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Simulation Advancements in “Industry 4.0”

Serge Viau / Sales Representative / CGTech



Who is doing simulation that includes the machine tool in their manufacturing process?

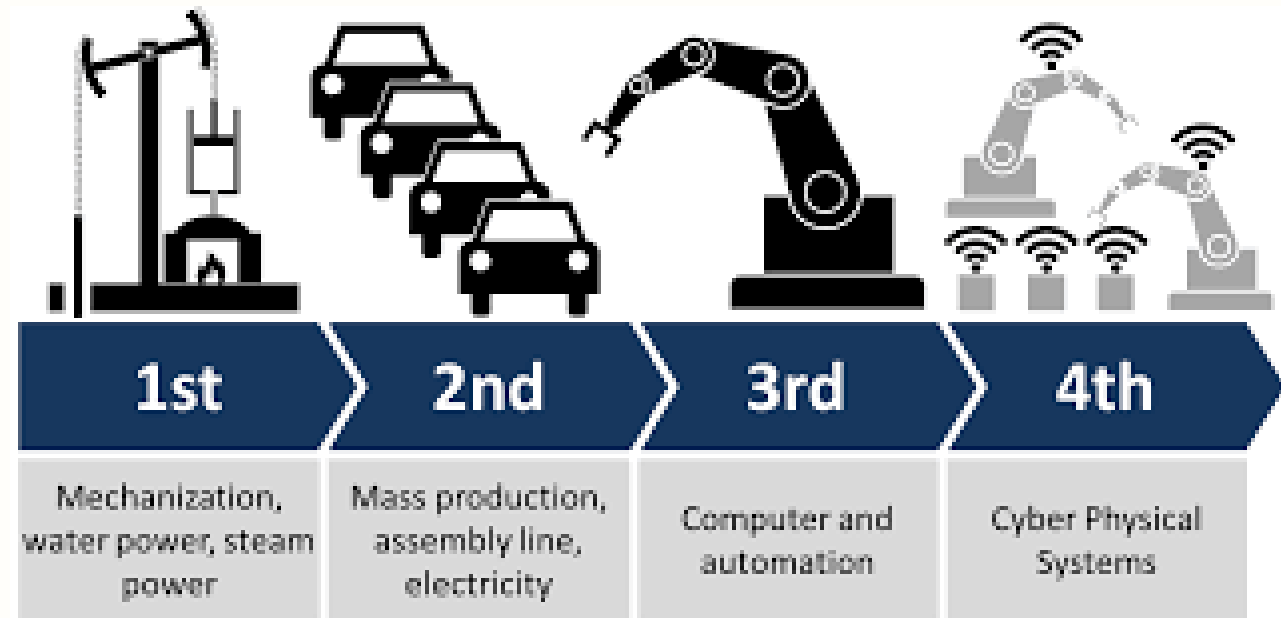
If you are, you are implementing (knowingly or not) a form of 'Digital Twin' that relates to Industry 4.0



(Image from Logical Advantage)

Industry 4.0

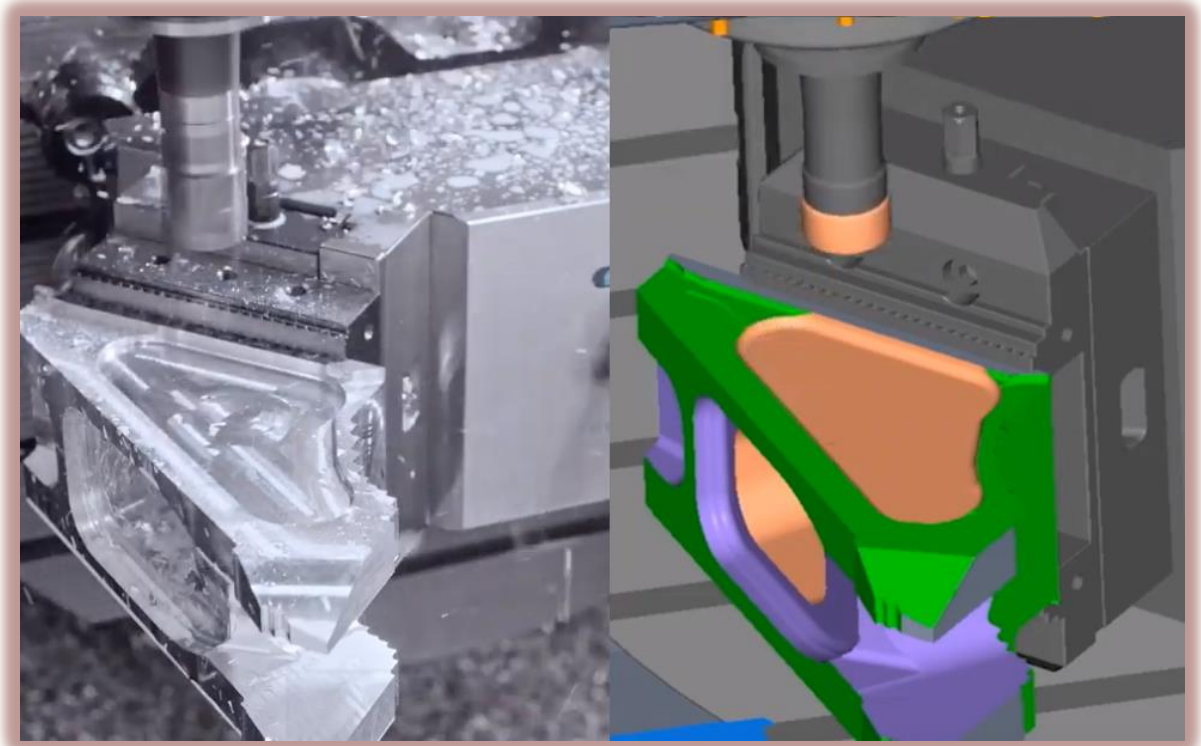
- Current trend of automation and data exchange in mfg technologies
- Referred to as 4th industrial revolution
- 4 design principles:
 - Interconnection
 - Information transparency
 - Technical assistance
 - Decentralized decisions



https://en.wikipedia.org/wiki/Industry_4.0

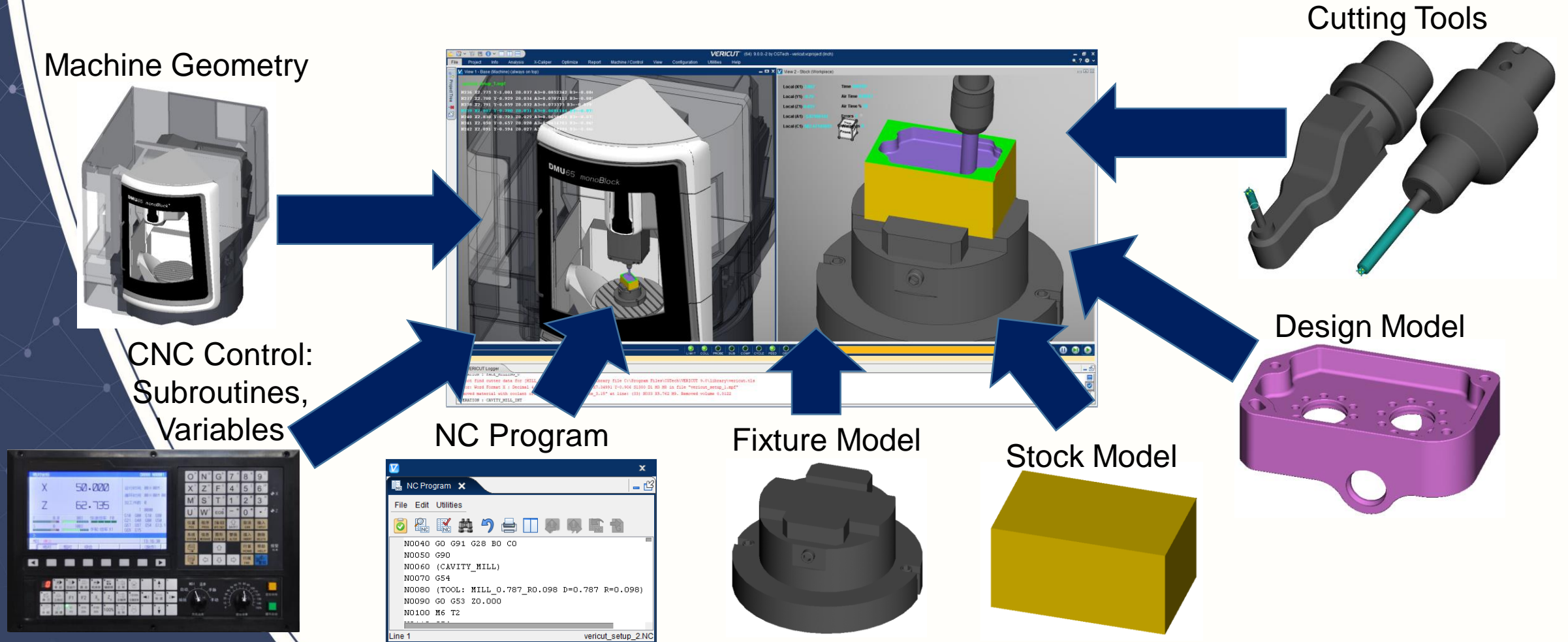
Digital Twin

- Digital replica of a physical asset
- Bridges the physical and virtual world
- Connection established generating real time data using sensors on physical device



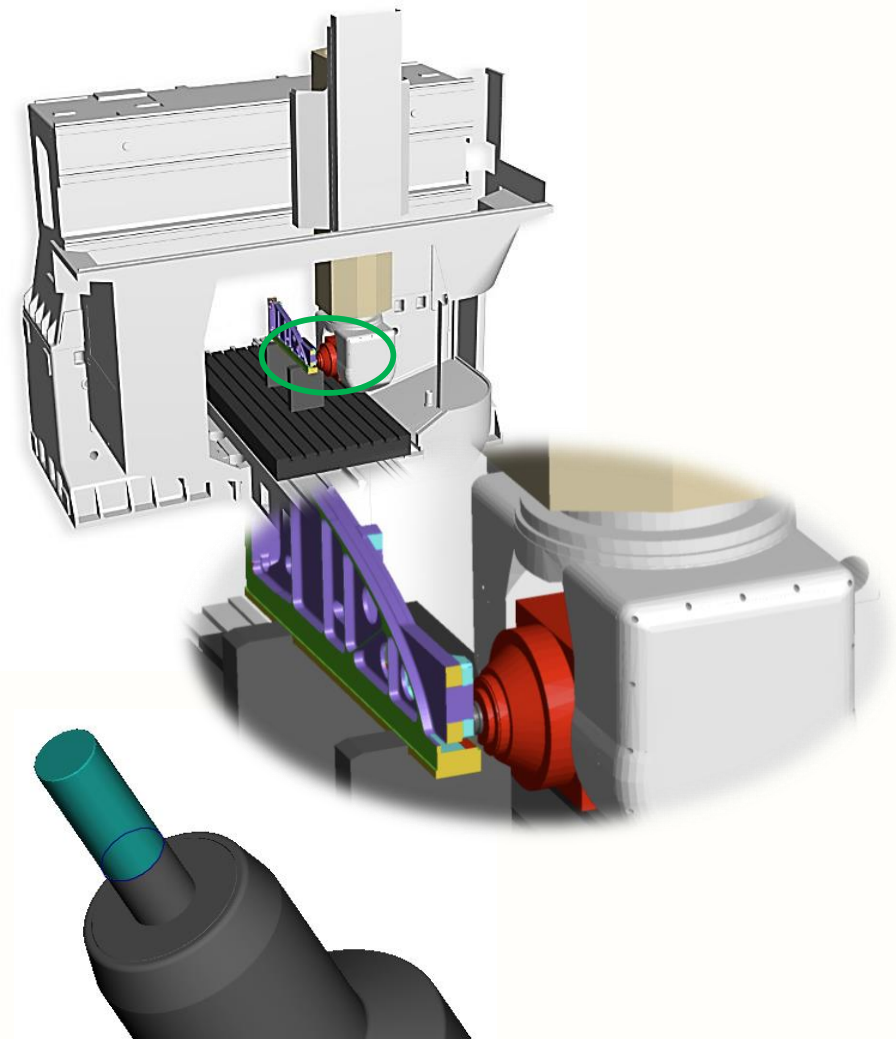
How does this relate to simulation?

- Culmination of all necessary data needed to machine a part



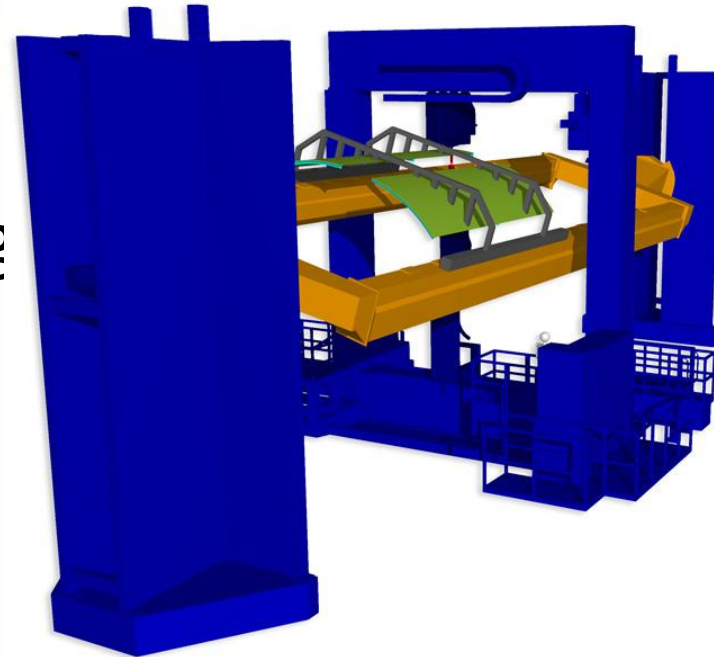
Digital Twin for NC Simulation

- Mission critical – models that exactly match part(s) on the shop floor
 - As realistic geometry as we can get
- Examples:
 - Machine geometry is accurate, but does not need every nut, bolt, screw...
 - Design, stock, fixture need details/accuracy
 - Cutting tools, need accuracy but not fluting on cutter



Not just for CNC Machining...

- Simulation can apply to:
 - EDM Die Sinking
 - Additive
 - Grinder Dressing
 - Drilling & Fastening
 - Composite Programming
 - Composite Simulation
 - Robot Simulation



Data Availability/Accessibility

- Part of Industry 4.0 – (Principle 1) – Interconnection (Interoperability)
- Data available throughout enterprise/suppliers
- Challenges
 - Data/models not available
 - Vendor will not supply
 - Data is inaccurate

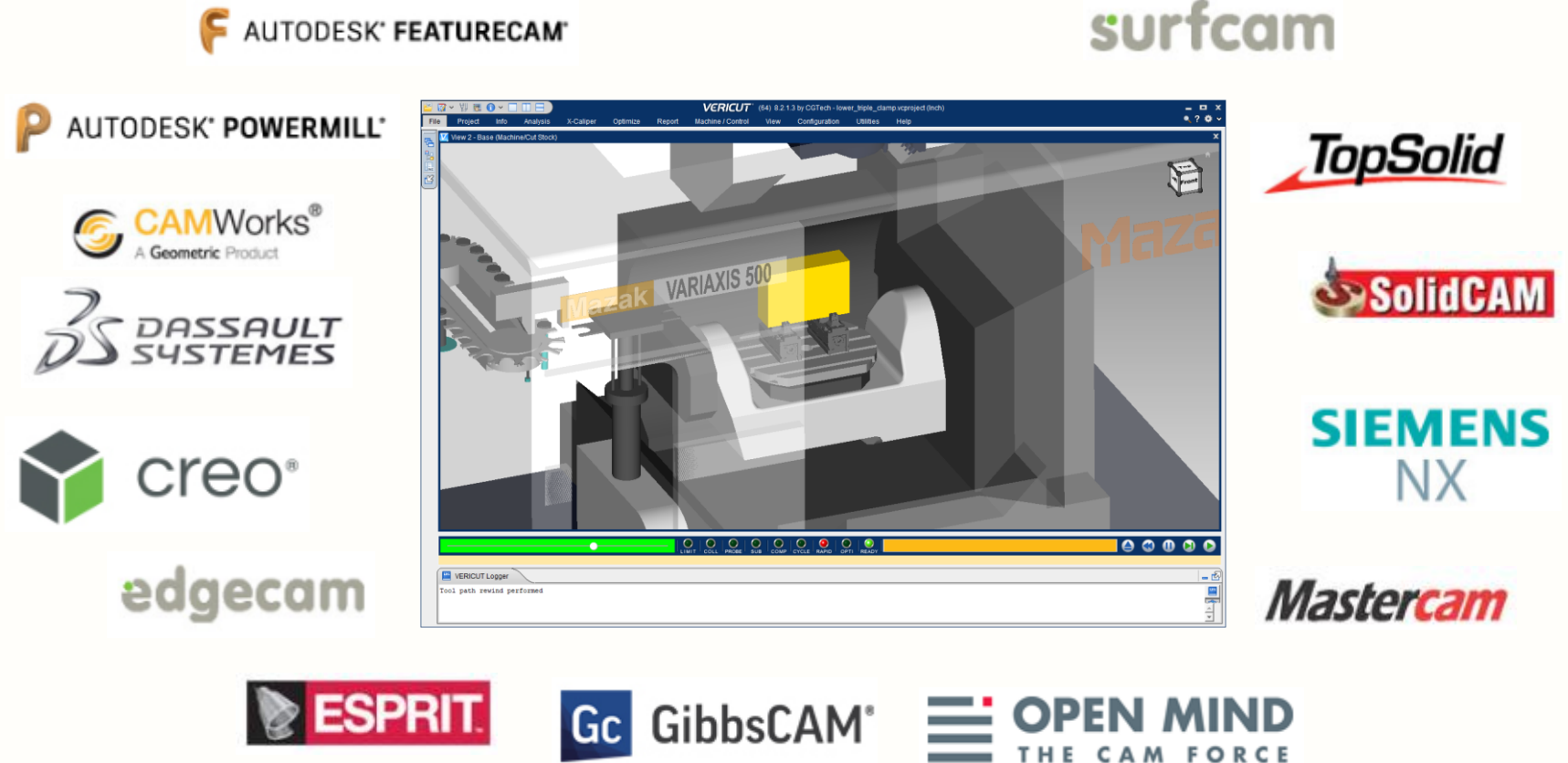
CNC Machine Data

- Requires knowing the machine
- Building a machine that works like the real machine can be challenging
- Technology Partners

The logo for Mazak, featuring the word "Mazak" in a bold, orange, sans-serif font.The logo for HERMLE, featuring a red circle with a white horizontal bar through the center, and the word "HERMLE" in a bold, black, sans-serif font to the right.The logo for starrag, featuring the word "starrag" in a bold, black, sans-serif font, with a red arrow pointing to the right above the letters "rag". Below it, the text "Starrag Group" is written in a smaller, black, sans-serif font.The logo for MAKINO, featuring a blue circle with a white horizontal bar through the center, and the word "MAKINO" in a bold, black, sans-serif font to the right.The logo for OKUMA, featuring a blue stylized "L" shape, and the word "OKUMA" in a bold, black, sans-serif font below it.The logo for HAAS, featuring a red square with a white stylized "H" shape, and the word "HAAS" in a bold, black, sans-serif font below it.The logo for DMG MORI, featuring the words "DMG MORI" in a bold, black, sans-serif font, with "DMG" in green and "MORI" in red.The logo for chiron, featuring the word "chiron" in a bold, black, sans-serif font, with a red underline below it.The logo for CMS Industries, featuring the words "CMS Industries" in a bold, black, sans-serif font, with "CMS" in blue and "Industries" in black.The logo for Matsuura, featuring a green stylized wave shape, and the word "Matsuura" in a bold, black, sans-serif font below it.The logo for ELECTROIMPACT, featuring a black square with a white stylized hammer and pencil icon, and the word "ELECTROIMPACT" in a bold, black, sans-serif font below it.The logo for HELLER, featuring the word "HELLER" in a bold, blue, sans-serif font.

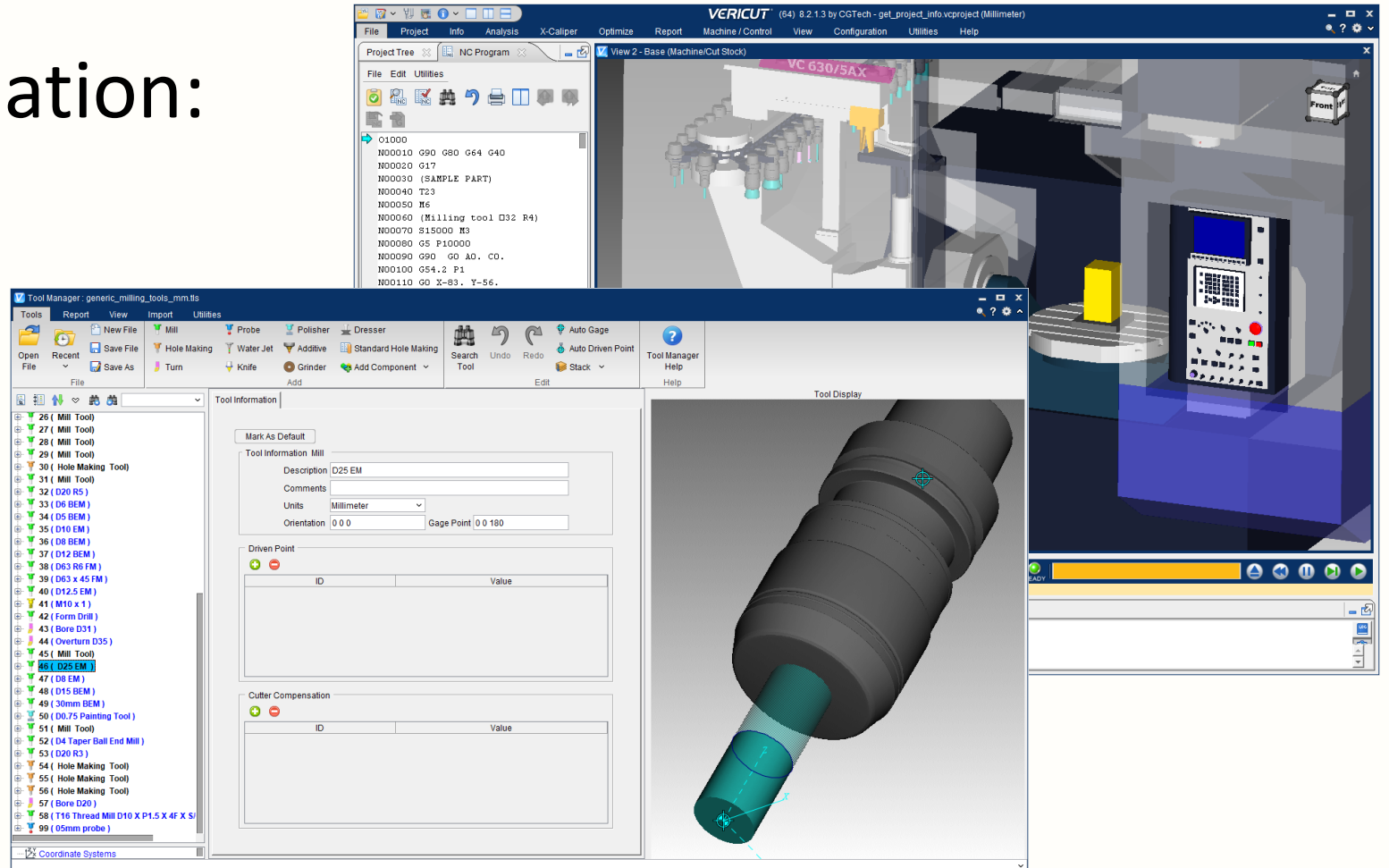
Connectivity to CAD/CAM Systems

- Reuse available data and information via interfaces
- Already setup from previous applications
- Removes human error



Advantages with Interfaces

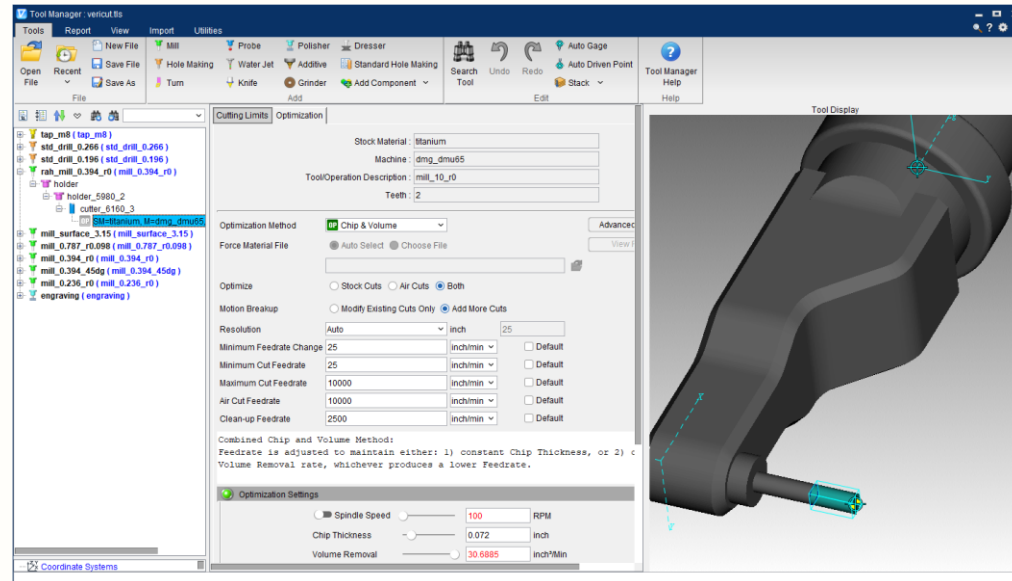
- Sets up a simulation:
 - Fixture
 - Stock
 - Design
 - NC Program
 - Work offsets
 - Tooling





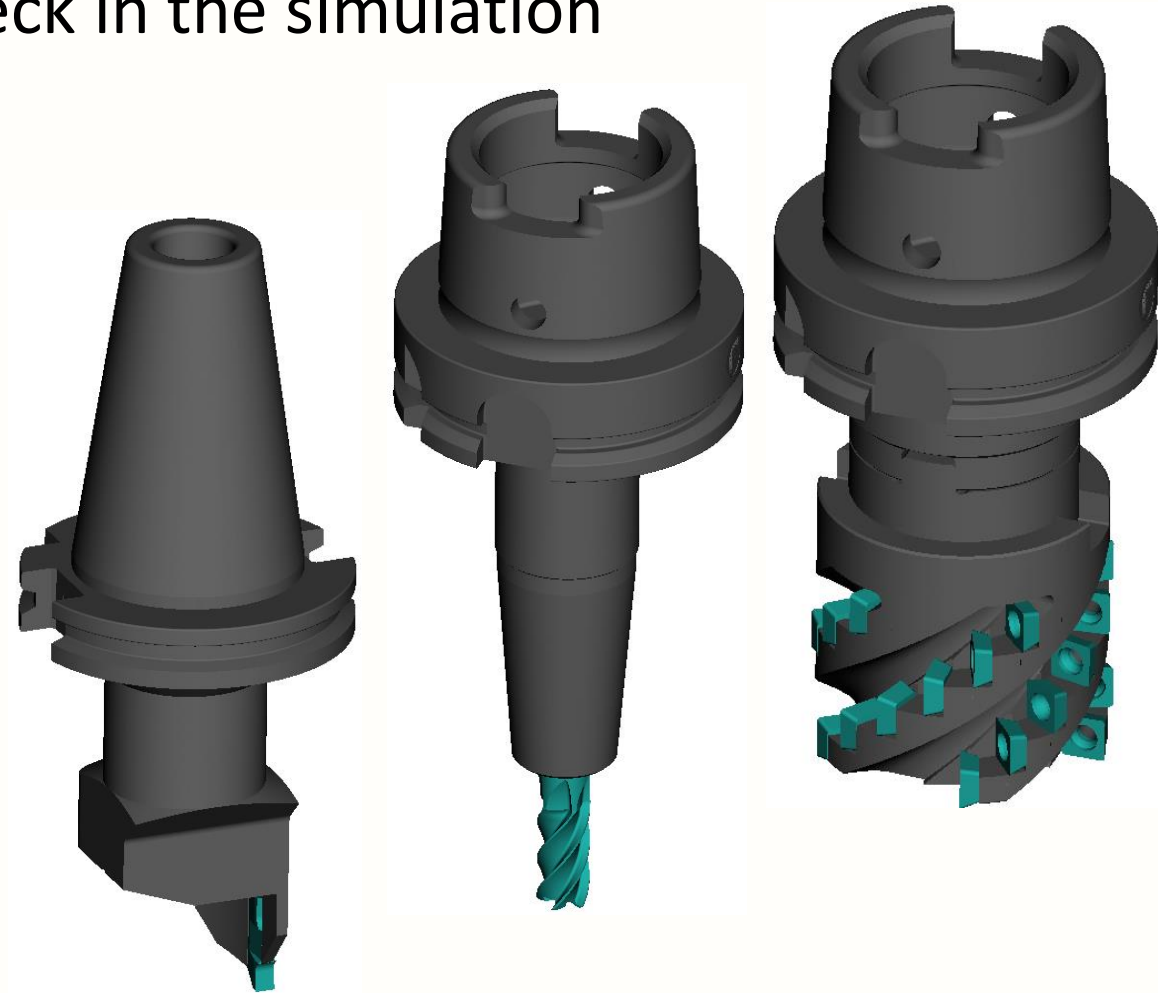
Connecting/Reusing Tooling Data

- Utilizing data from data management systems
- Tooling data and cutting parameters reused from various systems



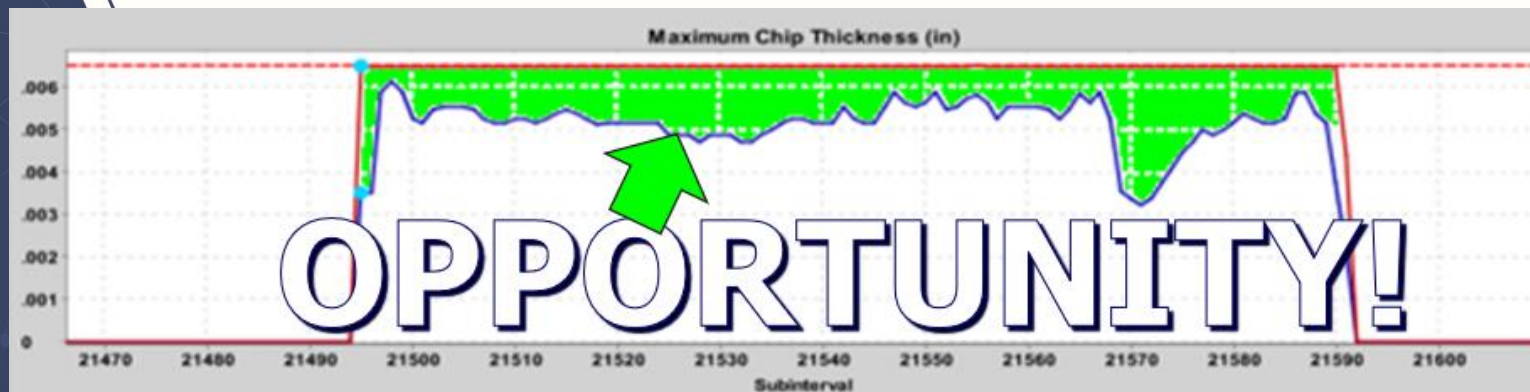
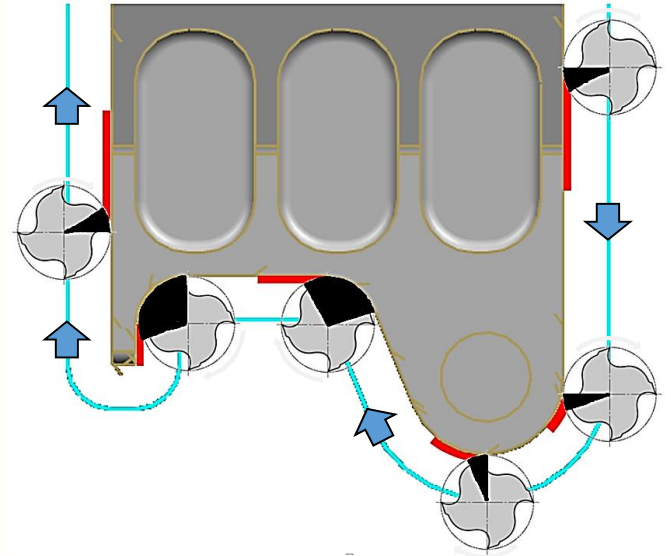
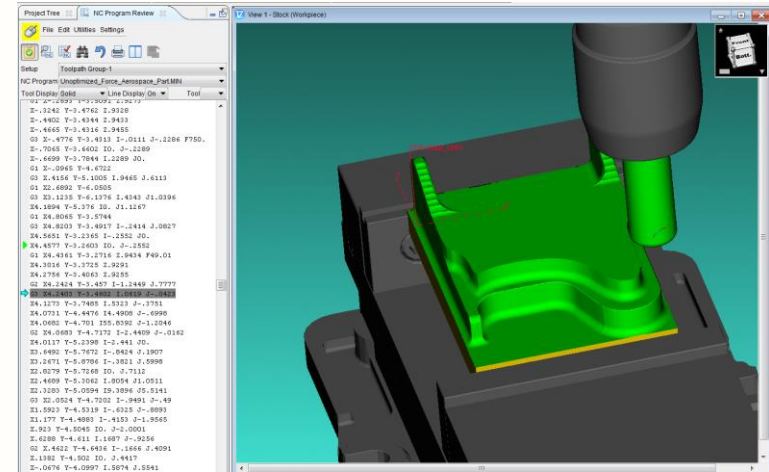
Tooling Data

- Tooling data can be read to check in the simulation
 - Tool assembly geometry
 - Gage length/Driven Point
 - Spindle Speed
 - Feed rate
 - Step over/step depth
 - Chip thickness
- Check parameters against simulation results
- Then use tool data to optimize the toolpath



Optimizing Toolpaths

- Part of Industry 4.0 – (Principle 4) – Decentralized decisions
- Non optimal feed rates in NC programs
- Leaves cost savings on the shop floor
- Does not take full advantage of cutting tool capability



Original vs. Optimized NC Program

Compare NC Programs

NC Program Type: G-Code Data

Original NC Program: partOkuma Event Dec 2017 C... Davala - mastercam\Unoptimized_Force_Aerospace_Part.MIN

Optimized NC Program: Unoptimized_Force_Aerospace_Part.Opti

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X4.3651 Y-3.2365 I-.2552 J0.
X4.4577 Y-3.2603 IO. J-.2552
G1 X4.4361 Y-3.2716 Z.9434 F49.01
X4.3016 Y-3.3725 Z.9291
X4.2756 Y-3.4063 Z.9255

G2 X4.2424 Y-3.457 I-1.2449 J.7777
G3 X4.2403 Y-3.4602 I.0619 J-.0423

X4.1273 Y-3.7485 I.5323 J-.3751

X4.0731 Y-4.4476 I4.4908 J-.6998

X4.0682 Y-4.701 I55.8392 J-1.2046
G2 X4.0683 Y-4.7172 I-2.4409 J-.0162

X4.0117 Y-5.2398 I-2.441 J0.
X3.6492 Y-5.7672 I-.8424 J.1907
X3.2671 Y-5.8786 I-1.3821 J.5998

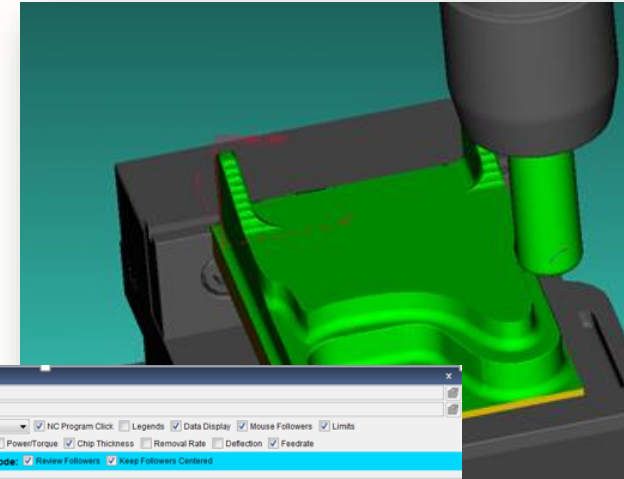
X2.8279 Y-5.7268 IO. J.7112

X2.4689 Y-5.3062 I.8054 J1.0511

X2.3283 Y-5.0594 I9.3896 J5.5141

G3 X2.0524 Y-4.7202 I-.9491 J-.49

X1.5923 Y-4.5319 I-.6325 J-.8893
X1.177 Y-4.4883 I-.4153 J-1.9565
  
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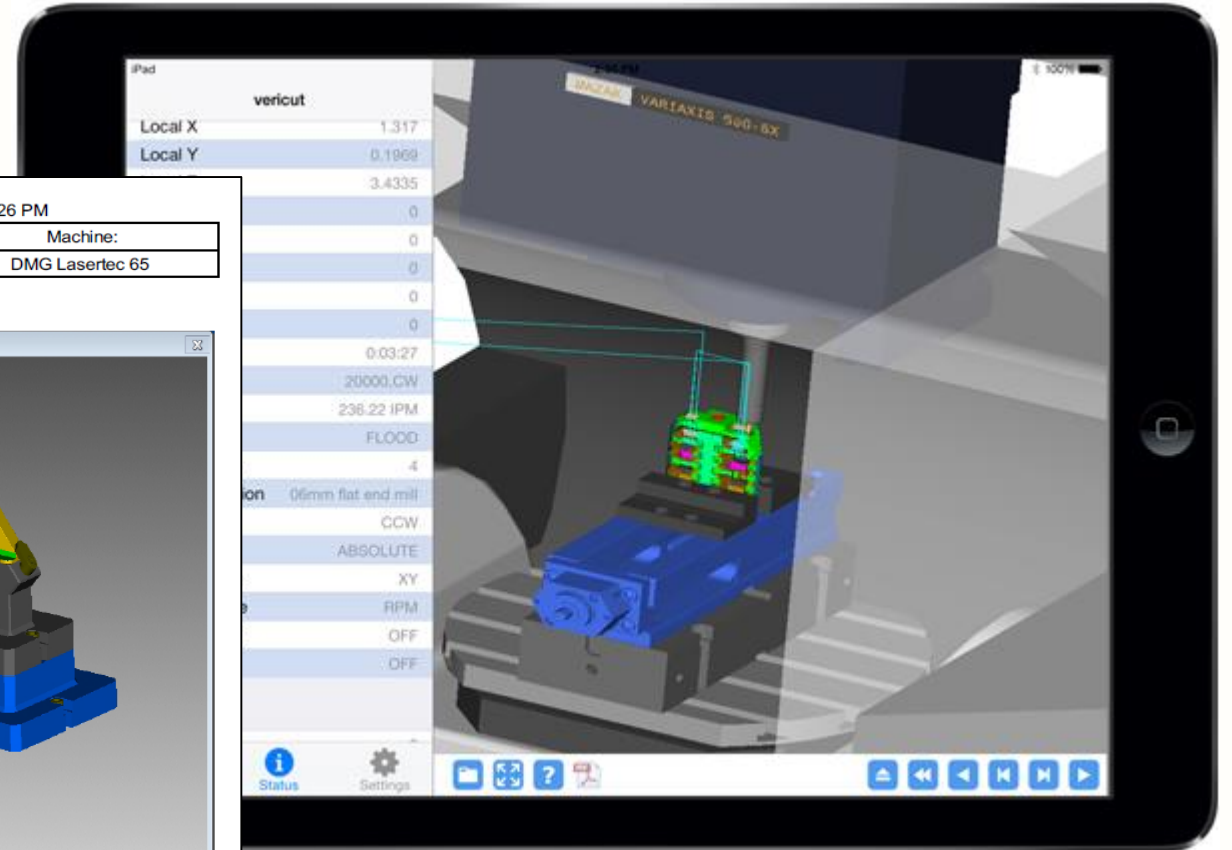
Design Model vs. Cut Stock



Sharing Data

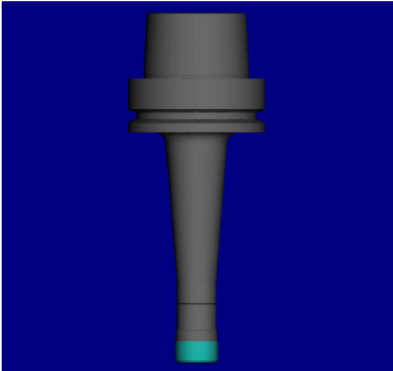
- Part of Industry 4.0 – (Principle 3) – Technical assistance
- Simulation results used many ways
- Generate reports
- Show simulation to shop floor

Reports and Reviewer

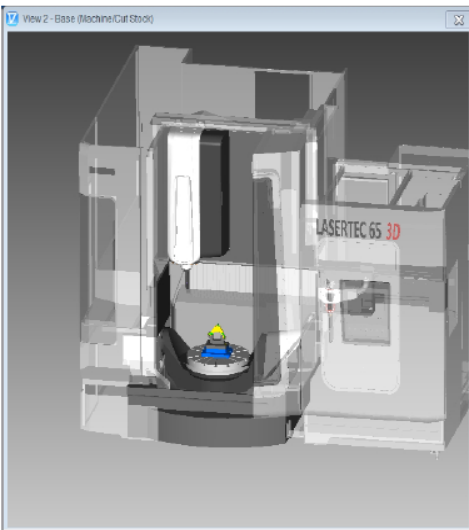


Programmer: Jeff Voegele January 2, 2018 3:30:26 PM

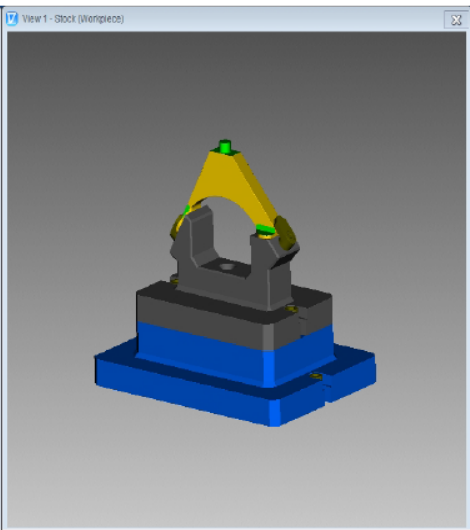
Part #:	Material:	Setup/Operation:	Machine:
ABC123	Titanium	SETUP_1	DMG Lasertec 65



View 2 - Base (Machine/Cut Stock)



View 1 - Stock (Workpiece)



Tool ID	Tool Description	Cutter Diameter	Cutter Height	Flute Length	Optimized By	Original Time	Optimized Time	Time Diff %	Errors	Warnings
MILL_0.787_R0.078	MILL_0.787_R0.078	0.5079	0.3972	2	No Optimization	0:04:57	0:04:57	0%	6	0
						0:04:57	0:04:57	0%	6	0

Utilizing data from CNC Machines

- CNC machines stream data telling what the physical machine is actually doing
- Part of Industry 4.0 –
 - Principle 2) – Information transparency
 - Principle 3) – Technical assistance
- Streaming data used for:
 - Analytics
 - Calculations
 - Shop 'health'

Utilizing data from CNC Machines

- Protocols/Methods to exchange data between shop floor equipment and software applications
 - I.e. Machine Monitoring
- Part of IoT – internet connectivity
- Many possibilities
 - MTConnect
 - OPC UA (Open Platform Communications Unified Architecture)
 - FANUC CNC: FOCAS, FASOPC
 - umati (Universal Machine Tool Interface)

MTConnect®

 OPC UA™

FANUC FOCAS

 **umati**
universal
machine tool
interface

NC Simulation saves \$\$\$

- Industry 4.0, Digital Twin, Simulation are significant to your mfg processes
- Can simulate real world issues before part is run on shop floor
- Simulation software's connectivity in the NC Manufacturing environment
- What data to seek, what to avoid, and why
- How simulation interoperability and “good” data help
- How physics-based software tools help with optimization and analysis

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CGTech

- Privately held and 100% self financed.
- Established in 1988
- World leader in NC verification
- Largest group of CNC machining experts in the world
- Headquartered in Southern California with offices in 12 countries

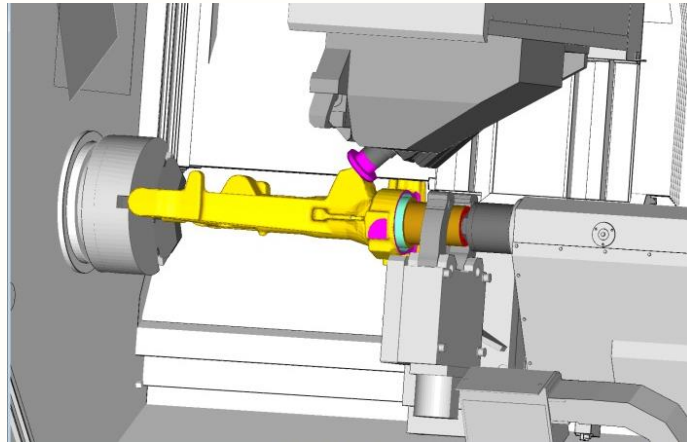


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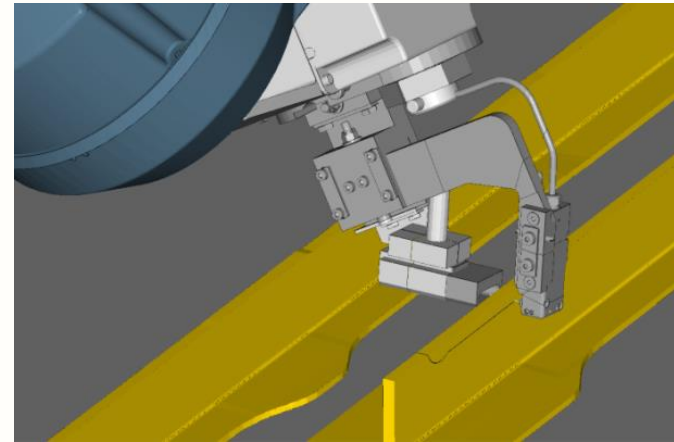
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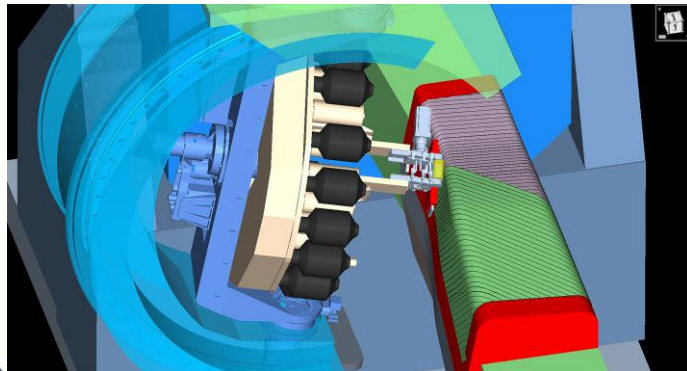
VERICUT software improves automated processes in several domains.



Machining Simulation



Trimming Simulation



Automated Composite Layup



Assembly Drilling & Fastening

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Questions

