# From 3D model to finished part
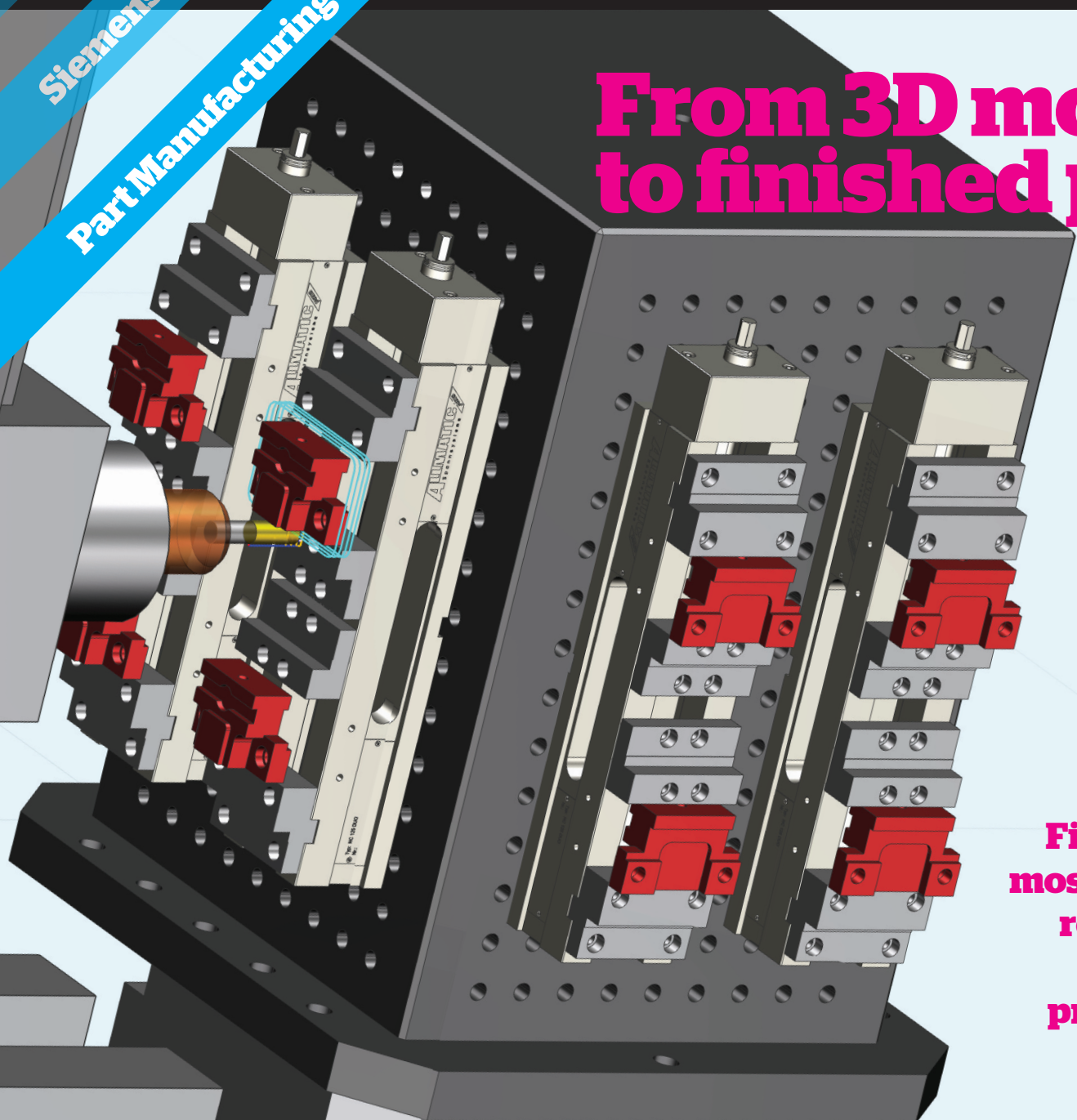
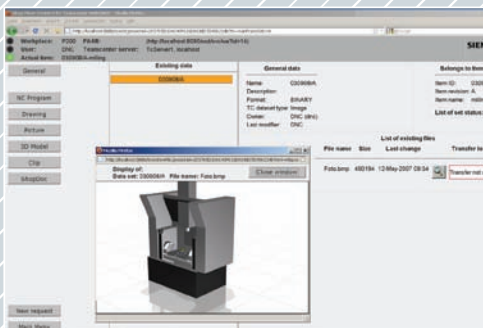**Finding the most efficient route from design to production**

## PLUS

### Part manufacturing
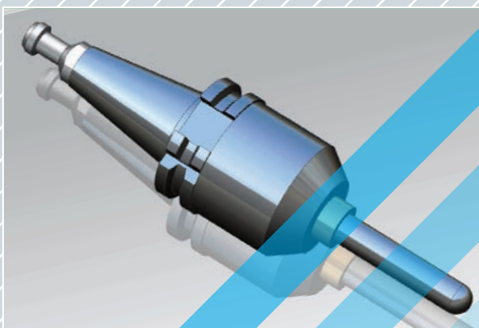Overcoming the key challenges

### Boosting efficiency
Connecting PLM to the shop floor

### Resources reigned in
Building intelligent libraries for benefit

# Key challenges for part manufacturing

**Beset by pressures on all sides, part manufacturing is ripe for optimisation, both in terms of process and workflow. We look at six of the top challenges and how Siemens PLM Software's part manufacturing solutions can help overcome them**

## Efficiency

In the context of manufacturing, discussions on efficiency often focus on the optimisation of a limited band of processes — such as NC programming and machining.

Today's leading organisations, however, are widening their gaze to the entire process — from the preparation of a 3D model all the way to the production of the finished part.

But optimisation is not just about tuning individual parts of a process. The connections between the various applications, systems, people and equipment also need to work as efficiently as possible.

Building intelligence into the process — such as by reducing the need for repeated data entry, introducing more encompassing search tools and enabling access to up to date information — can pay huge dividends here.

Siemens can assist with 'whole process efficiency' by providing intelligent design and NC preparation tools sitting on a Teamcenter powered digital backbone.
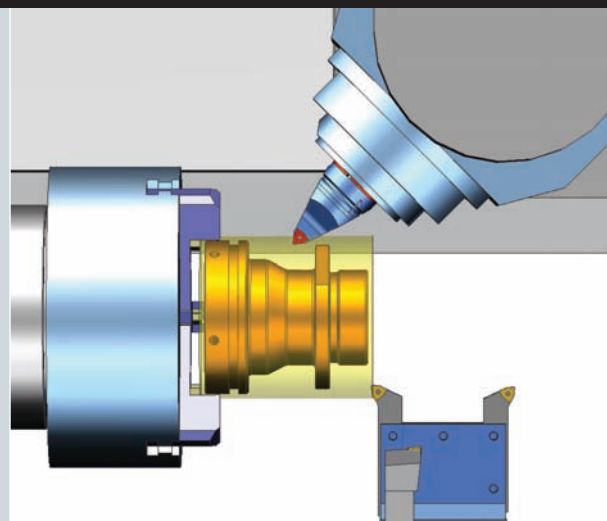
NX provides the manufacturing engineer with a single platform for part preparation, tooling and fixture design, CAM and CMM programming

Teamcenter provides complete data and process management for the entire process including the ability to connect release work packages to the shop floor

## Quality

Across all industries there are increasingly complex design requirements for ever more sophisticated products.

Quality has always been a prime concern, but it is often difficult to quantify — particularly in these hyper competitive times.

The idea of perceived quality is paramount to many customers, with the key drivers being improved surface finishes, accuracy and fit.

Alongside this, 'quality' relates to manufacturing parts according to their specification with better management of the complete process, using a fully documented plan. As traceability gains more importance, this will only become more key to many organisations.

And of course, there's then the traditional metrics for quality and ensuring that parts are manufactured to the required tolerance.

NX has a range of tools to integrate the use of coordinate measuring machine (CMM) inspection into the digital process, from CMM programming to reuse of 3D PMI.

NX uses design requirements to automate the programming of CMMs directly from the model-based measurement and tolerance annotation (PMI)

## Cost

Within a manufacturing context, cost often relates to both raw material and machine running costs, but in today's economy, it is also about making the most of all resources; materials, machines and people.

Standardising the manufacturing process is one way to maximise cost savings. For example, this could mean using a standard set of cutting tools across all

machining facilities (see the Manufacturing Resource Library on page viii of this document).

When it comes to machining time optimisation, Siemens PLM Software's NX CAM suite is perfectly placed to help create operations which are lean and efficient. It not only helps save time, but can reduce wear and tear on both machine tools and cutter hardware.



*Teamcenter for managing standard resources such as cutting tools and fixtures*

## Control

Efficient working processes based on digital part manufacturing data require control. Often seen as an additional burden, if done correctly, data control can actually make processes more efficient.

While control helps ensure that data is centralised and up-to-date, it also has the advantage of delivering a much richer set of information to those that

need it. Within the context of manufacturing, this means that work packages are based on the latest release data. It also allows consumers of that data to interact with the related assets and to feed back errors when they occur – quickly and efficiently. Teamcenter is an intelligent backbone through which data is controlled, complete and made accessible to all those that need it.



*Teamcenter for data and process management – revision control, workflow notifications, and the production release of work packages*

## Compliance and traceability

Many industries are now facing increasing regulatory and compliance demands. While already widespread in the aerospace and medical sectors, traceability is now a key requirement for many more organisations.

Satisfying this demand for record keeping and data tracking presents a serious headache for organisations without data and lifecycle management

systems in place. Additional problems arise when the data moves from design and development into manufacturing – where data management processes aren't as commonplace.

Siemens' Teamcenter can assist with these challenges and help ensure that a complete record of change and decisions is maintained from development right into production and inspection.
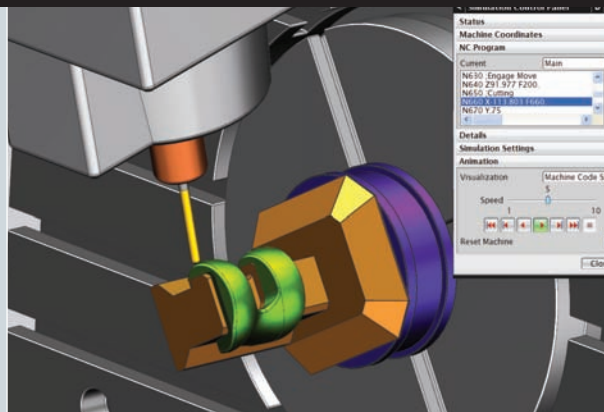


*Teamcenter with secure access, full records of change, and managed delivery of the work package all the way to the point of execution (machine tool)*

## Globalisation and flexibility

Globalisation is a major challenge faced by many manufacturing organisations. While the mainstream media tend to portray it as a threat of impending doom, those in the know see globalisation as a opportunity for expansion and business growth.

What is key – particularly when dealing with multi-site, geographically dispersed manufacturing centres – is the ability to

balance workloads, keep the production facilities flexible enough to handle rapid introduction of new business lines, cope with demand fluctuation and handle new machine tool deployment efficiently.

Siemens PLM Software's NX and Teamcenter have been developed to meet these many challenges of globalisation for some of the world's leading global players.



*NX is used by the smallest job shops to the biggest global companies. Teamcenter provides a platform for a design-anywhere build-anywhere business*

# Planning to production

## From world-leading design and engineering to the provision of tools through the PLM Software group, Siemens is synonymous with innovation. We detail how it can help take parts to production with a rapidly expanding product portfolio

**M**anufacturing is the rapidly changing stage of a process that leads a product from conceptualisation, through design and engineering and into production.

While historically, the 'design, make, sell' company has been common place, global pressures, lower cost economies and the battle for survival have meant that the manufacturing sites of our fathers are not ours — and far from it.

Manufacturing today sees the tools used to design a product combined with the manufacturing execution tools that allow data to be reused. That same intelligent 3D data source can be used to drive the development of tool-paths, to create and optimise inspection processes, and to produce job sheets and work lists.

The problem is, this process can often become fragmented, disconnected and unmanaged.

Into this fray steps Siemens, an organisation steeped in global engineering and manufacturing heritage. In the manufacturing sector, Siemens has been a supplier of machine tool control and drive equipment for decades. Its Sinumerik machine controllers have long been leaders in the aerospace industry and many more machine tool builders are now offering Siemens controllers.

The establishment of the Siemens PLM Software division, with the NX product suite, has brought with it a set of tools to assist not only in the design of new products and parts, but also with the preparation of those parts for production. This includes mould and die design, advanced applications for the programming of multi-axis machine tools, mill-turns and into CMM programming and inspection.

### Part manufacturing

Siemens's part manufacturing solution, taken in the context of the whole NX offering, takes this foundation, along with Siemens' activity in manufacturing in general, and builds a complete solution that can truly benefit any organisation that takes it on board.

From the development of the part geometry within the context of NX, it's possible to develop, iterate, simulate and finalise the form and function. When required, this same geometry with associated tolerance and manufacturing information, can be taken further. Here technologies such as NX's Synchronous Technology, which enables history free editing, can be taken advantage of to create tooling, add machining stock and other preparatory processes.

CAM programming is something that NX has been well respected for since its beginning, building on the tools already present within Unigraphics. These have been expanded since.

This means that production-ready machining programs can be created, optimised and output. This output can then be combined with the documentation required to produce a part to form an intelligent work package for delivery to the shop floor

As a result of the legacy of the NX system and the direct experience Siemens has at the controller or DNC level, the system is able to control not only the mainstream machine tool equipment, but also the advanced technology now becoming available such as embedding the Siemens'

## Delphi Thermal - improving profitability with intelligent processes
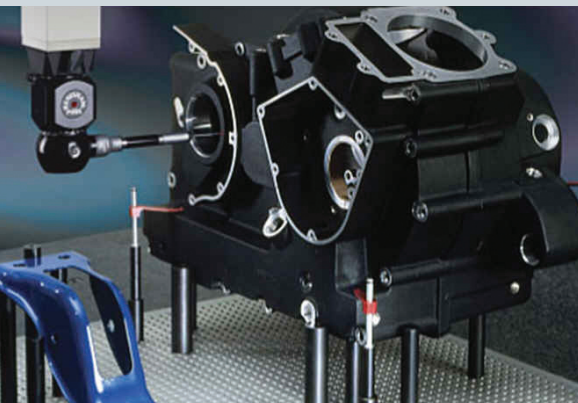


Delphi is a leading global supplier of mobile electronics and transportation systems, including powertrain, safety, steering, thermal, and controls and security systems, electrical/electronic architecture and in-car entertainment technologies.

Faced with increasing competitive pressures in a contracting automotive market, subsidiary Delphi Thermal realised that 'good enough' wasn't going to accomplish its ambitious goals nor satisfy automotive OEMs that are demanding lower cost components with tightening quality requirements.

One of the key components of the automotive supplier process is a strict compliance to OEM quality requirements through Production Part Approval Process or PPAP. With a quality solution for inspection programming and execution built on Teamcenter, Delphi Thermal has been able to meet PPAP requirements much more efficiently while increasing its final PPAP acceptance rates.

This has had a positive impact across multiple domains, but especially in removing delays from production.
**www.delphi.com**

controller cycle software code into NX CAM.

**Data and process management**
Alongside the core creation and preparation tools, Siemens also has Teamcenter, its Product Lifecycle Management solution. While PLM is often seen as a 'design-heavy' solution, Siemens is building a new set of tools into the system for managing and controlling all manner of manufacturing and production information.

This ranges from the direct management of the part geometry, through to the various constituent parts of the CAM tool-path, such as fixtures, machine tool models, cutters, work piece and individual operations.

The new Manufacturing Resource Library provides a new integration between NX (for geometry creation) and Teamcenter which allows the modelling of both form and metadata of the cutter so the whole enterprise can access a standardised and centralised library. This saves both time and cost in procurement (see page viii for more details on the Manufacturing Resource Library for Teamcenter).

Teamcenter is well versed in process management and now has specialised workflows and processes to support part manufacturing. This includes production plan building, task assignment, job approval and release, change management and traceability — which is becoming increasingly important.



1 The full suite of Siemens solutions relating to part production, from design through machining and into inspection and quality inspection. All are built on a backbone managed and controlled by Teamcenter

**Effective connection to production**
To support the deployment and use of these tools, Siemens has now released the Shop Floor Connect for Teamcenter. While you can read more about the benefits of this technology on page vi, the concept is as follows: The shop floor is a dramatically different environment to the design or production planning office, but the same access to data is fundamentally key if efficiency is to be boosted.

Shop Floor Connect for Teamcenter provides a web-based architecture for those on the shop floor to interact with the Teamcenter-managed work packages and supporting information, along with process integration. This is delivered in a stripped back manner that makes it suitable for lower powered PCs, tablets and even more advanced DNCs, right where it's needed.

**Integrated quality solution**
When it comes to building a complete workflow around intelligent data and process management solutions, it is essential that the complete process is covered and closed out. For part manufacturing, the final stage in the process is quality inspection.

Again, there is often a disconnect between the quality department and shop floor inspection and the core backbone of data. However, the combination of NX and Teamcenter can bring this back into the production loop. Capabilities include CMM programming with the new tools introduced into NX, the management, distribution and execution of those routines using Teamcenter, and the storage and sharing of the resultant reports with those that need them.

## **Workflow** The CAD/CAM/CNC process chain

1 Siemens' Synchronous Technology allows geometry (either part or fixture) to be edited and re-purposed without prior knowledge of its construction or source
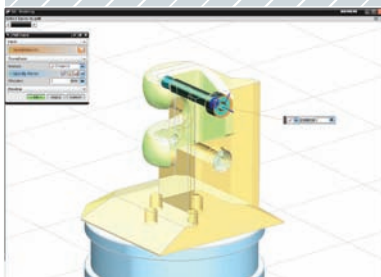
2 Using the new Manufacturing Resource Library for Teamcenter, tools can be selected from a centralised library, which is optimised and managed across the enterprise
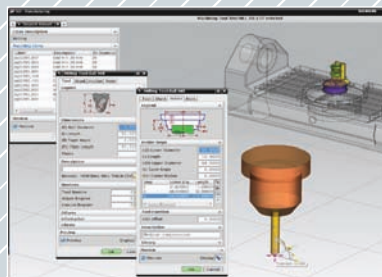
3 NX CAM provides the environment in which to create, optimise and output the NC code required to drive all manner of machine tools and cutters
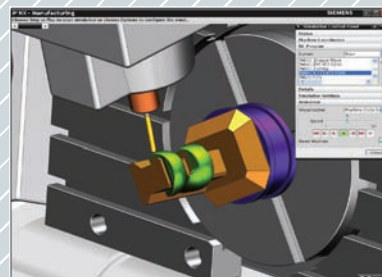
4 Using Teamcenter in combination with NX's production preparation solutions, a work package can be put together and distributed efficiently to those that need it
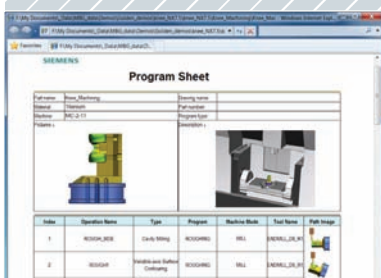
5 Siemens' Shop Floor Connection allows the entire up to date work package to be accessed in a controller environment on the shopfloor - and allows feedback to be given
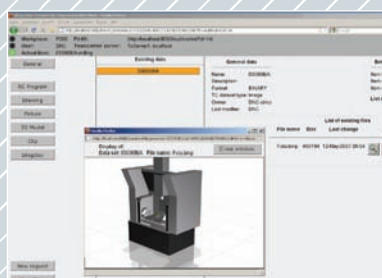
6 From basic parts to complex programming of multi-turret mill/turns, 5 axis mills, NX has all the bases covered. It can then move into inspection and quality

# Connecting the work package

## Data and process management are becoming commonplace, but their benefits often break down when projects move into production. To bring order to this chaos, the new Shop Floor Connect for Teamcenter aims to keep production in the loop

**W**hen considered in the context of the whole product development process, manufacturing is one of the most complex stages. However, it is often unmanaged, disconnected from the source data and fragmented.

Then come the connections from the shop floor to the critical data used for actual manufacture. Due to the reliance on paper and a lack of appropriate search and retrieval tools, even if an organisation is using a data management solution, there can be problems with incorrect or out of date data. There's often no reliable change record available and it's difficult to ensure that those tasked with managing production can find the right information at the right time.

On the shop floor there are multiple disconnected databases and applications. These include tooling, jigs and fixture supplier catalogs, cutting libraries, 3D models and stock management — perhaps even machine tool specific applications. All of these disparate sources of information add to the complexity and potential for error.

Many of these issues can be traced to the methods available to the enterprise to take the information — already part of a data management process — and make it available to the shop floor. However, the tools available to search, view and retrieve key information in the design or management office are often entirely inappropriate for the shop floor. This is where Siemens PLM Software's new Shop Floor Connect (SFC) for Teamcenter comes into play.

The higher level concept of SFC is to build on the capabilities within Teamcenter for managing, tracking and controlling product data across all manner of industries, then provide access to the manufacturing information right at the point of use — namely, the shop floor.

**Task appropriate interaction**
Teamcenter has been extended beyond the existing tools that manage and control CAD geometry and lifecycle during the design and development phase to manage part preparation, tooling and fixture design, CAM and CMM programming process management and tool libraries.

With the addition of Shop Floor Connect, those on the shop floor now have a number of ways to interact with Teamcenter. Using a server-based solution, SFC can be accessed by any device available. Much of the extraneous functionality of the fully functional Teamcenter client is stripped away and a much simpler interface used. This means that the data can be accessed not only on a standard or lower-end PC, but also other hardware platforms with lighter requirements, whether that's an iPad or a more modern machine controller with a web browser.

**1** Today's DNCs are much more powerful allowing the shopfloor to access manufacturing critical information directly at the point of use

**2** Shop Floor Connect for Teamcenter provides a stripped back interface to access production data live from Teamcenter which can be delivered to a range of devices from the DNC or Apple's iPad

**1**



**2**
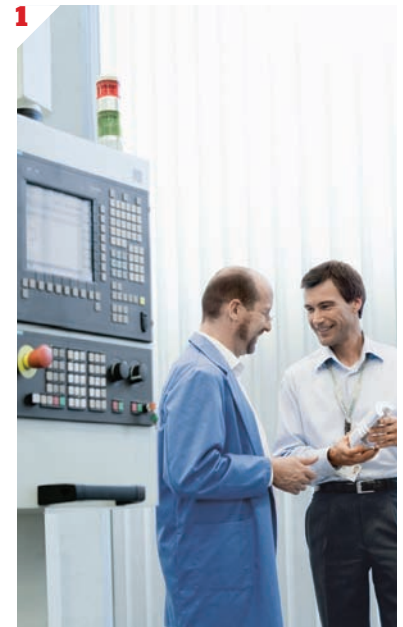
# Pump up the volume

**PLM and CNC integration provides seamless data flow from CAD/CAM to machine tool controllers, automating production and saving time & money**



**A** ndritz Ritz manufactures pumps and submersible motors used for municipal and industrial water supply and sewage systems, mining applications and offshore platforms. The firm is a leading manufacturer in its market segment with more than one million pump systems installed worldwide. It produces pump systems and replacement parts, and on occasion embarks on spectacular engineering projects, such as the world's largest pump, which was created for the Las Vegas, Nevada municipal water system.

Andritz Ritz's IT infrastructure is constantly evolving and improving. For example, after implementing abas ERP software for 58 users it was able to retire four legacy systems. An upgrade from 2D CAD to a 3D design process using Solid Edge from Siemens PLM Software improved the efficiency and accuracy of the engineering department.

The next goal was to improve numerical control (NC) programming and cutting tool management. "We have organised all of our technical and commercial systems in such a way that colleagues benefit from the work of others throughout the design-through-production process chain," says Hans-Juergen Steeb, manager of IT and organisation at Andritz Ritz. "Therefore, our CAM system selection criteria were heavily focused on the ability to establish a fully integrated process."

A number of computer-aided manufacturing (CAM) systems were evaluated based on selection criteria such as cycle time reduction, quality improvement, user friendliness, and the ability to deliver a higher degree of process automation between engineering, NC programming and shop floor machining. The company chose the Adanos partner network, led by A+B Solutions. The latter partners with Siemens PLM Software to provide solutions such as NX and Teamcenter, as well as comprehensive product lifecycle management (PLM) services including implementation.

The implementation proposal included streamlining the manufacturing planning and shop floor production processes by integrating Teamcenter (data and process management) with Shop Floor Connect (a web client for use on the shop floor to access, manage, view and deliver CNC programs to machine controllers).

### Integrated PLM environment

Today, when an engineer begins a session using Solid Edge, Teamcenter is started at the same time and every newly created component is registered and managed by the PLM system. All design changes, update notifications, and release processes are initiated and carried out automatically.

Design and manufacturing revisions are also managed and tracked throughout the entire process, from initial design, to each design variant, and on through to manufacturing. Standard parts are classified within the library for fast and easy retrieval, and their use is tracked within every design. Finite element analysis (FEA) simulations are also saved and managed with Teamcenter. The NC programs are created at two NX CAM workstations, which are connected to Teamcenter. Even the packaging and release of NC data to production is managed by the manufacturing release process of Teamcenter. Using Teamcenter, NC programmers can easily find and select the required tools and clamping devices for their respective CNC machines.

Before running the actual machine, all NC programs are run through a virtual machining simulation using NX CAM. These simulations allow NC programmers to check tool paths in the context of the complete machine assembly, providing comprehensive collision protection. Finally, tool lists and setup sheets are created and stored together with the work plan, detailed drawings, NC data and machining simulation videos.

### Closed-loop manufacturing

Another important aspect of Andritz Ritz's implementation is the seamless transfer of project information from manufacturing planning to production. On the shop floor, workstations are connected to one or several machine controls. There, machine operators log into Shop Floor Connect to gain role-specific access to released data. For each job, the user is shown only the information that is needed. Simulation data, CAM parts, CAD models, pictures, videos, and work plans may supplement the default information of NC data, shop floor drawings and tooling sheets.

NC programs are transferred directly to the controller. Sometimes, programs need minor adjustments and optimisation at the machine controller. When this occurs, the machine operator can easily record the changes, and then notify and transfer the modified program back to NC programmer via Teamcenter.

### Shop floor information within PLM

By bridging the worlds of engineering and manufacturing with PLM, smarter decisions can made to produce better products. Andritz Ritz has established an integrated work environment that ensures a reliable process chain, from design through production. Project cycles became more efficient, while continuing to remain lean. The ongoing trend toward business growth suggests the need to hire more. All the while, the fundamental principles of process reliability and continuous improvement remain uncompromised. "We are able to identify and fix potential issues much earlier in the process," says Steeb. "We save a lot of money, because we can avoid finding errors late in the process when they are the most costly to fix."

**1** Andritz Ritz produces pump systems and replacement parts for a wide range of industries

**2** Andritz Ritz uses a variety of software from Siemens PLM Software, including NX CAM, Solid Edge and Teamcenter

**3** Pumped up: the team at Andritz Ritz
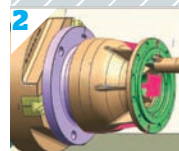
# Manufacturing Resource Library

## Siemens PLM Software's Manufacturing Resource Library takes a novel approach to tool management and allows you to get even more from your resources

When you need a cutting tool for NC programming don't waste any more time hunting through that clunky library or separate vendor catalogues. With the latest release of Teamcenter, Siemens PLM Software introduces the Manufacturing Resource Library (MRL) offering a new approach to managing resources that lets you easily find and use the tooling you depend on every day.

Nowadays, most CAM systems come equipped with built-in tool libraries. Unfortunately many of these libraries come with a hidden cost. These systems require your time to populate them with tool records and to maintain them whenever a new version of a vendor catalogue is published. Plus, each vendor's catalogue is organised differently, so you can't easily import their data into your system or you will spend countless hours sorting through these catalogues to find the tool you need.

The MRL stores and classifies its content in Teamcenter, with a full range of search functions and graphical displays so you can easily find and access your tools. Most importantly you can easily import vendor catalogues and then select the tools you want to use. You can even add your own content if you have special types of tools or other resources such as special fixtures to manage.

### Direct access to the tool library

Siemens PLM Software's NX CAM system, with its connection to Teamcenter, directly accesses all of the resource information using built-in menus. From NX CAM, you can search the library, find the tools you need, and pull accurate 3D models of the selected cutting tools right into the CAM programming session. This helps you create NC programs faster, run more accurate machine tool simulations, and automatically create complete shop documentation that contains up-to-date and correct information about the tools used.

The MRL supports current standards for defining and categorising cutting tools including the DIN and ISO standards. It is also flexible. Although the system is provided with an advanced classification structure, you can create your own structure. You can also use it for the other resources around your shop including machines, fixtures, robots, and tool handling equipment. You can even use it to keep your digital assets organised, such as CAM process templates, CAM wizards, drawing templates, programming setup templates and almost any other digital item you can think of.

### Working with tool vendor catalogues

The MRL is divided into three areas that keep the tooling vendor's catalogues and your tool components and assemblies separate. If a cutting tool vendor provides a CD or DVD with its catalogue content you can import this data directly into your library's Vendor Catalogue with a few simple clicks. The MRL intelligently maps the vendor's tool classes and attributes to its matching fields.

With the vendor data in your system, you can pull from this data to populate your Customer Area (the working library) with the tools and tool assemblies your shop uses. This way you don't clutter your working library with thousands of tool components that you never use.

### Cutting tool assemblies

Of course the system has to be able to handle both the tool components – tool holders, extensions, cutting inserts and so on – as well as fully assembled tools that are needed for machining. The MRL system helps you assemble tools based on rules that define connection points for the various tooling components.

### PLM integration

Because the MRL uses Teamcenter technology it means that the full range of PDM type functions can be used in the tooling area. For example it's possible to search for all jobs that used a specific tool

assembly or component. If the selection of tools in the customer (working) area is changed you can easily see which jobs or NC programs would be affected. This can help you make decisions on how to maintain your working database of cutting tools.

### What the Manufacturing Resource Library doesn't do

The MRL is not intended to replace shop floor or other production systems that manage physical tool inventories or resource procurement solutions. The MRL is designed for use in the manufacturing engineering stage of the process where programmers and planners are defining methods and setting up work packages. It can be set up to synchronise with shop floor tool management systems; for example to allow the programmer to check inventory levels before selecting a tool for a job.

### Key value

The big benefit associated with the Manufacturing Resource Library is the ease with which you are able to handle multiple tooling vendor catalogues and construct your own working library. This advantage, coupled with the tight solid model based integration with Siemens PLM Software's NX CAM, makes the MRL a step up in handling critical cutting tool information.

**1** Drive the use of standard tooling from your working library to help reduce tooling inventory costs - rather than have NC programmers select new tools from vendor catalogues

**2** Teamcenter can be configured so that tool lists for released jobs are sent to the shop floor for inventory checks in case new tool supplies will be needed for job

**3** The data in the library can be used in the CAM system to populate output in tooling lists, shop documentation, and run machine tool simulations


**1**


**2**


**3**