Enabling Learning for Manufacturing Machines

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Introduction

Who am I

• Dr. Martin Hardwick
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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

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

How do we learn to make corrections?

Example 2 – schedule team of robots

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How do we scale to airframe big?

Digital Twin → Airframe
Digital Twin → Wing spar

Shells

Digital Twin → Holes
Digital Twin → Digital Twin
Digital Twin → Holes

Path

Robot CNC

“Kill” Kenny

Drill and fill
Example 3– learn how to maximize tool life

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Change tool diameter

Compute tool engagement

Make linked data

Go / No Go

Machining Context

 Macros

OMAC

ANSI

STEP Tools

ISO

USAF

IOF

MTConnect

STEP Agent

STEP-NC

STEP2RDF

RDF

Gcode operations

Stream machining results

Filter Results

Add model data

Convert to RDF resources

Analyze and learn

AI

ML
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
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