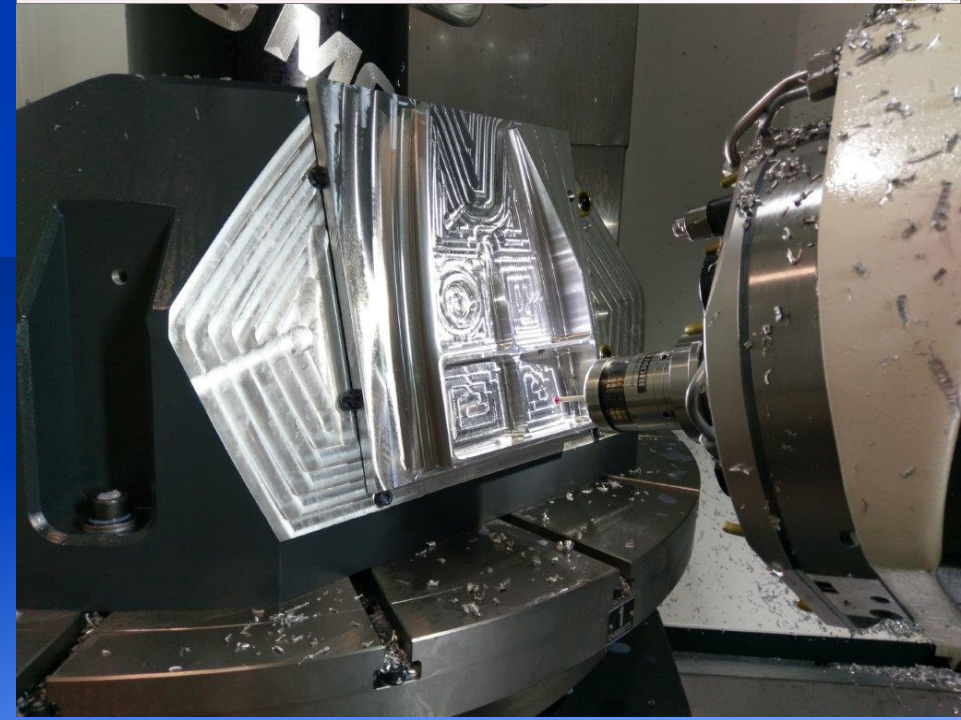
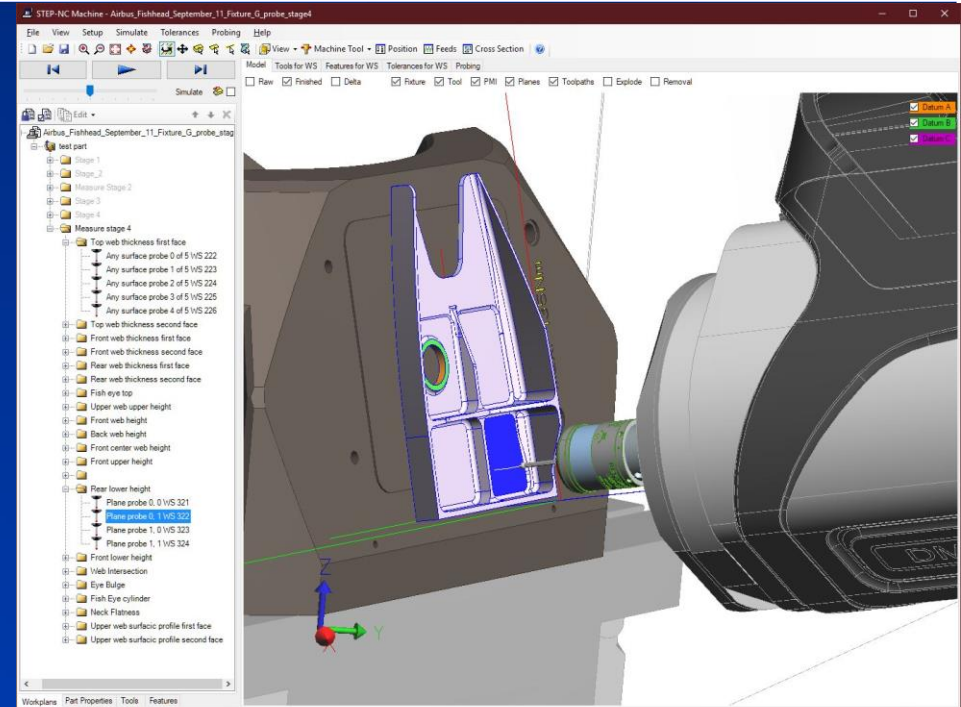


Digital Twin framework for manufacturing

“Delivery of Digital Twins to the customer and regulator”

Dr. Martin Hardwick
Convener ISO Digital Manufacturing



Introduction

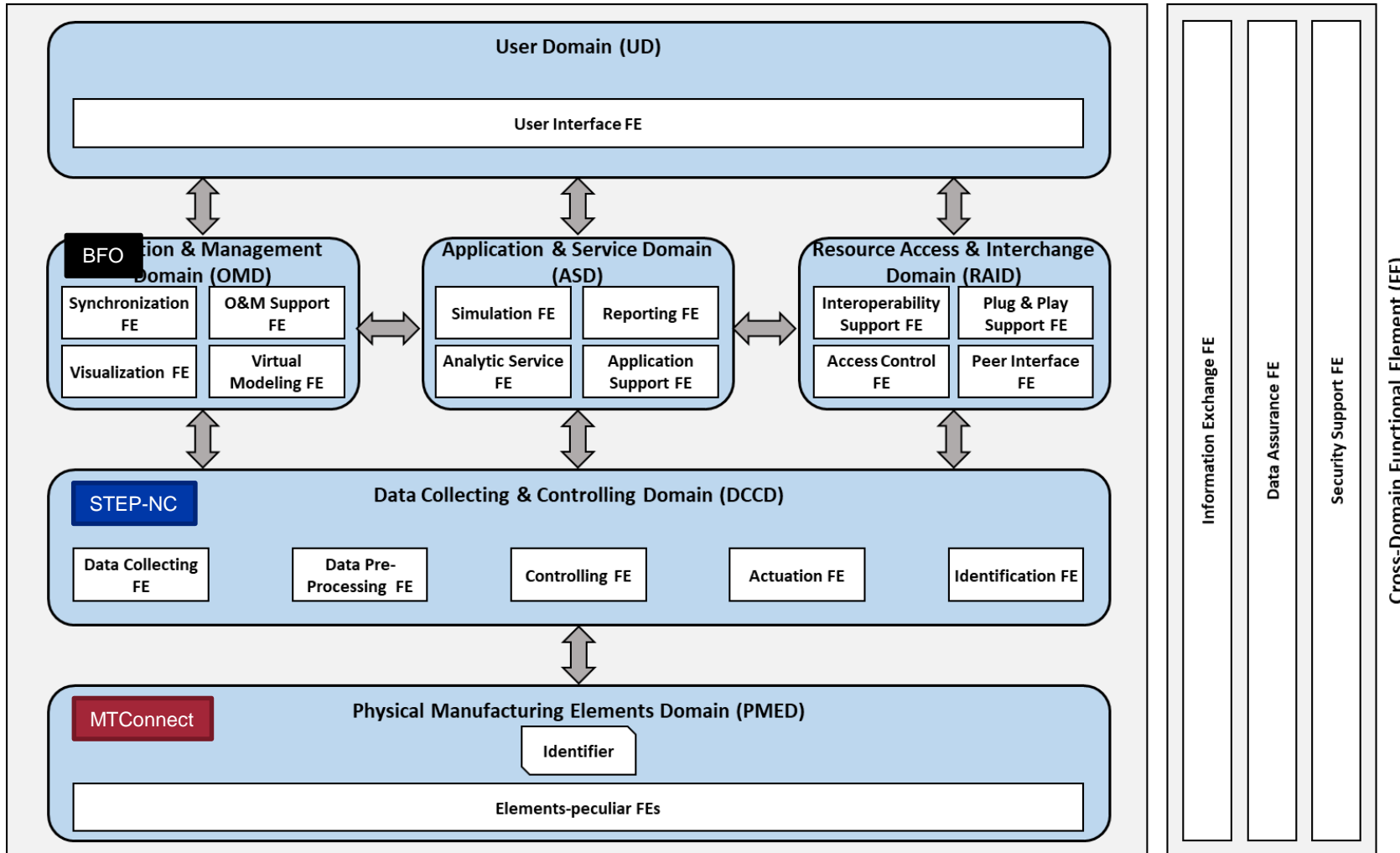
- **Who am I**
 - Dr. Martin Hardwick
 - Convener of ISO Digital Manufacturing working group
 - www.steptools.com, info@steptools.com
- **What standards are we developing / assisting**
 - STEP-NC integrated model for machine control – ISO 10303-238
 - QIF Quality Information Framework – ISO 23952
 -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

Every CAD system has a STEP interface

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

STEP-NC is the MCD format for the New Midsize Airplane (NMA)

Digital Twin framework for manufacturing – ISO 23247



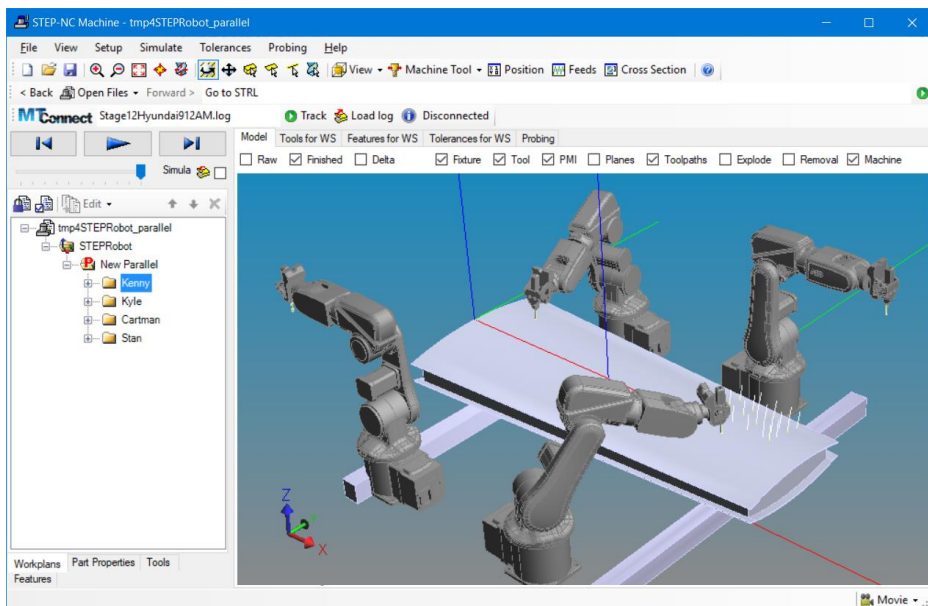
ISO 23247 layered on
the IoT architecture
ISO 30141

Enable learning and
predictions for
manufacturing
machines

CD ballot passed in
September, DIS
submission in January,
next face to face meeting
at Longacres in February

Example 1 – dynamic scheduling of robot teams

- Four robot STEP-NC program
 - Digital robot models from CAD systems include kinematics for all components
 - Digital robot teams synchronized with physical robots enabling dynamic control
 - Digital robot results that can be analyzed for opportunities, patterns and exceptions



Digital Robots

RDF

Digital Twin

STEP-NC

Digital State

MTConnect

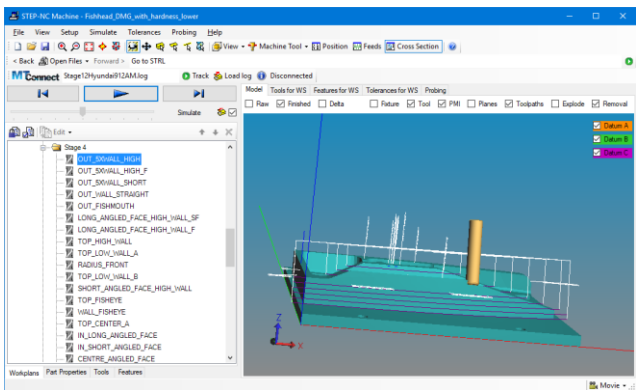
Digital Exhaust

ISO 23247
Digital Twin framework
for manufacturing

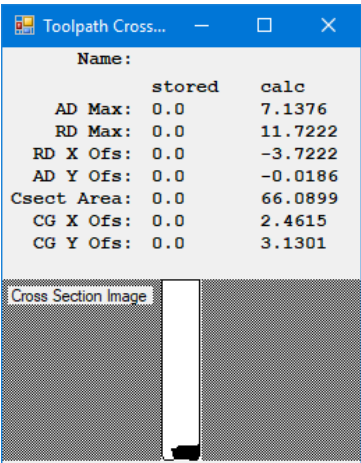


Robots on Rails

Example 2 – speed feed optimization to maximize tool life



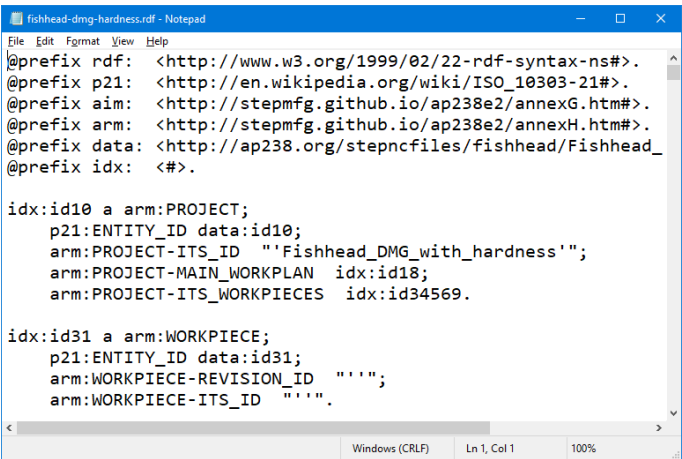
Change tool diameter



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://ap238e2.org/stepncfiles/fishhead/Fishhead_
@prefix idx: <#>.

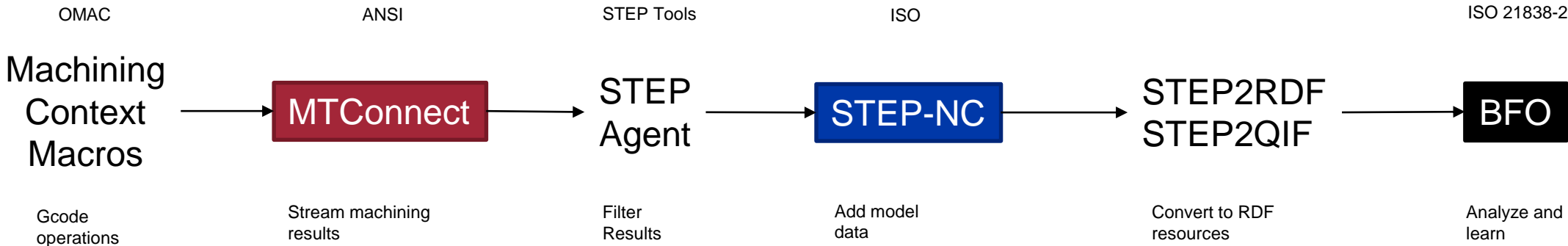
idx:id10 a arm:PROJECT;
p21:ENTITY_ID data:id10;
arm:PROJECT-ITS_ID "Fishhead_DMG_with_hardness";
arm:PROJECT-MAIN_WORKPLAN idx:id18;
arm:PROJECT-ITS_WORKPIECES idx:id34569.

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

Make linked data



Go / No Go



Goals for 2020

- Robust, safe, dynamic and flexible drill and fill for assemblies
 - Dynamic scheduling of robot movements as locations on rails changes
 - On demand measurement of robot and hole locations using sensors and digital state
 - Continuous monitoring of robot health using machine learning and material properties
 - Digital twin model for every hole that is drilled and filled