

IMTS and JIMTOF 2018 Challenge

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Base Goals

1. Digital Twin machining in multiple booths
 - Read STEP-NC process for fishhead
 - Transmit machining status to large screen TV's using MTConnect
2. Demonstrate digital twin framework
 - Stop the machining
 - Transfer to another booth
3. Digital Twin measurement to validate results meet AP242 tolerances
 - In process measurement at the CNC
 - Final measurement on a CMM
 - Feedback to the digital twin using QIF

Digital Twin Machining



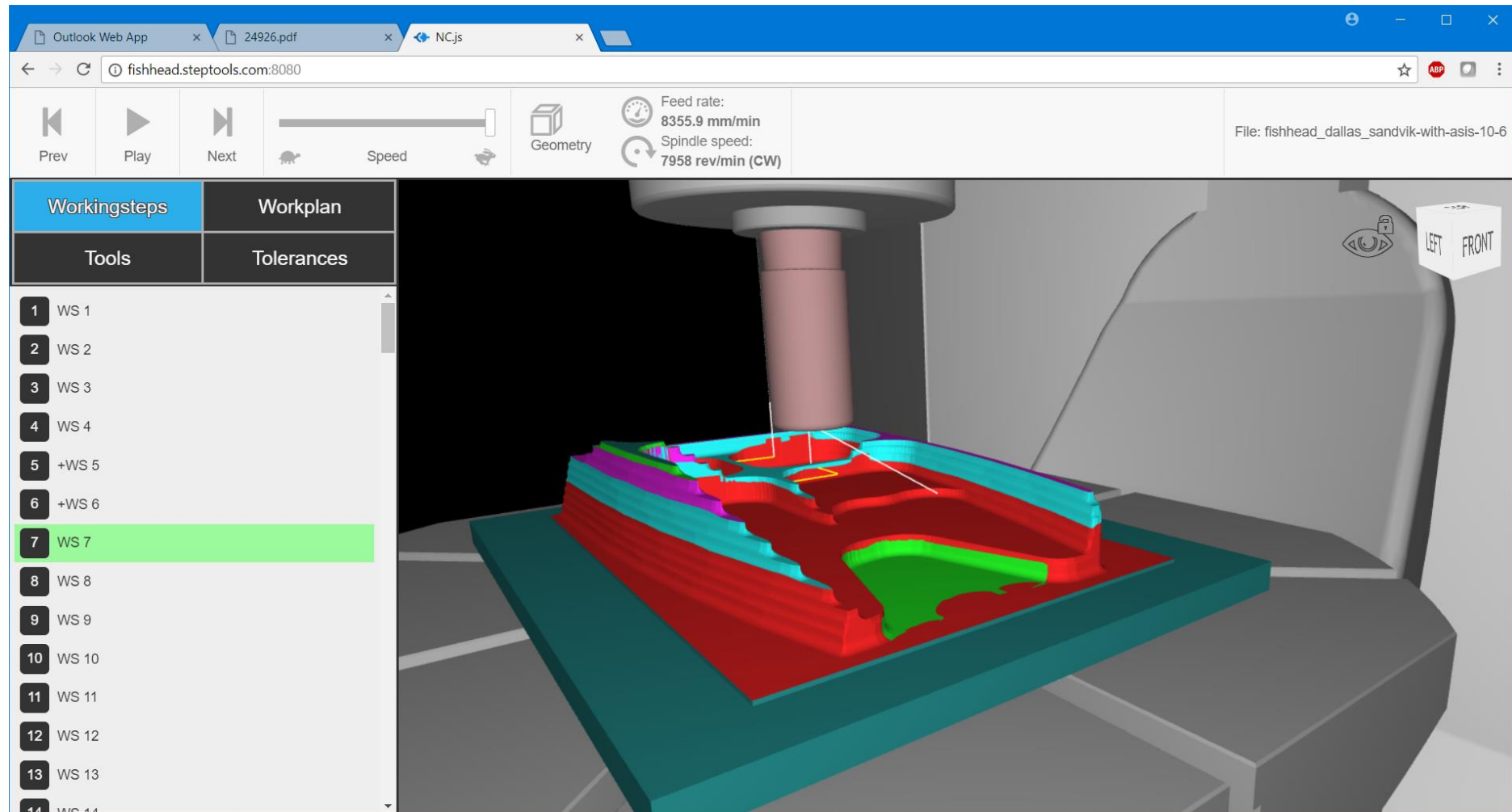
“Mind the Gap” 14-02-02



<http://fishhead.steptools.com:8080/>

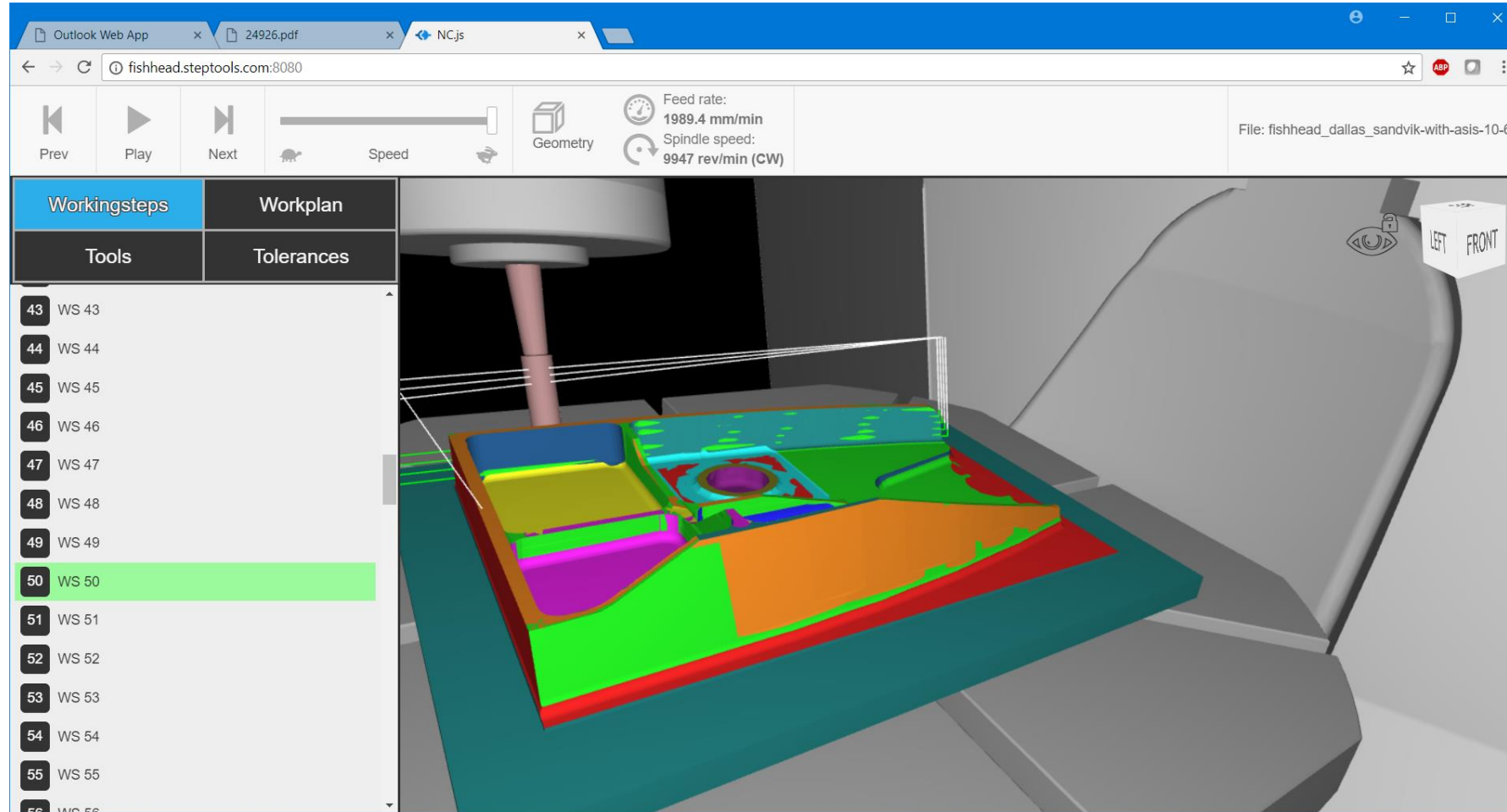
- Real time twinning from MTConnect
 - 1Hz trace the plan data
 - 250Hz model the run data
- Phone and large screen TV display
 - STEP in Node.js
 - View in Three.js
 - UI in React.js

Fishhead (aerospace test) at Workingstep 7



<http://fishhead.steptools.com:8080/>

Fishhead at Workingstep 50



<http://fishhead.steptools.com:8080/>

QIF results on STEP twin

The screenshot displays a web-based interface for a STEP twin simulation. The browser address bar shows `swim.steptools.com:8080`. The main window features a 3D model of a CNC machine tool cutting a workpiece. On the left, a 'Tolerances' panel lists various QIF (Quality Inspection Framework) results for the 'Current Workpiece'. The results are categorized by tolerance type and color-coded: green for pass, red for fail, and yellow for warning. The 'Diameter Size Dimension' results are highlighted in red, indicating a failure.

Tolerance Type	Value	Status
Perpendicularity Tolerance	- 0.025mm	Pass
Perpendicularity Tolerance	- 0.025mm	Pass
Perpendicularity Tolerance	- 0.025mm	Fail
Perpendicularity Tolerance	- 0.025mm	Pass
Linear Distance Dimension	- 60mm ± 0.3mm	Pass
Linear Distance Dimension	- 60mm ± 0.3mm	Pass
Flatness Tolerance	- 0.02mm	Pass
Flatness Tolerance	- 0.01mm	Pass
Flatness Tolerance	- 0.01mm	Pass
Flatness Tolerance	- 0.01mm	Fail
Flatness Tolerance	- 0.01mm	Pass
Diameter Size Dimension	- 12.7mm ± 0.3mm	Pass
Diameter Size Dimension	- 16mm ± 0.8mm	Pass
Diameter Size Dimension	- 16mm ± 0.8mm	Pass
Diameter Size Dimension	- 16mm ± 0.8mm	Fail
Diameter Size Dimension	- 16mm ± 0.8mm	Pass

Invited Participants

- Makino
- Okuma
- Hyundai
- DMG Mori
- Mazak?
- Limits
 - 4 machine vendors
 - 1 cutter vendor
- Supporters
 - Mitutoyo
 - Renishaw
 - DMSC/QIF
 - Dassault?
 - Autodesk?
 - NIST
 - Boeing
 - OMAC
 - ISO WG15 Digital Manufacturing
 - Sandvik
 - STEP Tools
 - AMT/MTConnect?

Sales pitch for the machine tool vendors

- Visit to Boeing to see STEP-NC Machining in production
- Write-up on what we are trying to do
 - Who we are
 - What we expect from each participant
 - What are the benefits
 - How we will publicize
- Ask them to participate in showing
 - Work movement with MTConnect at low resolution [1Hz] or high resolution [40Hz] for digital twinning
 - Fishhead to be machined from start to finish in each performance
 - Choice of which vendor performs which operation to be selected randomly at the start of each performance
 - Each performance ends at Mitutoyo for measurement with QIF results shown on the digital twin
- Vendors encouraged to show the advantages of the Digital Twin with applications to show
 - Automated setup
 - On machine Inspection
 - Tracking
 - Optimization
 - Bidding
 - Digital manufacturing framework
 - Other ideas

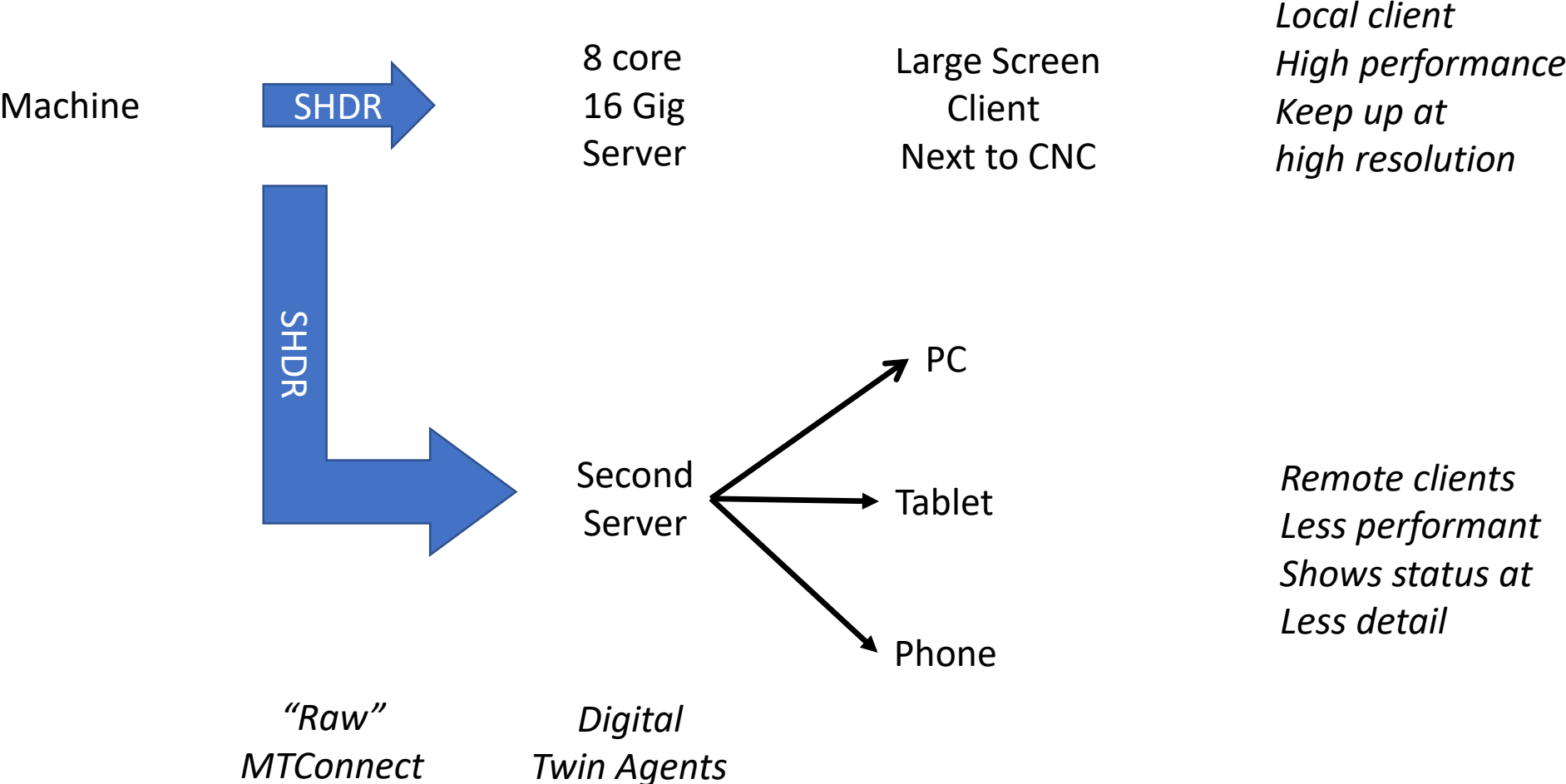
Grand Challenge preparation schedule

- Clean up fishhead data / model – Nov 30th?
 - Mitutoyo tolerances – Nov 30th
 - Boeing defined fixturing – Nov 30th
 - Boeing defined reference points – Nov 30th
 - Boeing defined ws names – Nov 30th
 - Boeing to divide into rough1, rough2, semi-finish, and finish
- Complete extract of AP238 from CATIA – Dec 31st
- **Finalize write-up – Jan 31st**
- Confirm support/funding – Feb 1st
- Visits to Boeing to see STEP-NC production machining, and machining of the fishhead test part
 - Visit 1 – Feb 15 (DMG?)
 - Visit 2 – Feb 28 (Makino?)
 - Visit 3 – March 15
 - Visit 4 – March 31
- Finalization of commitments May 1st
 - After this you may be able to join but we may not be able to help you
- Completion of detailed planning of the show logistics July 1st

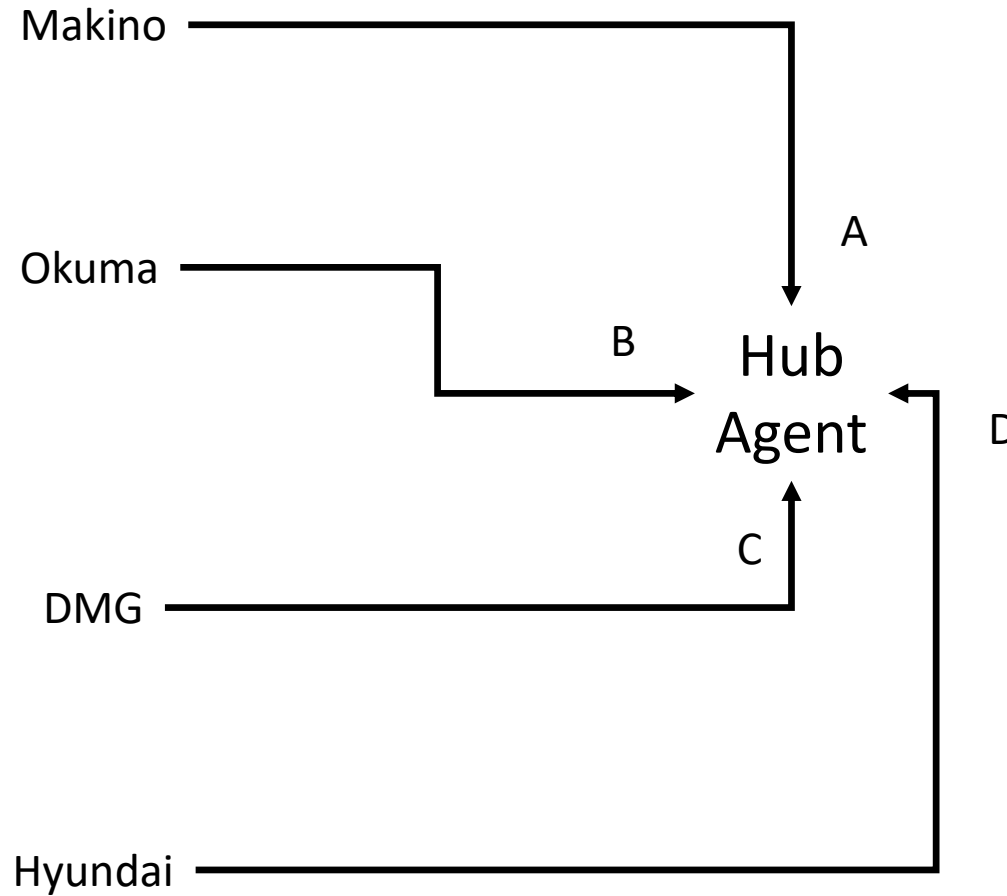
Sandvik hosting of digital twin hub

- Sandvik suppliers cutters under its standard terms for a show
- Sandvik shares models of its tools
- Machine vendor shares model of its machine
- High speed internet delivers MTConnect in real time
- Digital twin can be seen in vendor booth and at the twin hub
- Story board – November 30th
- Write-up – December 31st
- Agreement on minimal functionality – Jan 31st

Machine Twinning



Hub Twinning



Hub agent listens to each socket (one per CNC)

When a CNC starts streaming
Load the right machine model
Continue twin from the last CNC

Contents of the write-up

- Vision statement
- What will happen
- How to participate
- Check-list of requirements for participating
- How supporters can help

IMTS and JIMTOF Audience takeaway's

- Digital twin manufacturing is inter-operable
- Digital twin manufacturing is measurable
- Digital twin manufacturing is transparent and open

- Digital twin manufacturing enables many new savings
 - See the vendor demos

- Digital twin manufacturing is the future
 - Integration of devices
 - Gateway for machine learning