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# Digital Twin Manufacturing

*Fast, Flexible and Accurate*

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Digital twin manufacturing is making a model in real time to get better quality for the twinned part, and better performance from the twinned process.

Digital twin manufacturing is faster, more flexible and more accurate because your operators can get help from Internet services.

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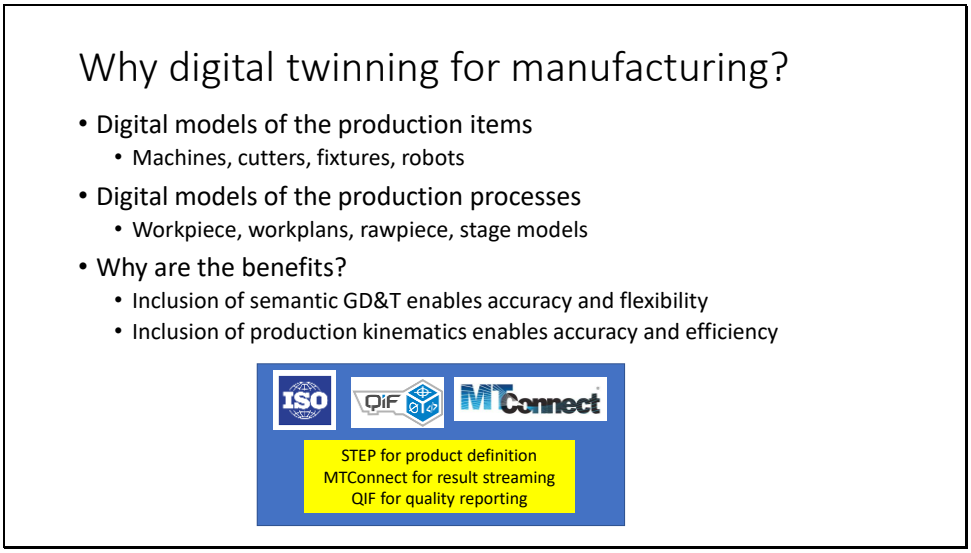


Digital twin manufacturing is enabled by digital models. They are the models made in CAD and CAM system but using standards we bring them to the shop floor.

They make manufacturing more accurate because they include computer processible definitions for the required Geometric Dimensions and Tolerances.

They make manufacturing more efficient because they include computer processible definitions for the machine kinematics so they can be adjusted to make the machining faster or more economic (less tool wear).

Our project has defined a framework for digital twin manufacturing that uses STEP for the product definition, MTConnect for real time communication and QIF for quality reporting.

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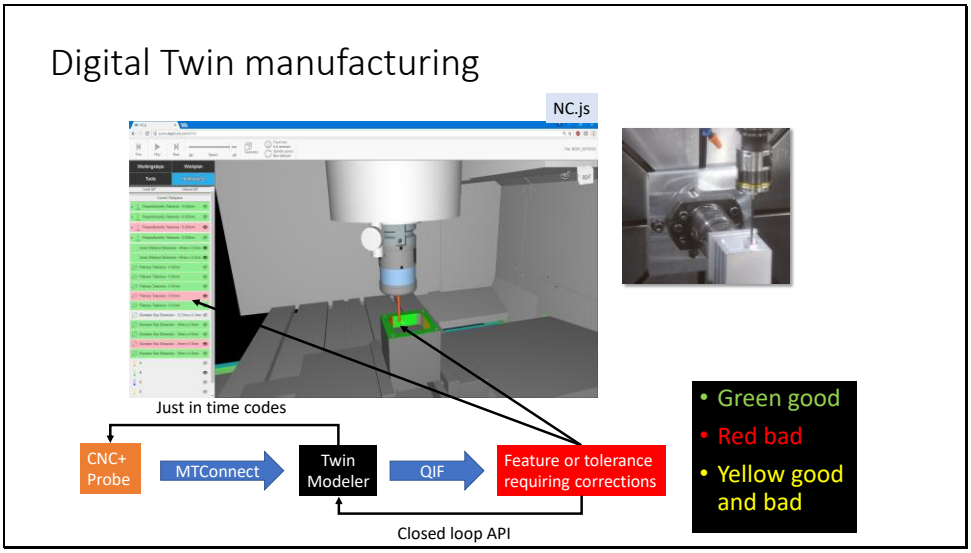


Here is an example for a part that we machined at the DMDII last summer.

As we machined the part we checked the tolerances in real time. There were dimensions and squareness constraints that needed to be checked.

We used a probe to make the measurements and were able to report the results over the Internet.

Red means an issue was found, green means no issue and yellow means this face met some of its tolerances but failed others. In this case the face was good for its location but not for its flatness.

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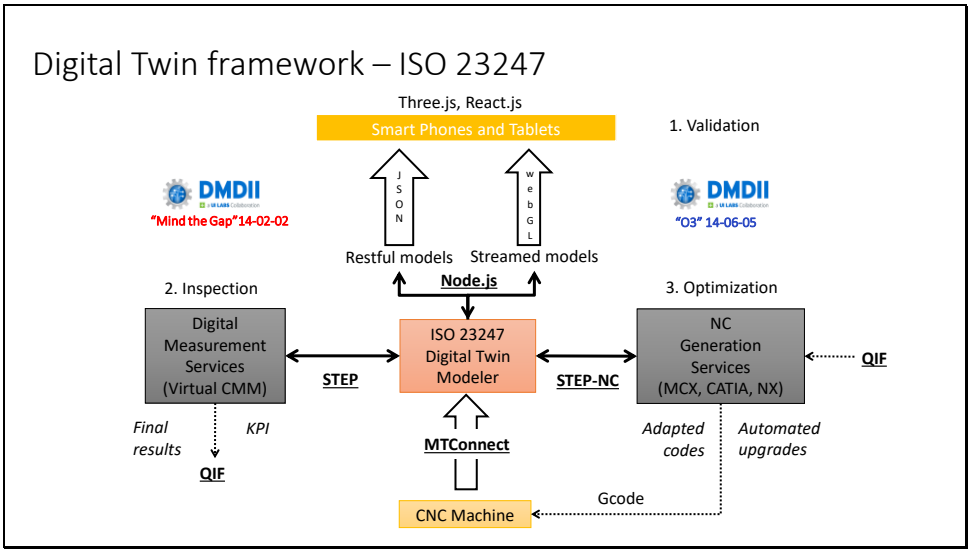


Here is a framework we use for digital twin manufacturing.

If a process needs to be "juiced" then we ask a tool vendor to send a new solution.

If a part is not in tolerance, then we ask an NC service to send better toolpaths.

If an expert needs to be called then data is sent to his or her smart phone.

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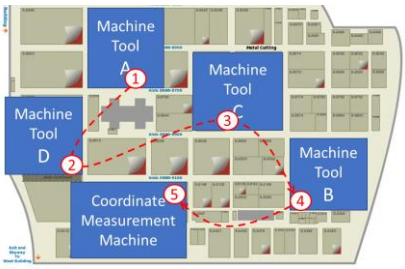
## Applications

- In-process measurement
  - Measure on the machine
- "Self driving" tools
  - Optimize feeds after tool changes
- Error free manufacturing
  - Prevent collisions on restarts
- Faster life cycle
  - Communicate issues and opportunities across the enterprise




Demonstrations at IMTS 2018 and JIMTOF 2018

Today we are showing some of this vision. Two machine tool vendors will make an aerospace part called the fish head.

Each will take turns with one doing the 3-axis roughing on one day, and the other doing the 5-axis finishing on the next.

We will check the results in real time using a Renishaw probe and off the machine using a CMM.

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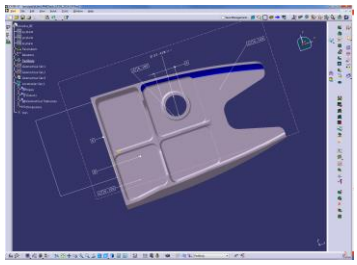
## IMTS and JIMTOF participants

- Participants and observers (* = contributing observer)
  - Organizations
    - ISO TC184/SC4
    - OMAC
    - NIST
    - AMT/MTConnect
    - DMSC/QIF
  - Technology Providers
    - STEP-Tools, Inc.
    - Dassault *
    - Autodesk *
    - Capvidia
  - Cutters/Holders
    - Sandvik Coromant
    - ISCAR *

**CATIA**



- Machine Tool Suppliers
  - DMG Mori (IMTS, JIMTOF)
  - Hyundai (IMTS)
  - Makino (JIMTOF)
  - Okuma *
- Metrology
  - Mitutoyo
  - Renishaw
- End Users
  - Boeing
  - Airbus

**Participants add value to STEP, MTConnect or QIF**

It is very important to enable wide participation in digital twin manufacturing. That is why our framework is defined by standards. With standards everyone can join in and make parts the new way.

A way that was not possible until recently because real time modeling requires a lot of computing power.

Now it is possible thanks to your teenage son and his obsession with computer games. Be sure to thank him when you get home.

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## Digital Twin manufacturing – fast, flexible, accurate

- Fast with cloud-based optimization services
- Flexible with model-based adaptable programs
- Accurate with standards-based measurement


Questions?

Please think about our efforts and how you can help.

We need to be sure we can measure all the different kinds of tolerances used by your industry.

We need to be sure we can model all the machines and processes used for your products.

Contact us at the address shown on the cards if you would like to join a follow-on meeting in Chicago In November.