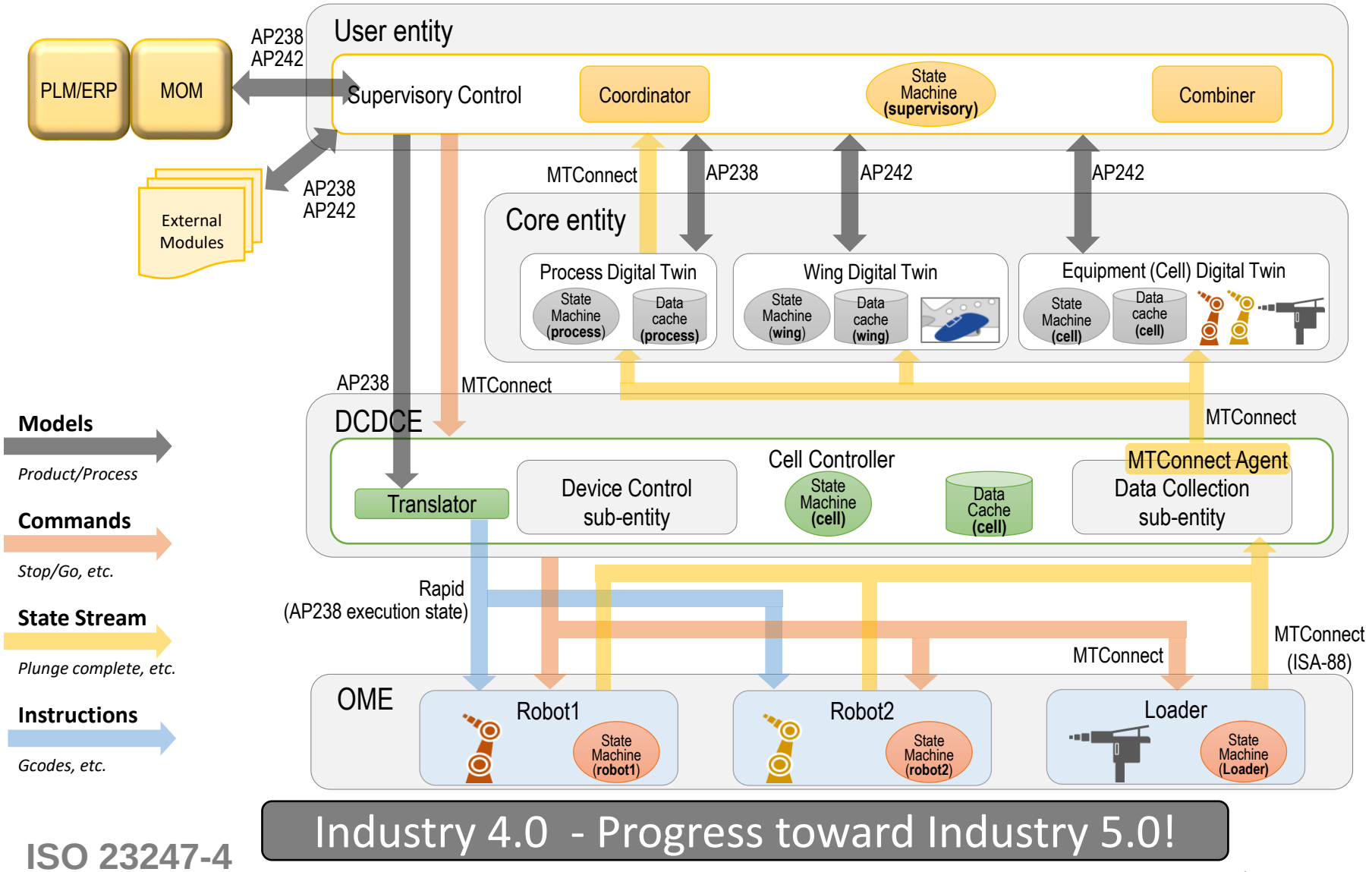


On-shoring can increase by 50%



Industry 4.0 ➔ Industry 5.0! – In all Cases, you need Materials

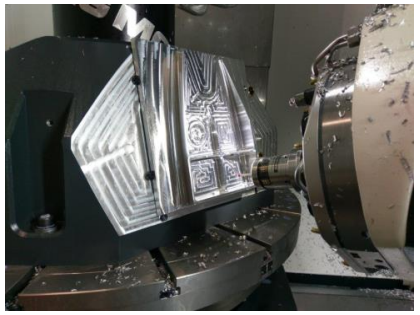
Digital Twin – BOEING/Robot Scheduling

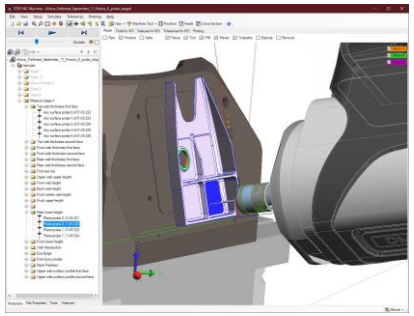


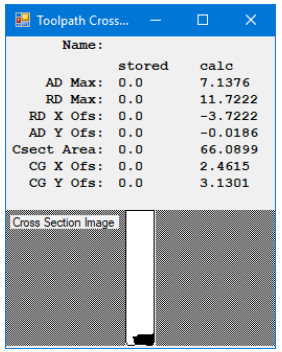
ISO 23247-4

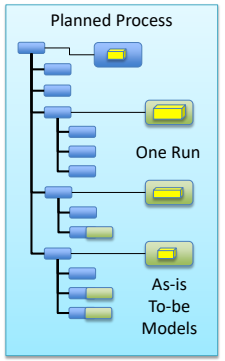
Industry 4.0 - Progress toward Industry 5.0!

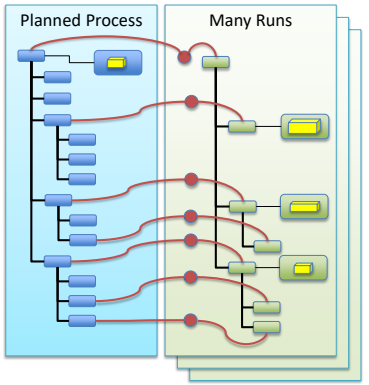
Use Case 2/Sandvik – Tool Life Optimization











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

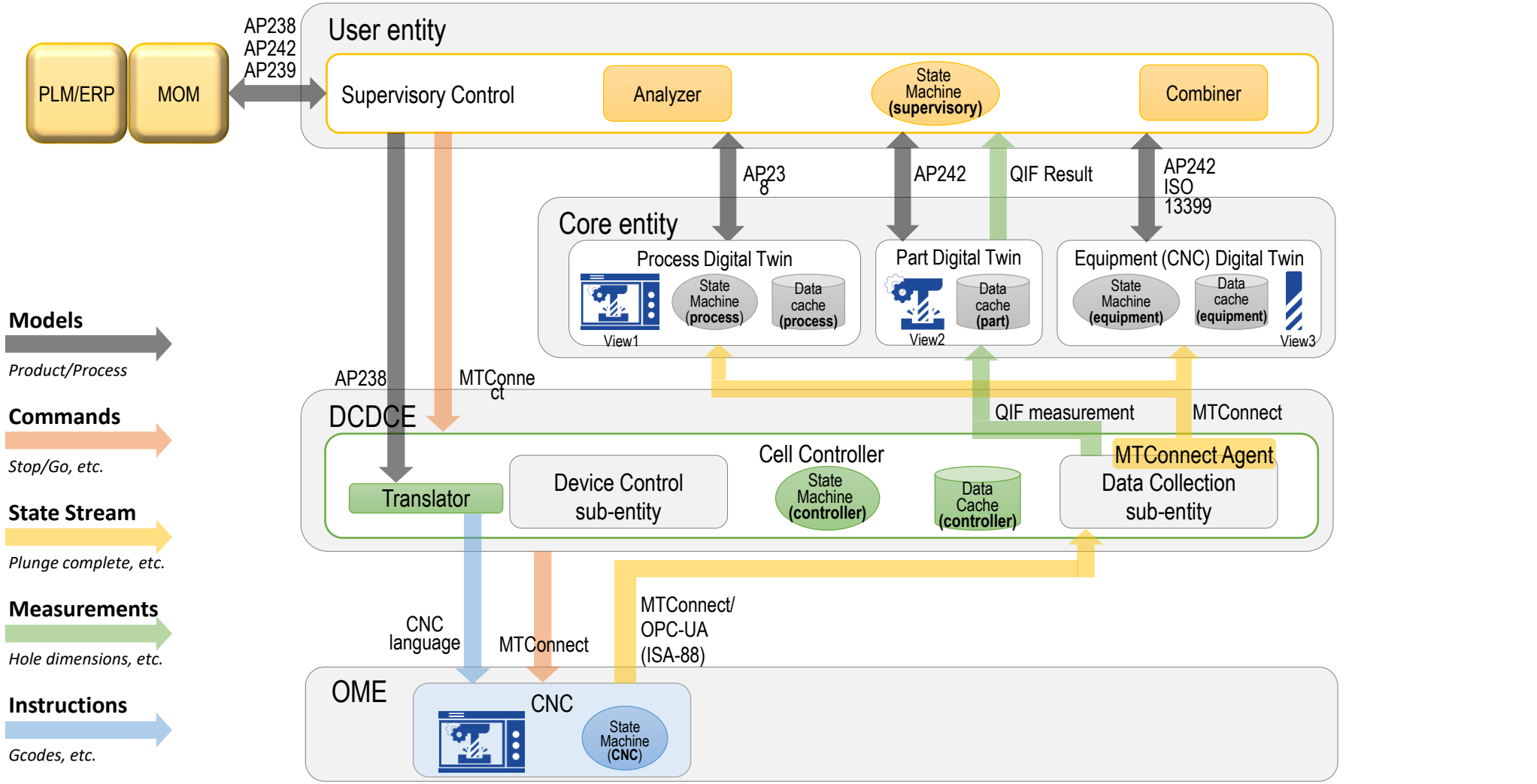
STEP-NC

Twin model

Tool life can in crease by 15%

Digital Twin - Connecting Modeling and Materials Communities Using a Common Language

Digital Twin – SANDVIK/ Tool Life Optimization



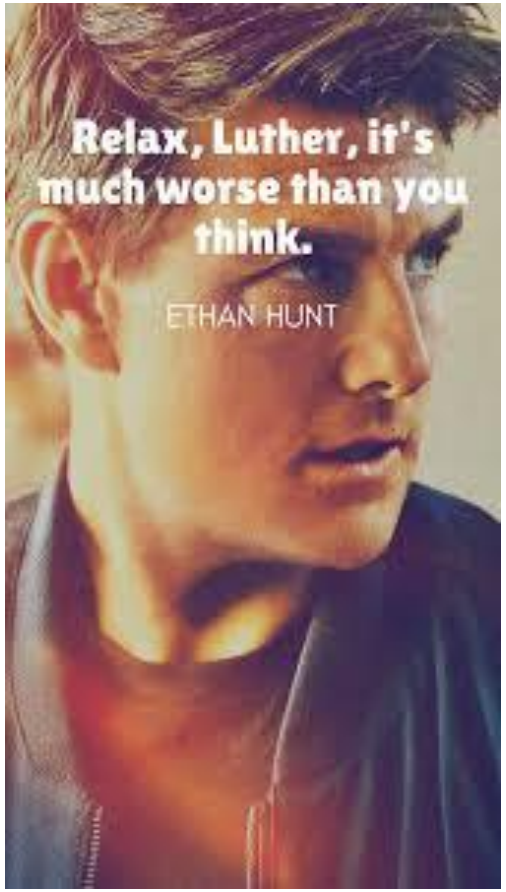
ISO 23247-4

…Requires Knowledge of Materials and Consumable Tooling

FAIR Principles – Interoperability – ***Mission Impossible***?

- **Interoperable**
  The data usually need to be integrated with other data. In addition, the data need to interoperate with applications or workflows for analysis, storage, and processing.

  - **I1. (Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.**
  - **I2. (Meta)data use vocabularies that follow FAIR principles**
  - **I3. (Meta)data include qualified references to other (meta)data**



Interoperability – We CAN do this, but we need a PLAN!

Interoperability – The Plan!

- **I1…formal… *broadly applicable language***
  - **…be able to exchange and interpret each other's data.**
  - **…be readable for machines without …specialised or ad hoc algorithms, translators, or mappings.**
  - **…each computer system at least has knowledge of the other system's data exchange formats**
  - **…controlled vocabularies, ontologies, thesauri, a good data model.**

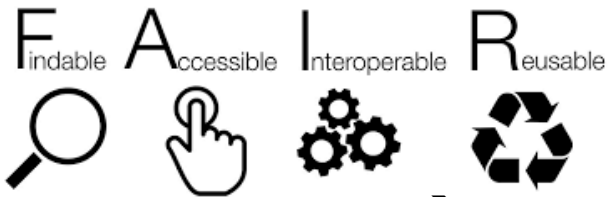
Can't we all just get along?

Interoperability – The Plan!

- **I1…formal… *broadly applicable language***

Can’t we all just get along?

- **I2…vocabularies that follow Fair Principles**
  - **needs to be documented and resolvable using globally unique and persistent identifiers**.
  - …needs to be **easily findable and accessible by anyone who uses the dataset**.



Ease of Communication ➔ Daunting
Foundation of Common Language!

Interoperability – The Plan!

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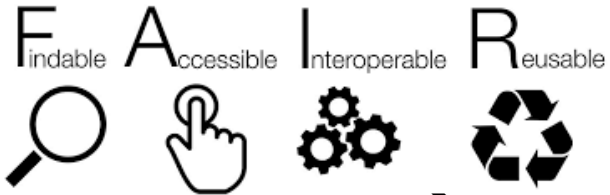


Ease of Communication ➔ Daunting
Foundation of Common Language!

- **I3…data/metadata include quality references to other data**
  - **…create as many meaningful links as possible between (meta)data resources to enrich the contextual knowledge …the scientific links … need to be described.**
  - **…all datasets need to be properly cited**.

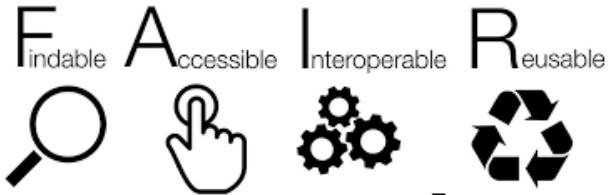
After Foundation, Linkage is KEY

Interoperability – The Plan!

- **I1…formal… *broadly applicable language***

Can't we all just get along?

- **I2…vocabularies that follow Fair Principles**



Ease of Communication ➔ Daunting
Foundation of Common Language!

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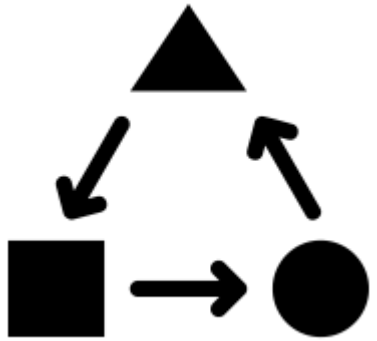
After Foundation, Linkage is KEY

Interoperability – Not EASY!

Summary – ASM Position on Interoperability

- Data Ecosystem – Counting on it!
- Communities of Practice – Encouraging it!
  - Other Societies, Gov't, Industry, Academia
  - Committees, Task Forces, Ad Hoc COP's



- Project, consortium, SDO actions – Building it!
- Data Sharing Formats Challenges – Tackling it!

- Collaboration – Embracing it!

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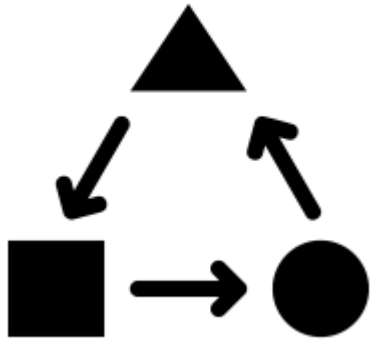

- Project, consortium, SDO actions – Building it!
- Data Sharing Formats Challenges – Tackling it!

- Collaboration – Embracing it!

Interoperability – Challenging, but ***NOT Impossible***!


THANK YOU!