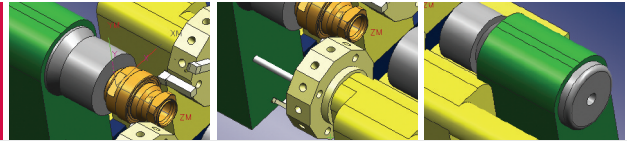


## The challenges of programming multi-function machines

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white paper



- ▶ Manufacturers are investing in multi-function machine tools to gain a competitive advantage. By combining multiple machining operations, such as milling and turning, in a single machine, multiple-function machine tools reduce the number of setups required to process parts, thereby machining parts more quickly and with fewer positioning errors. However, multi-function machines can require more complexity in NC programming, post-processors and machine simulation. Mastering this complexity is key to return on investment.

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## ► Introduction

Imagine being asked to generate a synchronized computer numerical control (CNC) program for a machine that does milling and turning from either of two turrets on either of two lathe spindles that can also be programmed like milling rotary tables. When people talk about multi-function machines, that's what they are talking about. These machines may have live tooling in a turret and may just as easily have a turning tool in a multi-axis head/turret.

More and more companies are looking at multi-function machines, realizing they can consolidate machine and tooling setups as well as combine multiple manufacturing steps into a single machine with a single setup. This consolidation can often reap substantial financial savings by reducing overhead costs and increasing production throughput. Of course, if it were just that simple and beneficial, more companies would already be using multi-function machines.

Multi-function machines offer great benefits, but not without challenges. First, these machines frequently have seven or more programmable axes that are operational within a fairly limited work envelope. It is typical to have machinery components passing within very close proximity of each other, which can translate into some white-knuckle CNC tape prove-outs with numerous changes that are followed again by re-proving. It does not stop here.

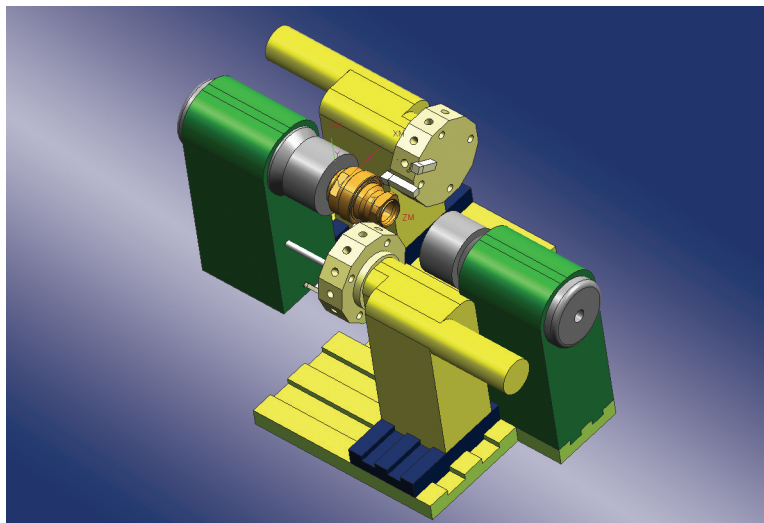
To maximize the benefits, it is desirable to have multiple cutting tools simultaneously removing material. Simultaneous and synchronized cutting becomes even more challenging as cutting tools can often reach more than one part/spindle at a time. Keeping track of the current state of the workpiece (often referred to as the in-process workpiece, or IPW) between cutting operations, as well as from spindle to spindle, can be tedious but is critical for generating efficient cutter paths.

Another critical element of the multi-function machine tool programming solutions is post-processing. When looking at how to post process anything from a CAM system for a multi-function machine, companies have found yet additional challenges. A multi-axis milling post-processor could be appropriate for an upper turret if that particular cutting operation requires it. But what if the cutting operation for the upper turret is a turning function and needs a turning post? A multi-function machine can often require several post-processors for the various combinations of mill vs. turning on an upper or lower turret, cutting on either the main or the subspindle.

	Main spindle	Subspindle
Upper turret milling	Post-1	Post-2
Upper turret turning	Post-3	Post-4
Lower turret milling	Post-5	Post-6
Lower turret turning	Post-7	Post-8

Figure 1: An example of post-processor requirements

As noted in Figure 1, some multi-function machines can require eight post-processors to get the correct output for the various possible combinations. How to match multiple post-processing requirements with the applicable post-processors can be problematic. If the post-processor selections are not stored within the CAM file, there will be numerous risks for error the next time the CAM data is used.



## ► The Synchronization Manager

The Synchronization Manager in Siemens PLM Software's latest NX® CAM solution goes a long way toward mitigating the challenges, risks and expenses of using multi-function machines to manufacture your products.

The Synchronization Manager orchestrates several of the NX products together. When fully utilized, the Manager allows exact and very detailed examination of all the programmable axes' motion. Even with multiple machine components moving simultaneously, all areas of machine travel that might be of concern can be carefully examined before ever getting to the actual machine on the shop floor.

Users gain significant cost savings by using NX to prove out CNC programming and sample several synchronization approaches before actually going out and tying up the machine and machinist's time. Typically, proving out a CNC program on a multi-function machine can require numerous (sometimes eight or more) prove-out cycles. (Each prove-out cycle consists of: generating the CNC programs; stepping through the CNC programs on the multi-function machine, checking for collisions/problems; making the required changes to the CNC programs and then starting the prove-out cycle over again.) Electronically proving out the synchronization with NX, even if it was only to obsolete the need for four of the eight prove-out cycles, could equate to significant cost savings. The NX Synchronization Manager

can save valuable multi-function machining time, dramatically reduce set up cost and minimize collision risk.

With all of these benefits and utilities being brought together, the quality of the user interface becomes a key component. NX's Synchronization Manager gives the programmer ultimate control over the synchronization process.

With the NX Synchronization Manager, the programmer of the multi-function machine can insert synchronization events and/or dwell events. Once inserted, these events can then be moved using normal drag-and-drop technology. From the same manager, the user can also display the CNC program's posted G-code (see Figure 2) and from that display can more specifically place the inserted events. At any point, the user can step through or play the simulation to see where the various multi-function machine components are going to be at any given time in the CNC program and make necessary adjustments to optimize the machine utilization.

All changes made within the Synchronization Manager become part of the database and are saved within the NX part file. Anytime later, the same NX part file can be reopened, and all of the synchronization information will still be there. Along with the synchronization information, the post mapping will also be stored within the part file.

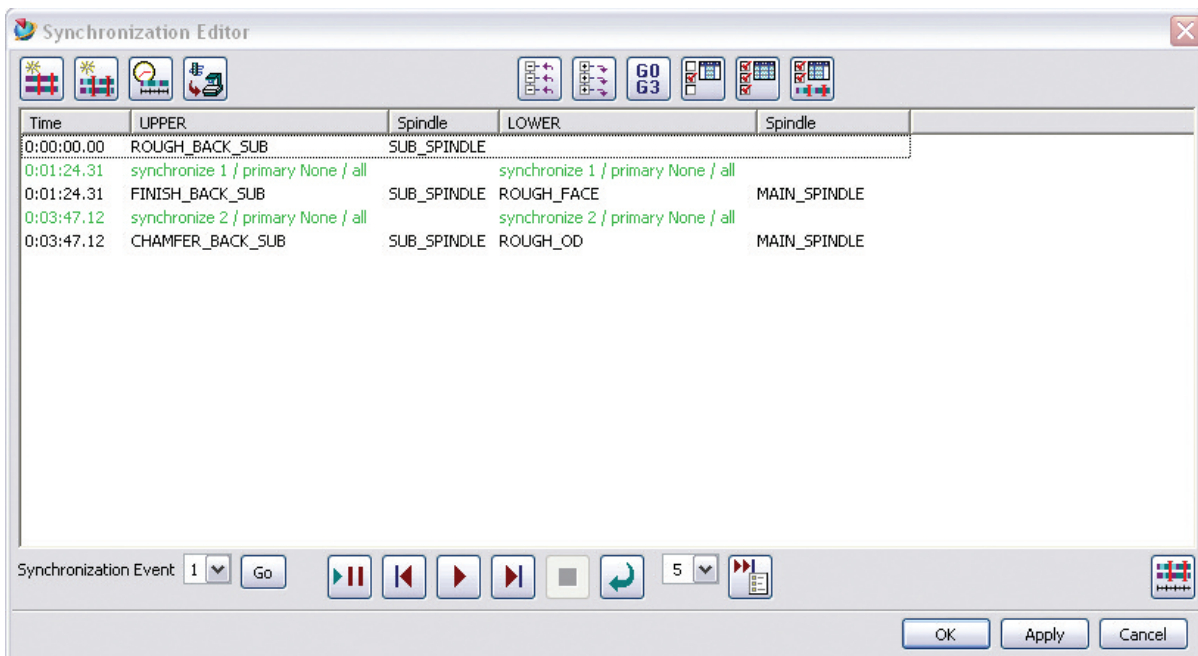


Figure 2: The NX Synchronization Manager with G-code display selected

## ▶ In-process workpiece

Another benefit that NX offers is improved utilization and tracking of the in-process workpiece (the model of the partly machined workpiece). If a lathe operation first removes substantial amounts of material, it is important that the next cavity mill operation is “aware” of what the resulting shape is so that the cavity milling cutter path will make fewer air cuts. Being able to take an IPW from the main spindle and pass it to the subspindle is equally important. NX tries to emulate exactly what the machinist will see on the actual multi-function machine at run time.

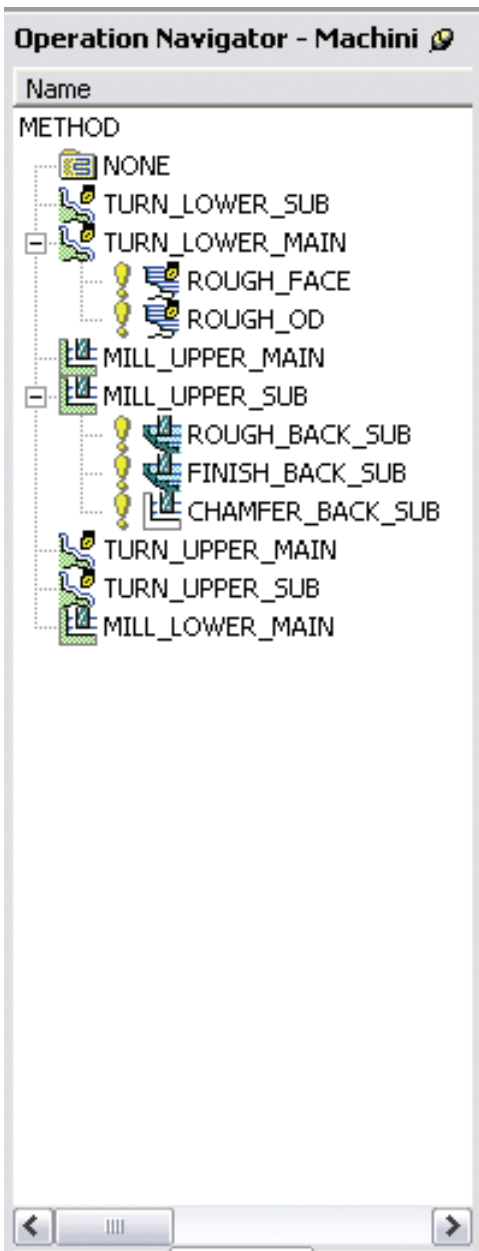


Figure 3: The operation navigator showing machining operations assigned to machine tool function and post-processor

## Post-processing

During creation of the post-processor, the *post builder* capability in NX allows the association of any of the individual posts with a specific machining method. All the user has to do is to place a machining operation within the correct method using the *operation navigator* display (see Figure 3), and the system takes care of the rest. Users no longer need to create cryptic notes to specify which post-processors are going to be required for each stage of a job.

In summary, many of the challenges, expenses and risks of generating CNC programs for multi-function machines are mitigated with the use of NX and its Synchronization Manager.

This solution provides an excellent blend of automation and programmer control, which translates into better utilization of multi-function machines with lower setup costs and improved productivity.

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