Manufacturing Software Solutions

Eventually, designs from a CAD system go into some form of manufacturing. For mass produced parts, this usually involves manufacturing tooling that is actually used to create the final needed part. This tooling can be quite wide ranging, from molds that creates a small plastic piece of a toy, or large pieces like the front fascia of a car to dies that may make simple stampings for a computer case, to complex hoods and fenders of automobiles. Plastic pieces from molds and metal stampings from dies are used in a huge percentage of assembled products.

Tooling for the Mold & Die industry is often lumped together as one market segment, because there are many requirements that are shared between the two. However, there is also some uniqueness between the two for manufacturing.

One critical component of working with the Mold & Die industry is the requirement of manufacturing quality tooling as quickly and efficiently as possible, all while working with differing data from various customers.

Some of the key functionalities that are necessary to be as efficient as possible, with as high of a quality as possible are:

▶ *CAD for Manufacturing*

Although many CAD systems have excellent design functionality, they are sometimes lacking functions useful to manufacturing tooling. This can encompass more generic functions like filling holes or creating die runoff data or it might include more specific CAD for manufacturing functions such as core/cavity separation or automatic electrode extraction.

Cad functions specific to manufacturing can save a considerable amount of time by automating a task to do in just a few minutes which may take considerably longer manually. Automatic Electrode extraction is a key example of this. With a simple curve, an electrode can automatically be extracted, tangent extensions can automatically be created, and the electrode can be placed on a fixture or clamping system. While all of these tasks could be done manually, it may take 10-20 times longer to do it manually versus using an automatic Cad for manufacturing routine.

▶ *Dynamic Stock Model*

Since CNC machining is a subtractive process, all CNC operations start with a piece of material, we refer to as the stock. Sometimes the stock starts out as a solid block or cylinder, other times it may be a casting, or it can be a complex 3D shape. Depending on the application, some people scan the initial stock, off of a casting or tool to be repaired, as the initial stock model.

Utilizing a digital version of the stock model allows for the CAM system to work as close to real life as possible. CAM systems that do not utilize a stock model for calculating machining operations are working only with theoretical milling conditions, and can be prone to errors or complications.

One time saving and practical use of stock models is when milling multiple details of a stamping die. Often, each detail has its own stock size, yet a productive programmer will mill several of them together on some form of pallet. It is important to be able to handle a variety of initial stock conditions so that the roughing cutterpaths can be as efficient as possible.

There can be two types of stock models, Dynamic and Static. Dynamic stock models allow the Cam software to work with the condition of the material during cutterpath calculations, just as if it were watching the machine mill the part every second. Static stock models allow the CAM system to know the condition of stock only at the beginning and end of a calculation, but not during.

Advantages of utilizing a Dynamic Stock Model are:

- **Safety:** Since the condition of stock is known during all phases of roughing, it can create the most reliable cutterpaths that are safest on the cutter, without dangerous potential movements from systems that do not know the dynamic stock condition.
- **Efficiency:** Since the condition of stock is known at all times, where material exists, and where material has already been removed, the roughing clean out passes can maximize efficiency with little wasted movement of theoretical movements.
- **Productivity:** Automatic Remachining cutterpaths based on the actual stock condition, from careful programming with various cutters, rather than theoretical corners, will not only be more efficient, but provide the most accurate milling scenario.

▶ *Feature Recognition*

Mold and Die components often can have many different holes. These holes may be through, reamed, tapped or something else. Feature recognition software allows for the fastest programming of holes in a part.

Previous methods of drilling holes involved finding the centers and depths and creating a drilling or some type of canned cycle command. This task becomes tedious when there are many holes, and can become difficult when the holes are at various angles.

Automatic feature recognition not only programs the holes based on the CAD design automatically many times faster than doing so manually, but this process can eliminate many of the common human errors when performing hole operations.

Again, the dynamic stock model becomes important when performing hole operations, as many people prefer to drill their holes, before milling the 3D shapes of the part. Thus the hole needs to start and consider different heights when compared to the CAD design.

Efficient and Automatic 3-Axis and 3+2 axis cutterpaths

Design for aesthetics is becoming more and more common. Many 3D parts are designed for a commercial aesthetic property, rather than for a strictly functional reason. These shapes can sometimes become quite complex.

When working with tooling, one often is milling hard materials, sometimes with a lot of steep slopes and complex 3D shapes. It is important to have a plethora of quality cutterpaths available for any shape. These cutterpath styles need to work equally well, and just as easily in 3+2 axis machining as they do in 3 Axis. Some cutterpaths which can make one more productive include:

- **Slope Based Machining** – utilizing a Z-Level strategy, especially on hard materials, for less tool deflections, and an automatic option for machining the remainder of the part.
- **Constant Scallop Machining** – Advanced cutterpaths can utilize a 3D stepover, such that the cutter load and cusp leftover remain constant. These types of cutterpaths are often ideal for high speed milling machines.
- **Continuous Finishing** – This cutterpath combines the best of Slope Based Machining and Constant Scallop to allow for high speed machining in a continuous motion, while maintaining a high surface finish.
- **Remachining to a 3D Stock Model** – Remachining is removing material leftover by larger tools. Sescoi's WorkNC was an innovator in this technology. Remachining algorithms should look at the stock model of actual remaining material, rather than theoretical corners many systems use.
- **Maximum Segment Length** – this option allows for uniform point density and distribution on all parts, regardless of the curvature. This provides better finishes and works best on high speed controllers.

5-Axis

Utilizing 5-axis machining, if it is available to you, can increase overall efficiency and productivity. Some of the benefits of 5-axis machining are:

- **Reduce or eliminate electrode milling** – With 5-Axis machining, it may be possible to machine areas one may otherwise have used an Electrical Discharge Machining (EDM) process on. This saves the time of milling several electrodes and the time spend in the EDM process.
- **Reduce polishing** – often one can use 5-axis machining to use a shorter cutter to mill the same areas mille din a 3 axis or 3+2 axis strategy. Utilizing shorter cutters allows for more tool rigidity, allowing for better finishes at faster feed rates.

Complex or large tools can often have CNC files with thousands and millions of points. Without good 5-axis programming algorithms, a CAM system may not be able to efficiently perform 5-axis machining. WorkNC has a module named Auto-5 which converts a 3-axis or 3+2 axis cutterpaths into a full simultaneous 5-axis cutterpath, while automatically avoiding collisions between the tool, tool holder and the part. This allows for milling the entire part, with short tools, quickly, automatically and safely.

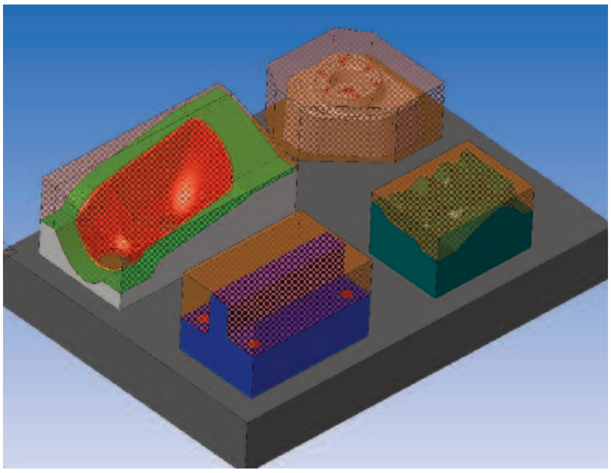
Speed

Many tools can get quite large. Think of stamping dies for large trucks, or molds for big aerospace pieces or a bumper fascia. Although these parts can be very large, they often have small radii designed into them. Often requiring a dozen or more different sized tools to completely finish the part. Tools down to 3mm diameter or smaller.

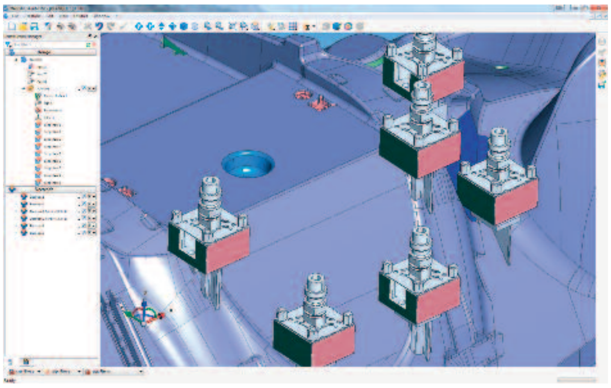
Data, for these tools can become quite large, as can the calculation times for those cutterpaths. It is necessary the CAM system work in a 64 bit environment for these large parts. Also, since calculation times can be large, it is necessary the CAM system utilize technology like multi-threading and parallel processing to reduce the calculation times as much as possible.

Conclusion:

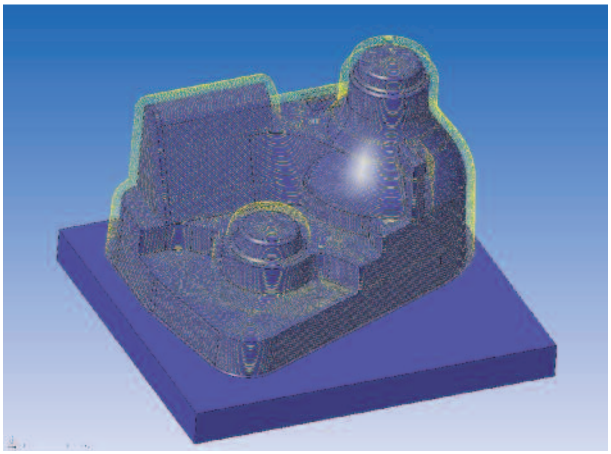
Machining tooling for molds & dies is a rewarding career. Cam software products may contain functions to automate much of the machining, to make it as simple as possible to be as efficient as possible. Making use of these advanced functions will help make you as efficient and productive as possible.



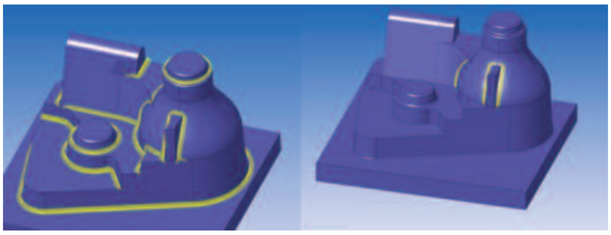
Utilize Dynamic Stock Models to accurately represent the stock, even when milling multiple components simultaneously. Also, automatic drilling should use the stock model for heights should on wish to drill before milling shapes.



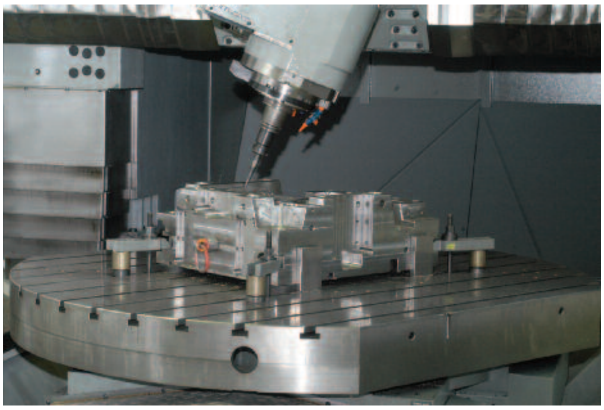
CAD functions for manufacturing streamline efficiency, such as electrode extraction.



Continuous finishing is suitable for high speed mills. Ittakes a top down milling approach, including a Z-Level component, suitable for hard materials.



Remachining mills corners automatically, on the left are theoretical corners from one finish tool. Prudent finish programming with multiple tools and use of the dynamic stock model can make remachining more efficient, as shown in the right.



Auto-5 axis milling can utilize a shorter tool for more of the part, creating better finishes, faster times and reduce the need for some electrode manufacture.

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