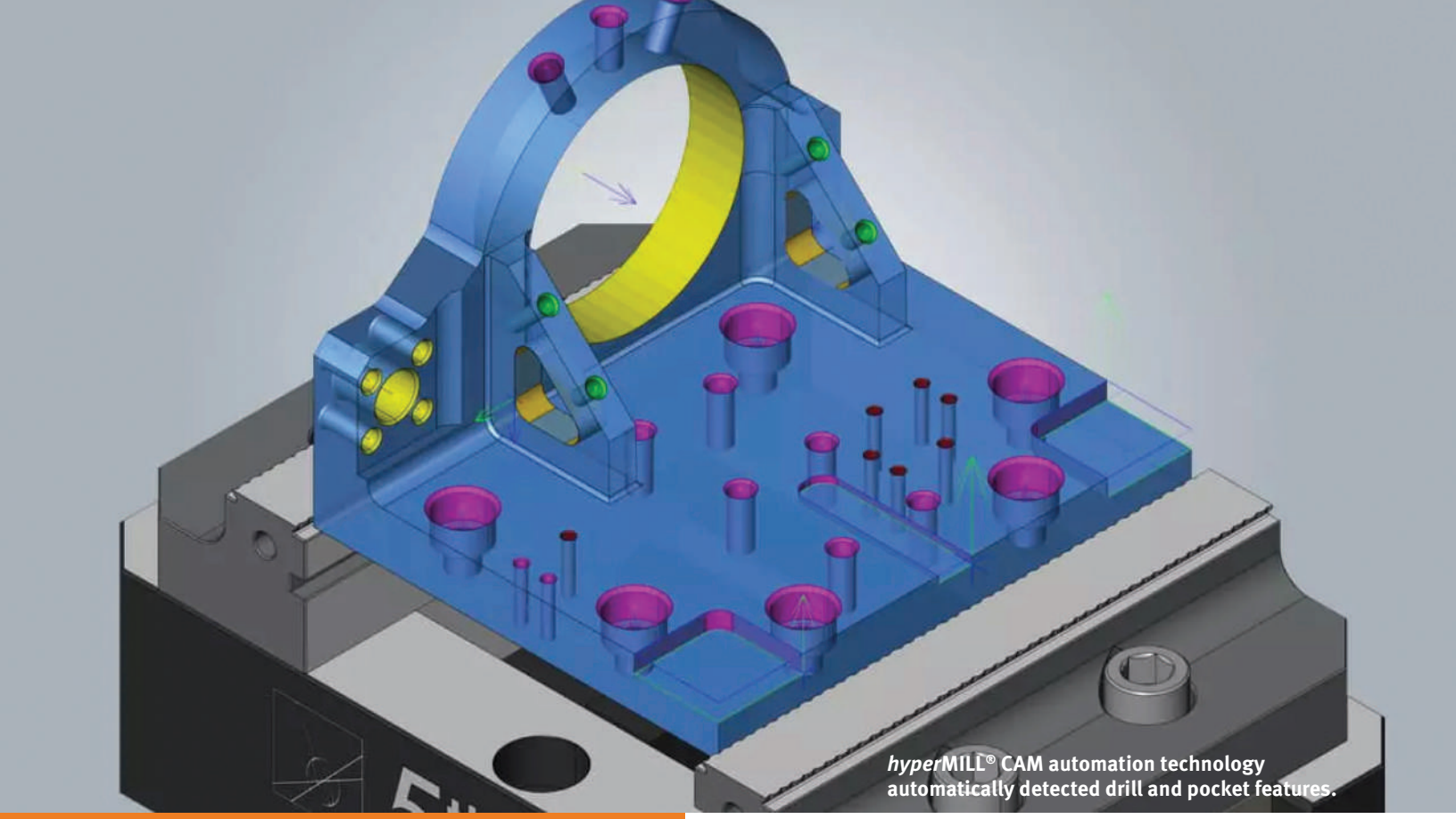

*hyper*MILL® CAM automation technology automatically detected drill and pocket features.

Technical Article

CAD/CAM Automation Advances Programmers
Three Styles Explored

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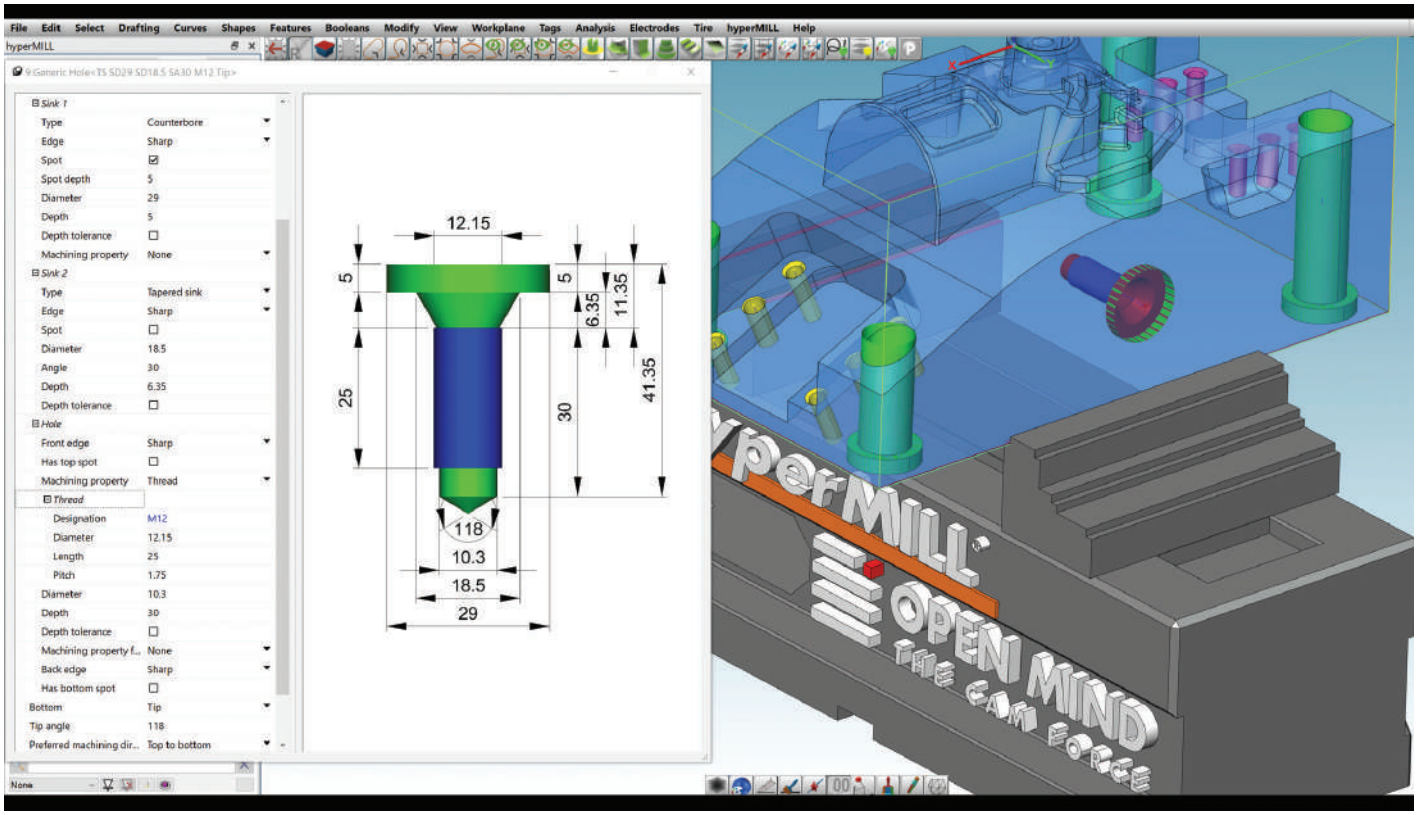
From the assembly line chaos of the 1936 Charlie Chaplin classic 'Modern Times' and the robot driven science fiction movies of the 1950's and beyond, automation (and its inherent robot-driven workforce) has always struck fear in the hearts and minds of organized labor. Since Ford Motor Vice President D.S. Harder first coined the phrase in 1946, the word 'automation' has gotten a bum rap.

Fast forward to 2021. Humans and robots work hand in pneumatic claw, a technological success story, allowing for faster production and lower prices to consumers. With this in mind, it is only logical that automation can and should be applied to another phase of the manufacturing cycle . . . CAD/CAM.

Automation within a CAD/CAM environment takes a different approach. Instead of replacing programmers with soul-less automatons, CAD/CAM automation gives those same engineers the tools to reduce or eliminate redundant tasks common to every programming example so they can focus on more skilled programming. Automation should be flexible enough to adapt to differences in geometry and should always, yes, always be defined by the programmer, utilizing his or her best practices instead of relying on what a CAD/CAM software engineer thinks stepovers and stepdowns should be. Common tasks such as roughing, pocket milling and hole processing should be capable of being fully automated. However, depending on the depth of the automation, full project programming is possible using any of three automation styles. . .feature-based, attribute-based and script-based.



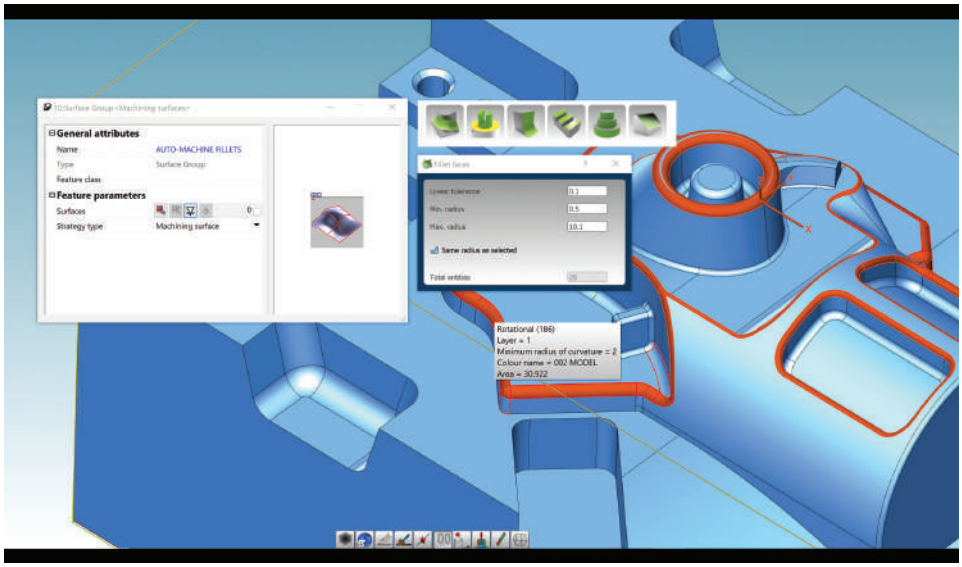
FEATURE-BASED AUTOMATION is driven off individual features of the model being programmed. In addition to holes and pockets, modern CAM system's feature-based programming can organize surfaces, curves, boundaries and even machining vectors into a customized feature.

1. Feature-based automation is driven off what the name implies – individual features of the model being programmed. Traditionally, these features consisted of various hole and pocket styles. Once those features are manually defined or, as is the case with more advanced CAD/CAM systems, automatically recognized, user defined macros, or sequences of programming cycles linked to the features, can be applied. The toolpath cycles should be intelligent enough to automatically adjust parameters for the features, parameters such as counterbore depth, depth of holes and whether a pocket is closed (requiring ramping step-down of tools) or open (allowing tools to plunge outside of pocket).

Many CAM systems import data from different CAD systems. During the import process, feature manufacturing data such as hole thread designations or fit tolerances become lost. Good CAM software utilizes the application of additional attributes to features which then activate the missing manufacturing data. For example, a hole with a diameter of .201" is just a hole with a diameter of .201". Make that hole a pre-defined color that represents ANSI coarse threads and suddenly, that .201" diameter hole has a 1/4-20 thread, and the system then knows to pull a tap out of the tool database to finish the processing of that hole.

Of course, feature technology should not just be limited to holes and pockets. Modern CAM system's feature-based programming should only be limited by the programmer's imagination. Surfaces, curves, boundaries and even machining vectors can be organized into a customized feature which can then populate multiple toolpath cycles, using one group of surfaces as machining geometry and a different set of surfaces as stop, or check surfaces. One or two toolpaths down the job list, the usage of those surface groups might flip-flop. In theory, it should be possible to turn the entire detail being machined into a customized feature. Also, the toolpath cycles should be capable of being fully populated by the geometry via their attributes, whether a simple roughing operation or dozens of toolpaths to rough, semi and even finish the detail.

2. This takes us to the second style of automation—**attribute-based automation.** Attribute-based automation allows the selection and programming of geometry based on specific attributes that are applied to said geometry. Make the male fillets on a model a certain color of blue (or any pre-determined color) and they are automatically machined. Put a closed contour on a level named Boundary and it is automatically selected in a semi-finishing 3D Profile toolpath. Select the surfaces that comprise the jaws of your vise and tag them with a user-definable name. Toolpaths will automatically avoid those vise surfaces, ensuring safe, collision-free machining. Adding or changing geometric attributes allows the sorting and selection of geometry and the population of toolpath cycles.

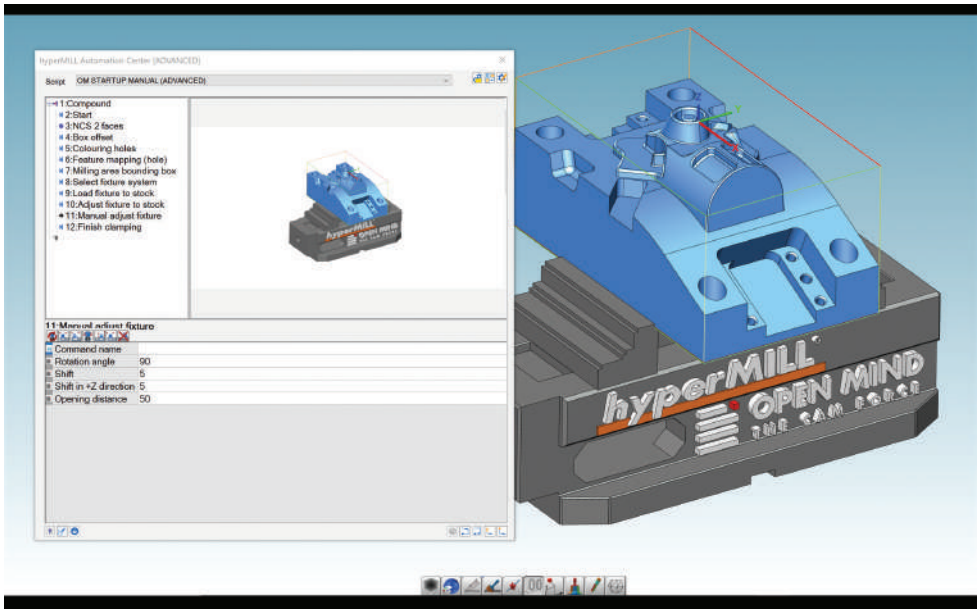


ATTRIBUTE-BASED AUTOMATION allows the selection and programming of geometry based on specific attributes that are applied to said geometry.

Of course, this adds a new level of manipulation of the data that is required by the programmer. A specific cycle is looking for all of the surfaces of a pre-defined color to automatically populate a toolpath cycle. It is up to the programmer to make all of those surfaces that pre-defined color first. This is where great CAD systems come into play. Dynamic selection capabilities should reside within the CAD environment, allowing quick and accurate selection of geometry. Smart selection filters should allow fillets, chamfers, tangent surfaces and other geometric entities to be selected by a simple click or two of the mouse. Analysis functionality should identify all radii, even if they are nurb surfaces, and color them appropriately. Chaining capabilities should allow multi-surface boundary creation at the click of a button. All these tools should be readily available and intuitive to use for easy manipulation of the geometry's attributes. Once colored, layered or tag-named, toolpaths residing in a dedicated database are applied, populated and correctly calculated. Theoretically, it should be possible to import the next part, change attributes, apply macros from the database and calculate.

3. Feature and attribute-based automation only scratch the surface of the deep capabilities of the third form of automation — **script-based automation.** Script-based automation is the best of feature and attribute-based automation, but on steroids. Using the full capabilities of a high-end, dedicated CAD system, script-based automation does indeed recognize features and can change the attributes of surfaces, in essence, prep the model for manufacturing, but it can do so much more than that.

A good, script-based automation system utilizes a CAD/CAM system's CAD capability much more than feature or attribute-based automation. It should be capable of patching over holes, coloring planes and radii, creating curves and boundaries, and creating layers to populate the created geometry. Script-based automation can import vises and fixtures, find best-fit coordinate systems and create multi-axis machining vectors. Macros consisting of the full manufacturing process can be applied and all toolpaths are populated by the geometry the script-based automation generated or manipulated. Automation can include the creation of a current stock chain, calculation of the toolpaths and generation of the posted G-Code. Finally, full documentation of both the job list and the included tools is generated and saved in the project folder. True script-based automation can accomplish the above list with a minimum of user intervention and no more than a handful of mouse clicks.



SCRIPT-BASED AUTOMATION utilizes a CAD/CAM system's CAD capability and should be capable of patching over holes, coloring planes and radii, creating curves and boundaries, and creating layers to populate the created geometry.

CAD/CAM automation is a technological boon for skilled programmers, taking care of the rote tasks that can bottleneck productivity and prevent those same programmers from concentrating on high-value processing. It is also advantageous in assisting management with the difficult task of hiring high level CAD/CAM programmers. In a manufacturing world hungry for a technologically advanced workforce, CAD/CAM automation can feed less experienced programmers a healthy diet of pre-defined, best practice programming standards developed by more seasoned engineers. This vastly increases the size and scope of available CAD/CAM engineers, dramatically reduces the return on the investment of hiring someone with an unknown skill level, and rapidly allows in-house programmers to become productive by immediately following corporate programming standards.

OPEN MIND Technologies

About OPEN MIND Technologies AG

OPEN MIND Technologies AG is one of the world's leading developers of powerful CAD/CAM software solutions for machine and controller-independent programming. OPEN MIND develops optimized CAD/CAM solutions that include innovative and unique features that can deliver significantly higher performance in both programming and machining. *hyper*MILL® is a completely modular CAD/CAM solution that provides state-of-the-art CAM technologies on its own CAD platform: from 2.5D, 3D and 5-axis machining as well as turning strategies and solutions for additive manufacturing, HSC and HPC machining. Whether automation, simulation or virtual machine – trendsetting technologies expand the product range and enable continuous digital process chains. Special applications, seamless interaction with all popular CAD solutions and exceptional customer service rounds out the company's products and capabilities.

According to the "NC Market Analysis Report 2024" compiled by CIMdata, *hyper*MILL® is a leading, worldwide CAD/CAM solution. Innovative CAD/CAM technologies fulfill the highest demands in the automotive, tool and mold manufacturing, production machining, medical, job shops, energy, semiconductor and aerospace industries. OPEN MIND is a Mensch und Maschine company and has subsidiaries and qualified sales partners on all continents. You can find more information at https://www.openmind-tech.com/en-us/.

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