

Digital Thread/Digital Twin Use Cases

Situation-Target-Proposal

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Context-Based Machine Monitoring/State Display

“Surely I should know more about what is going on than a bunch of numbers changing on a screen”

Situation

- Typically, CNC machines only have low level process information and are unaware of part and higher level process information. This limits their ability to make smart decisions during manufacturing, as well as provide context for events that occur during manufacturing

Target

- CNCs receive information about the process they are performing, and the features they are performing them on. They also are able to display and transmit this context information

Proposal

- Define and publicize standard methods for transmitting this information, using presently available infrastructure at machines

Leader **OMAC**

Key Technical Support [Boeing](#), [Airbus](#), [Siemens](#), [Fanuc](#), [Heidenhain](#)

Full Models Available Pre-Purchase

“Why is it so hard to buy a machine?”

Situation

When purchasing machine tools with complex kinematics, it's difficult to determine whether part(s) will fit on that machine, or even if they do fit, if there is an accurate, efficient location for them.

Target

Machine work envelope, kinematics, and predicted machining times are available in STEP format so a customer can “try before they buy” and compare machines easily

Proposal

Define/develop standard representations of machine using STEP and other standards. Develop, Publish, Publicize.

Leader **NIST**

Key Technical Support [DMG/Mori](#), [Makino](#), [Okuma](#), [Hyundai](#)

Security/Integrity/Provenance

“How do I that I am machining with the right program”

Situation

Concern is increasing regarding the security and reliability of CAM process data. New concepts, such as Digital Thread/Digital Twin result in more comprehensive data being passed through manufacturing systems/entities.

Target

Secure, correct, data from known sources is guaranteed.

Proposal

Identify available security infrastructure. Demonstrate capabilities and advocate.

Leader **STEP Tools**

Key Technical Support, [Lockheed](#), [Argonne National Labs](#), [NIST](#), [US Military](#)

Collision/FOD/COA/Setup Validation/Safe Entry Detection/Process execution validation

“How can I stop crashing my machine/part?”

Situation

Toolpath validation tools have greatly reduced the number of machine crashes. However, they still occur. Typically crashes happen due to unexpected conditions at the machine (clamps left in place, wrong stock loaded, wrong cutter, wrong offsets). They also happen when recoveries are being made after process interruptions. Additionally, there is no way to know if a process has been fully executed. Some tools are emerging in this area, but configuration is difficult due to the non-standard, non-comprehensive interfaces that are utilized.

Target

Easily configurable digital twins are used to reduce likelihood of crashes and confirm process execution.

Proposal

Fully define digital twin using STEP and other standards. Provide interfaces for process validation and crash prevention tools.

Leader [Hyundai/Wia](#), [DMG/Mori](#), [Makino](#), [Okuma](#)

Key Technical Support [KTH](#), [NIST](#)

Integrated Flexible GD&T

“I want to make smart decisions regarding GD&T throughout the manufacturing/inspection process.”

Situation

Traditionally, GD&T information is only available as flag notes in CAD. A separate, paper/drawing based path is used through the manufacturing/inspection process. This increases the risk of error, makes it hard to make changes, and limits the ability to analyze “as built” tolerances from “as designed”

Target

GD&T information are available in the 3D model, and in a standard format throughout the design/manufacturing/inspection cycle. All interested entities have access through standard interfaces.

Proposal

Fully define GD&T in CAD/CAM using native tools. Export to manufacturing as a STEP 242 file. Use 242/QIF to manage measurement data

Leader [Mitutoyo](#),

Key Technical Support [Boeing](#), [NIST](#), [Airbus](#), [Dassault](#), [Renishaw](#)

Third Party Toolpaths/Process Sharing

“I want to be able to share process information with my suppliers and customers, not just 3D solids”

Situation

3D solid translation using STEP (AP203/AP214/AP242) is ubiquitous and reliable. However, machining process information translations in use are generally crude, “point to point”, and unavailable. This limits the ability of different suppliers and technology providers to share data. This results in “hand waving” for communication of manufacturing processes and limits flexibility.

Target

Full process, part, fixture, stock, and cutter information import and export using STEP is ubiquitous and reliable.

Proposal

Develop, test, and demonstrate comprehensive STEP import/export in several mainstream CAD/CAM systems.

Leader Sandvik, Iscar

Key Technical Support Concepts NREC

Cutter Assembly Management

“I want to know more about my cutter assemblies, and want to quit retyping data into systems”

Situation

Cutter assemblies can be quite complicated and difficult to represent. Typically, they are defined in non-standard methods in CAM systems. This data is manually entered from other sources. Consequently, translation errors are made, full definitions are not translated, and it is harder to use new cutter concepts

Target

Cutter assembly information from a variety of sources are instantly available within CAM

Proposal

Demonstrate import from multiple cutter manufacturers, to multiple CAM systems using ISO 13399. Demonstrate export from multiple CAM systems of ISO 13399 data. Explore enhancement of ISO 13399 for other capabilities i.e. “Oil Life” or dynamic characteristics.

Leader **Sandvik**

Key Technical Support [Iscar](#)

Native AP238 CNC

“Why is the interface to modern CNC technology locked up in a 1980s box”

Situation

Traditional CNC interfaces (user and data) make it difficult to implement new technologies and access their full capabilities.

Target

A breakthrough CNC that easily utilizes modern, standards based CNC technology

Proposal

Build and demonstrate a modern “STEP-NC” CNC

Leader [Hyundai/Wia](#),

Key Technical Support [STEP Tools](#), [Boeing](#), [DMG/Mori](#)

Smart Adaptive Control

“I want adaptive control that doesn’t cause problems”

Situation

“Adaptive Control” allows machines to make process adjustments in real time based on process feedbacks. This technology has been around since the 1970s, but has shown limited adoption. A key reason for this lack of success is that without proper knowledge of the part being machined, and the process being used to machine it, adaptive control process adjustments are frequently wrong, and can overstress machines, and damage parts and cutters.

Some adaptive control implementations take this into account, but a failure to use standard data makes part setup difficult

Target

“Smart Adaptive Control” that is reliable, efficient, and easy to configure.

Proposal

Provide infrastructure, including cutters, process, part, stock, fixture, and machine information in a standard format that can be used to inform adaptive control.

Leader [Pratt & Whitney/CCAT](#), [Rolls Royce/CCAM](#), [GE/DMDII](#)

Key Technical Support [Makino](#), [Hyundai/Wia](#), [DMG/Mori](#), [NIST](#)

Seamless tooling optimization

“I want simple tool management and optimization of machining solutions”

Situation

The information management through the working steps from design of tool assembly to analysis of achieved machining process result contains many gaps. There is no digital thread to support the circular workflow from tool as designed – tool as realized – tool as used – tool as analyzed – back to tool as designed. Furthermore, data collected from the machining process has very limited or no relation to the context of the product and the tool. This makes it very difficult to analyze and optimize machining solutions. Another problem is the lack of standardized data from machine controllers, which leads to that the only practical option for collecting data for optimization and improvements is manual registration.

Target

Model-based tooling optimization enabled by the digital thread.

Proposal

Develop and demonstrate a scenario for optimization of machining solutions based on ISO 13399, STEP-NC and other relevant international and de facto standards such as MTConnect and OPC-UA, also considering possibilities with state-of-the-art mobile communication

Leader **KTH**

Key Technical Support [Sandvik](#), [Iscar](#), [NIST](#), [Scania](#)