

Enabling Learning for Manufacturing Machines

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Convener ISO Digital Manufacturing

GLOBAL PRODUCT DATA
INTEROPERABILITY
S U M M I T
2019



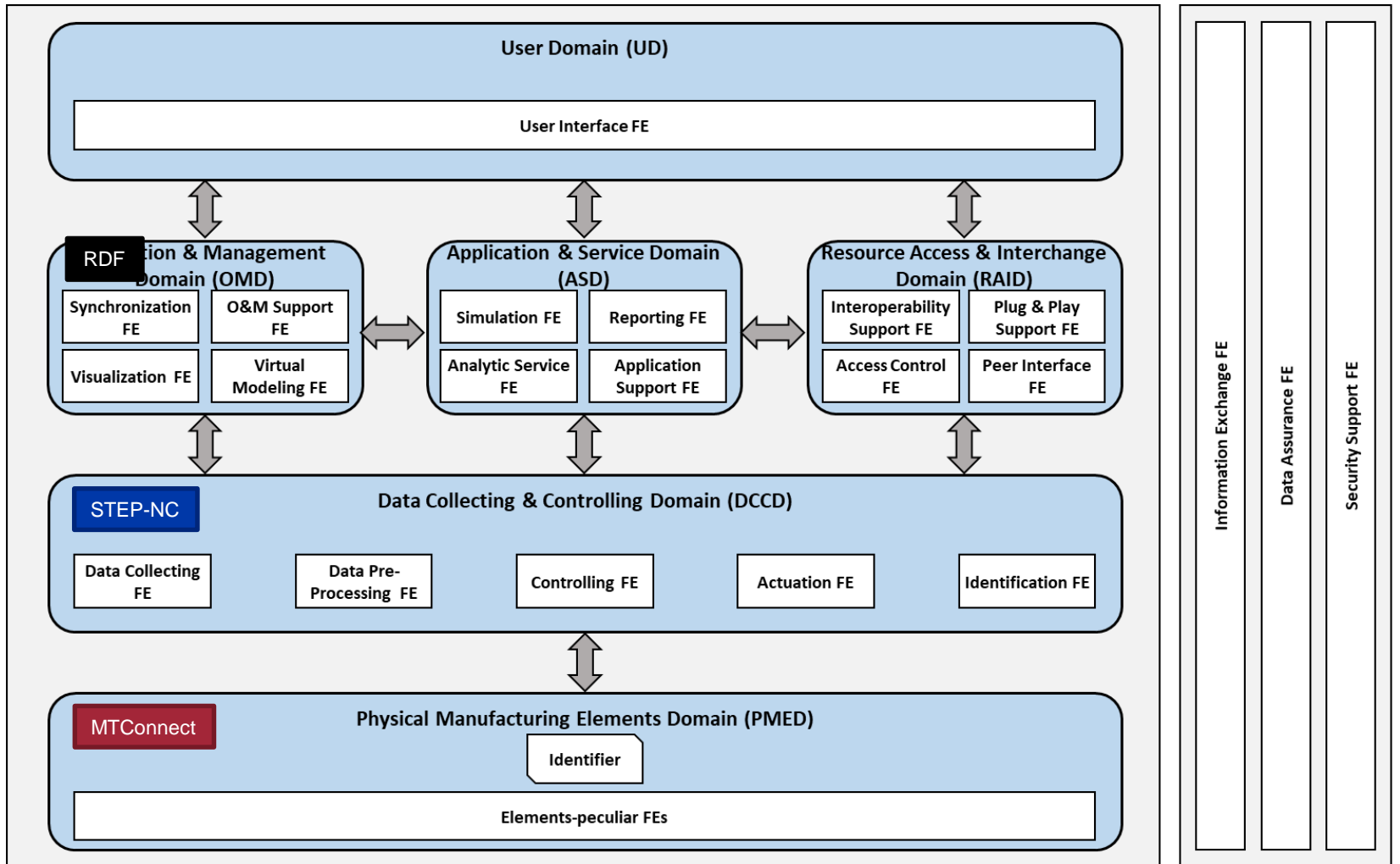
Introduction

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- **Who am I**
 - Dr. Martin Hardwick
 - Convener of ISO Digital Manufacturing working group
 - www.steptools.com, info@steptools.com
- **What standards are we developing / assisting**
 - Digital Twin manufacturing framework - ISO 23247
 - STEP-NC integrated model for machine control – ISO 10303-238
 - QIF Quality Information Framework – ISO 23952
- **What do I want to talk about**
 - Using digital twins for machine learning

Digital Twin manufacturing framework – ISO 23247

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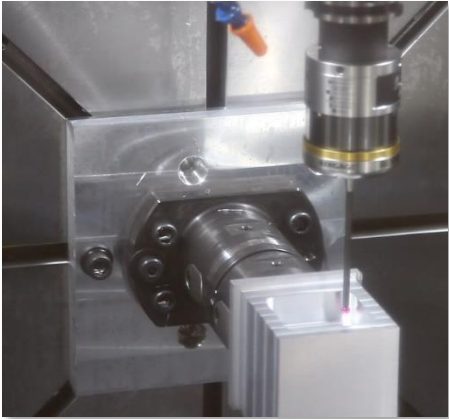
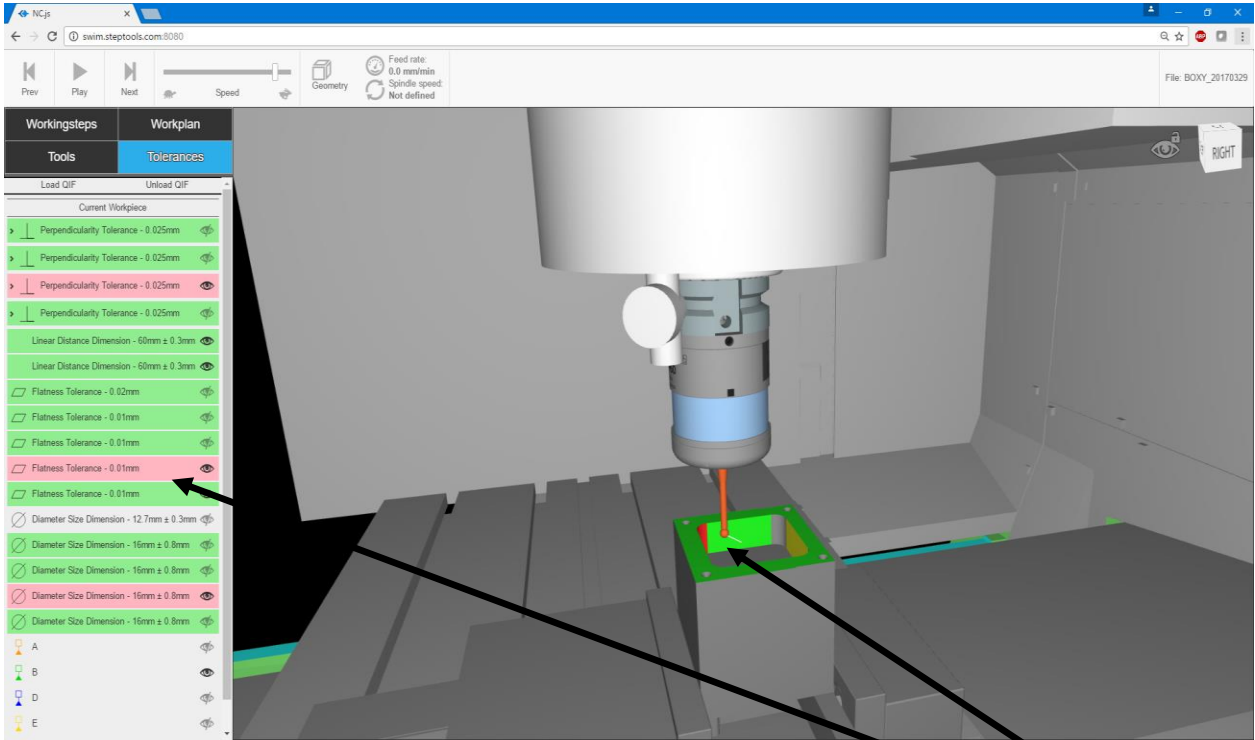
ISO 23247 layered on the IoT architecture ISO 30141

CD ballot passed on September 4

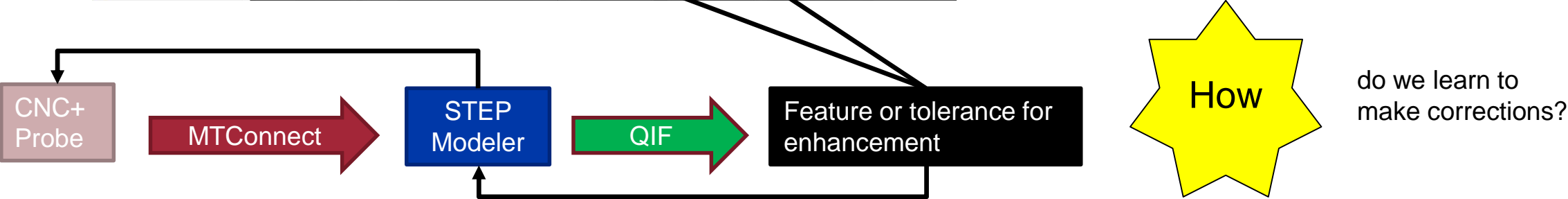
RDF, STEP and MTConnect are example technologies for each level

Example 1 – on machine measurement

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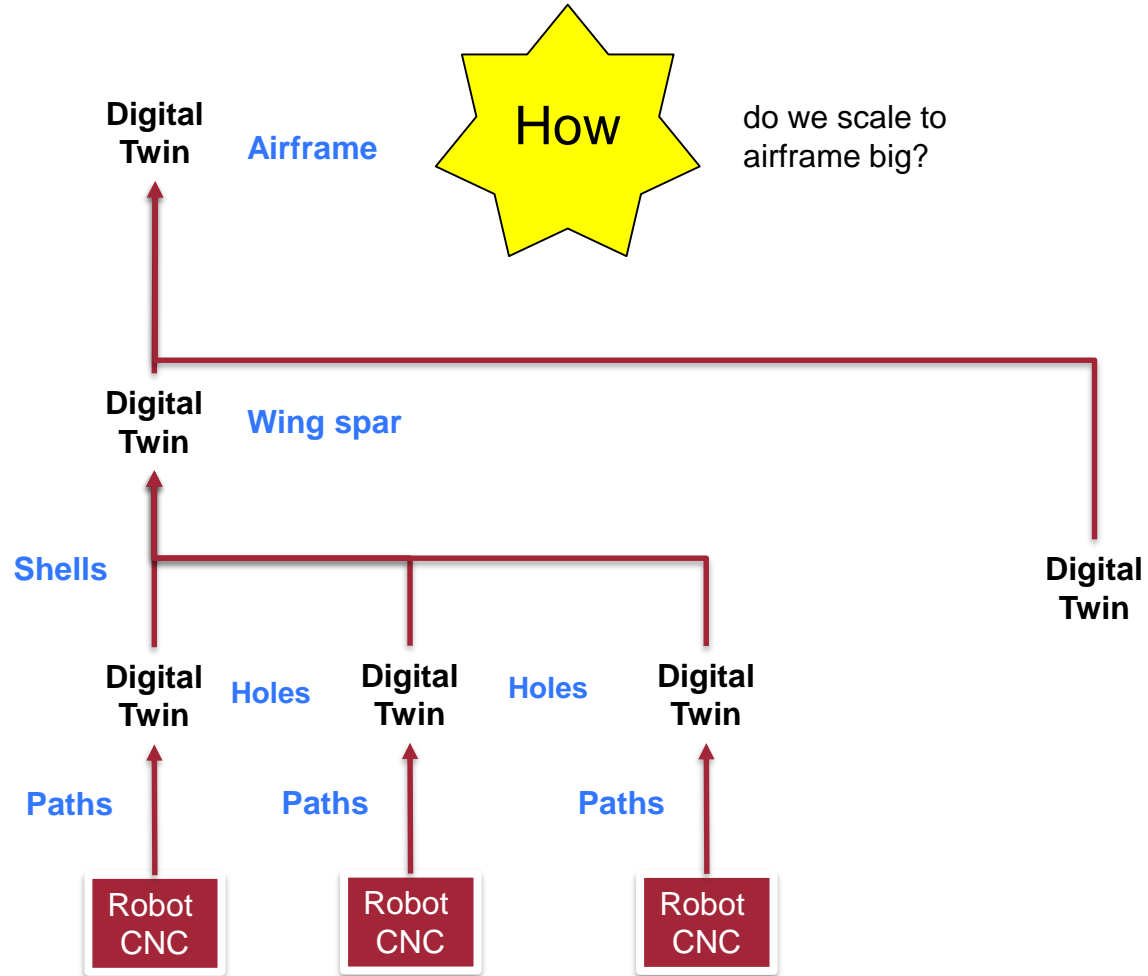


<https://www.mmsonline.com/articles/machining-demonstration-shows-the-digital-twin-concept-in-action>

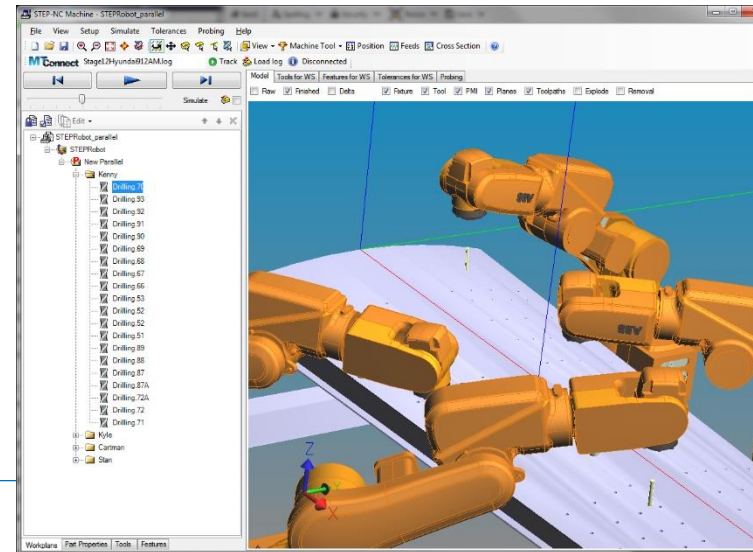


Example 2 – schedule team of robots

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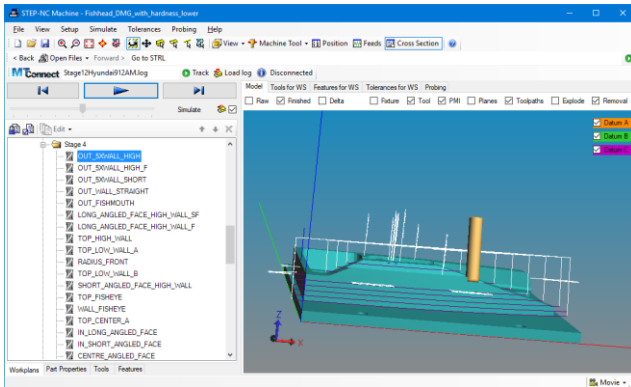
“Kill” Kenny



Drill and fill

Example 3– learn how to maximize tool life

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Change tool diameter

Name:	stored	calc
AD Max:	0.0	7.1376
RD Max:	0.0	11.7222
RD X Ofs:	0.0	-3.7222
AD Y Ofs:	0.0	-0.0186
Csect Area:	0.0	66.0899
CG X Ofs:	0.0	2.4615
CG Y Ofs:	0.0	3.1301

Cross Section Image

Compute tool engagement

```

fishhead-dmg-hardness.rdf - Notepad
File Edit Format View Help
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.
@prefix p21: <http://en.wikipedia.org/wiki/ISO_10303-21#>.
@prefix aim: <http://stepmfg.github.io/ap238e2/annexG.htm#>.
@prefix arm: <http://stepmfg.github.io/ap238e2/annexH.htm#>.
@prefix data: <http://ap238.org/stepncfiles/fishhead/Fishhead_
@prefix idx: <#>.

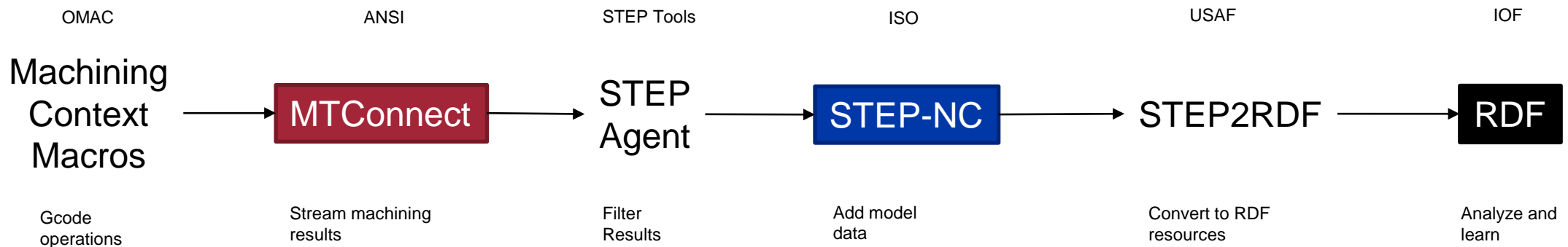
idx:id10 a arm:PROJECT;
p21:ENTITY_ID data:id10;
arm:PROJECT-ITS_ID "Fishhead_DMG_with_hardness";
arm:PROJECT-MAIN_WORKPLAN idx:id18;
arm:PROJECT-ITS_WORKPIECES idx:id34569.

idx:id31 a arm:WORKPIECE;
p21:ENTITY_ID data:id31;
arm:WORKPIECE-REVISION_ID "";
arm:WORKPIECE-ITS_ID "".
    
```

Make linked data



Go / No Go



Other use cases

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1. Process optimization (deployed at Boeing)
2. On machine measurement (example 1)
3. Dynamic scheduling (example 2)
4. Tool life management (example 3)
5. Materials identification
6. Closed loop machining
7. CNC to CNC data exchange
8. CNC to CAM data exchange
9. CAM to CAM data exchange
10. CAM to CAD data exchange

Machine Learning

RDF

Learning standard

STEP-NC

Modeling standard

MTConnect

Machining standard

Machine Manufacturing

ISO 23247

Concluding remarks

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- **Fit between STEP and RDF is a good one**
 - RDF is more powerful and flexible than EXPRESS
 - RDF has seamless interfaces to JSON-LD and Python
 - RDF is made practical by Turtle and SHACL
- **Work described here is early**
 - Intelligent GD&T is new to the public domain
 - Integration with BOF and Industry Ontology Foundry (IOF)
- **Starting experiments with an industry team**
 - ASM for materials experts
 - Boeing for manufacturing experts
 - USAF for ontology and machine learning experts

