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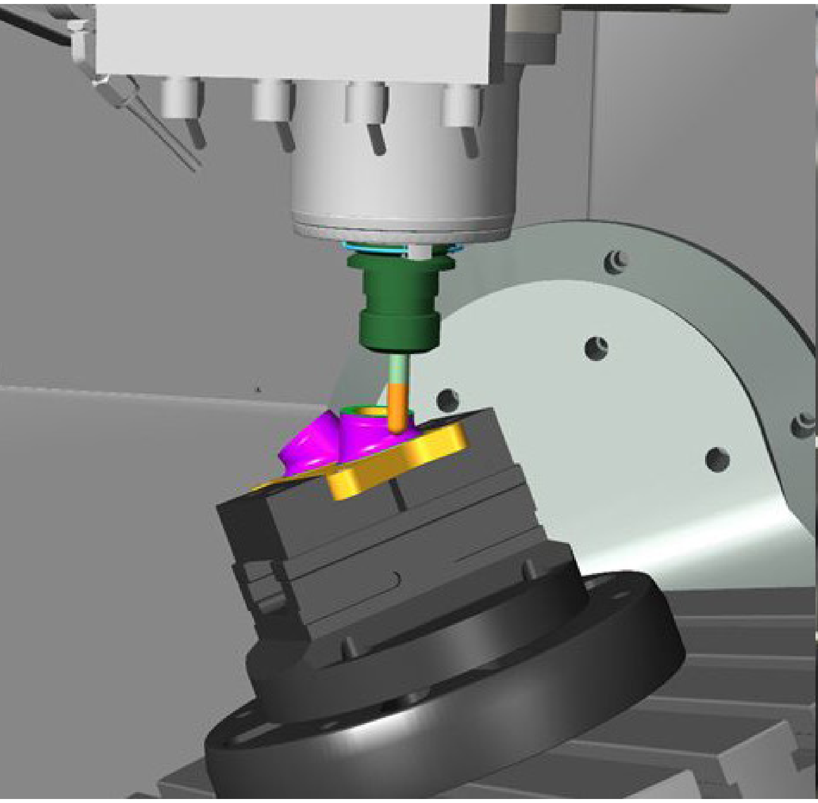
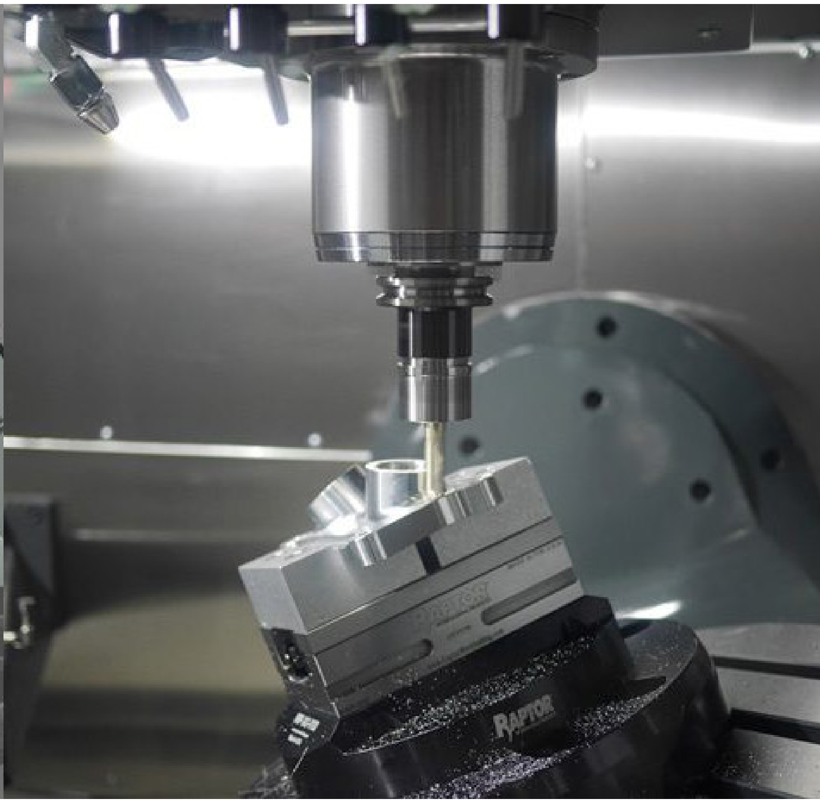
Insights from CIMSOURCE





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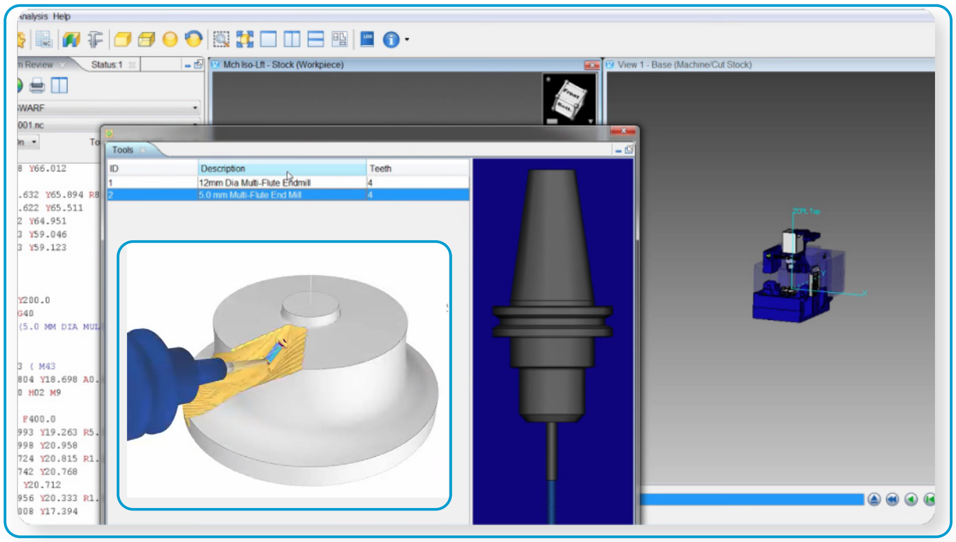
CAM AUTOMATION & AI

BUILDING BLOCKS FOR THE DIGITALIZATION OF MACHINING OPERATIONS

by Ingo Laqua

You might think that the digitalization of machine tools was completed with the introduction of numerical controls. And it's true: the associated NC process chain is inherently digital—after all, what else but programs and data would you use to drive a CNC machine?

But what about the level above the shop floor—engineering and planning departments? What methods and tools are available to generate the necessary data and, ideally, to verify it before actual production begins? Here, it's important to distinguish between the CNC process chain and the broader manufacturing job processing workflow.



For accessibility within the machining area, safe tool changes, and checking the engagement conditions at the machining point, precise models of the tools are required.

The CNC Process Chain

The tasks involved in the CNC process chain—often referred to collectively as "industrial engineering"—include process planning (defining the machining sequence for a part, organizing the steps of the machining processes, selecting tools and defining cutting strategies), NC program generation and process verification.

shipping logistics. The SalesSupportServer (3S) from CIMSOURCE is perfectly designed for the required "make to order" process.

To support automation, CAM systems offer solutions on two levels:

- **Process planning**
- **Toolpath generation**

In both areas, simulation tools are used to validate the results.

Feature recognition and macro technologies are well-established methods for automating CNC programming. Part geometries are analyzed algorithmically and mapped to predefined macro libraries to automatically generate time and cost estimates. The required feature- and tool libraries must be created and maintained within the CAM system. This significantly reduces programming time and increases process reliability through standardization.

Tool diversity can also be reduced using feature and macro technology. This form of automation is particularly beneficial for part families—when similar components need to be programmed repeatedly.

To reduce the effort required to build these libraries with the help of AI, a large number of use cases is necessary. No single company has enough statistically relevant data to achieve reliable pattern recognition. That's why AI-based assistant systems rely on data aggregated from many users.

Examples include **up2parts, Xometry**, and **Spanflug,** which help users to quickly arrive at machining strategies and estimate production times and costs. Crucially, the output generated by these systems is intended for human experts to review, typically experienced CAM programmers.

Automating Toolpath Generation?

Unlike process planning, the result of toolpath generation is passed directly to the machine controller as a sequence of coordinates. Here, the recipient is not a human—it's a machine. CAM systems support this through machining

"The digitalization of mechanical manufacturing offers immense potential and can lead to significant cost savings."

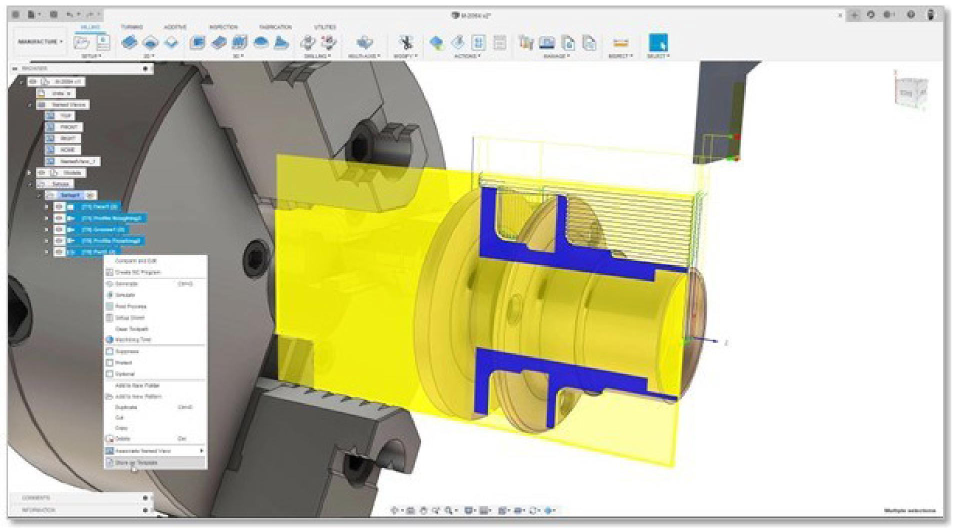
Ingo Laqua

cycles that simplify the description of toolpaths. However, the input—called parameterization—must be precise.
Statistical data is of no use here: the machine controller needs exact coordinates, not approximations.

Digital Twins for Simulation

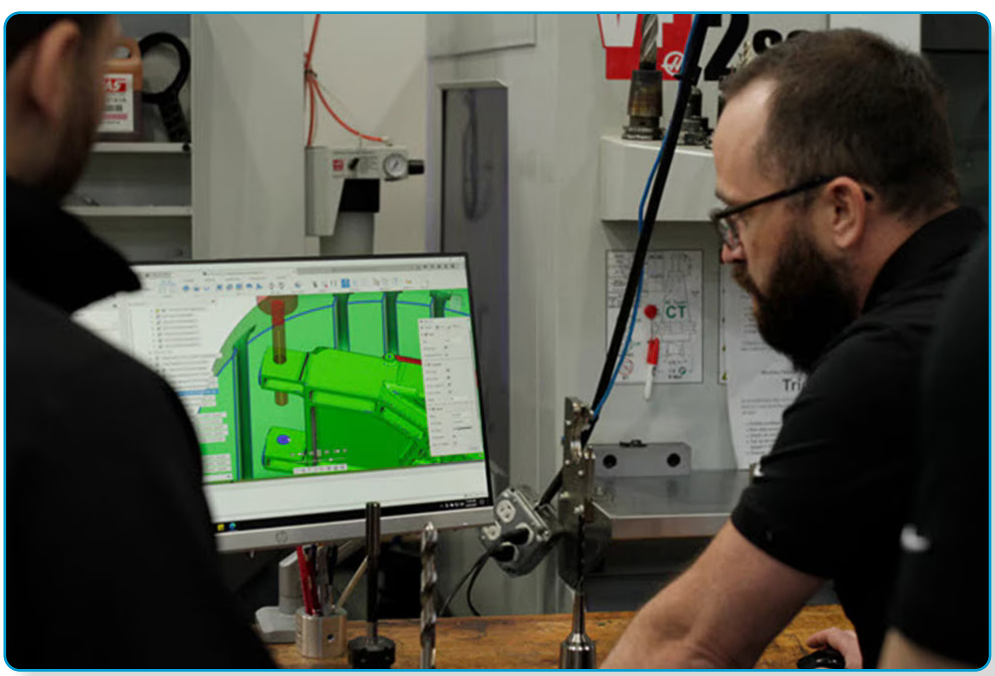
What about validation within the NC process chain? Broadly speaking, this includes collision detection as well as verifying whether the planned cutting parameters can actually be executed by the specific machine or controller.

For collision detection, digital twins—especially of tools and machines—are essential. Whether it's for ensuring accessibility within the working envelope, safe tool changes, or verifying engagement conditions during cutting, accurate models of both individual cutting components and complete tool assemblies are required.



Statistical information is unsuitable for path planning because control requires specific coordinates.

These digital twins must precisely match the physical tools. AI-generated geometries are not acceptable. And even the simulation itself ultimately comes down to a computed solid body intersection—again, not something that statistical methods or AI can assist with.



AI can make suggestions for tool selection, but the final decision on tool usage is made by the experts.

Lessons Learned

Digitalization starts with making workflows, products, and manufacturing processes machine-readable. Automating manual processes is typically achieved through "traditional IT" as workflows. Full automation, however, requires that all "products"—including set up sheets, documents, and templates—to be digitized in a machine-readable format. Only that will lead to workflows that run without human intervention.

AI-based automation adds another dimension beyond that: enabling data gathering, -preparation, and -analysis through assistant systems, thereby allowing faster and higher-quality decision-making.

Conclusion

Digitalization is the foundation of automation—whether traditional or AI-driven. And in machining, tools and their digital twins play a central role. CIMSOURCE provides precisely that.

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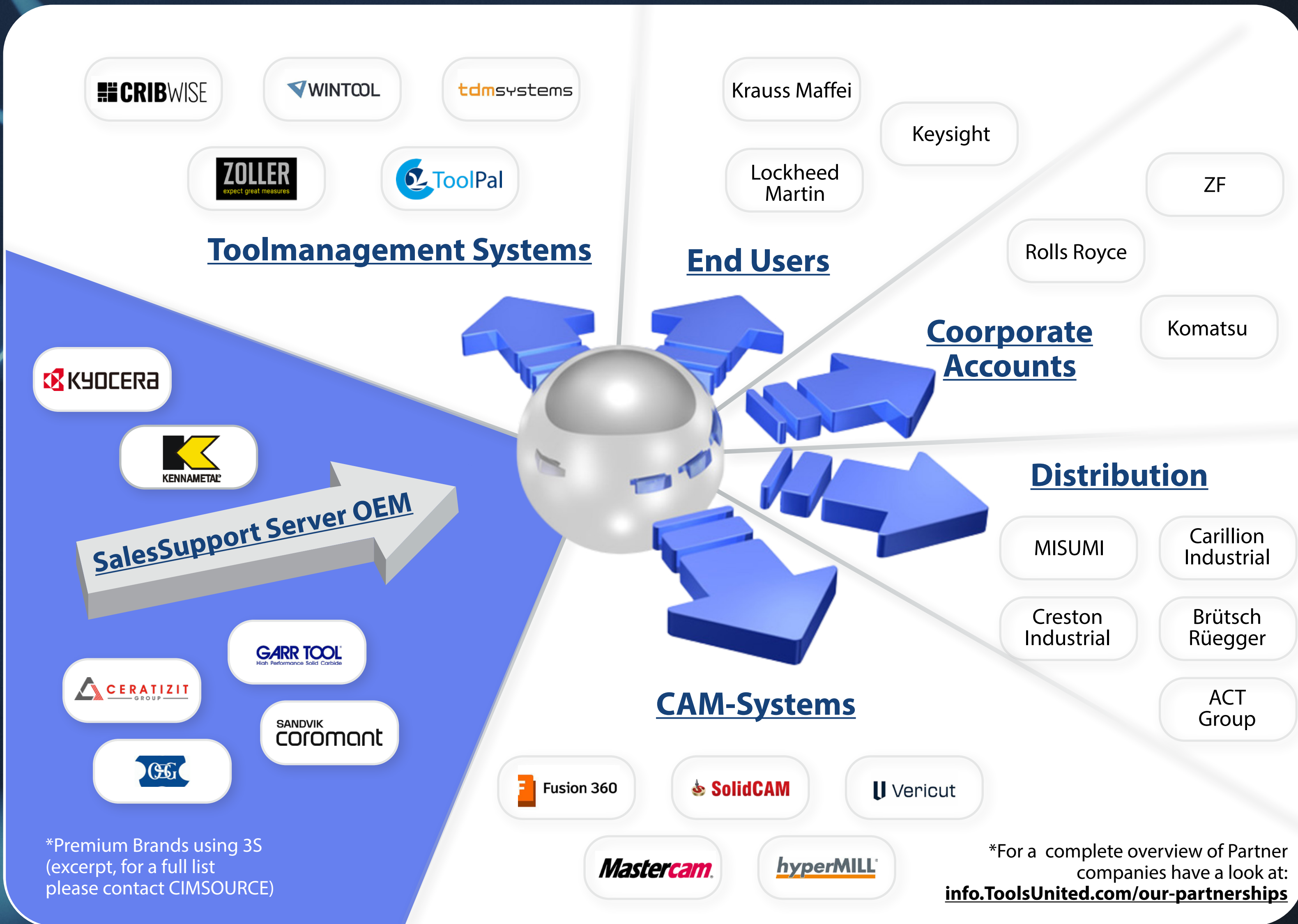

*Premium Brands using 3S (excerpt, for a full list please contact CIMSOURCE)

*For a complete overview of Partner companies have a look at: **info.ToolsUnited.com/our-partnerships**

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