

Dr. Charles Clarke

NX CMM INSPECTION PROGRAMMING PRODUCT REVIEW

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Introduction

The business of inspecting parts remains an important element of a quality assurance process. The available technology that relates to inspection has changed significantly over the past few years in both hardware and software. Probes and scanning devices can collect data far faster. The coordinate measuring machine (CMM) remains a key piece of equipment for accurate measurement but it requires a separate inspection program for each component and complex part geometry can require multi-axis probing paths for efficient measurement on single set-ups.

Preparing these inspection programs has typically been a standalone task, outside of a PLM process, with the user often working from a 2D engineering drawing. The result can be slow, and error prone with limited traceability back to the design and manufacturing models and data. When design changes take place it's very easy for the inspection programs to become out of step.

This review looks at a new application from Siemens for preparing advanced CMM inspection programs. It is designed to utilize model based product and manufacturing information (PMI) to create inspection programs automatically. It uses the latest 3D simulation software for full validation of the programs and produces industry standard output ready for your CMM.

Dr. Charles Clarke

Charles Clarke is a recognized consultant and writer in CAD/CAM/CAE and PLM and related topics. With a background in engineering, the CAD/CAM industry and with direct experience of planning and implementing these systems for high profile companies, he has good experience on which to base product assessments and reviews. Dr. Clarke is a regular contributor to a number of industry magazines both in the UK and internationally.

Industry trends and requirements

There are several inputs that have motivated Siemens PLM Software to create this new application. Firstly the latest high-speed probing and scanning technology can collect data somewhere between 10 and a 100 times faster than older equipment. Not only can more inspection be carried out but the new equipment allows more complex measurements to be made. These systems can't be easily programmed by hand, or by using traditional 'teach' mode methods, so you really do have to use an off-line programming tool. The big issue for inspection programmers is that the methods they are currently using to create these more involved inspection programs are too expensive and take too long.

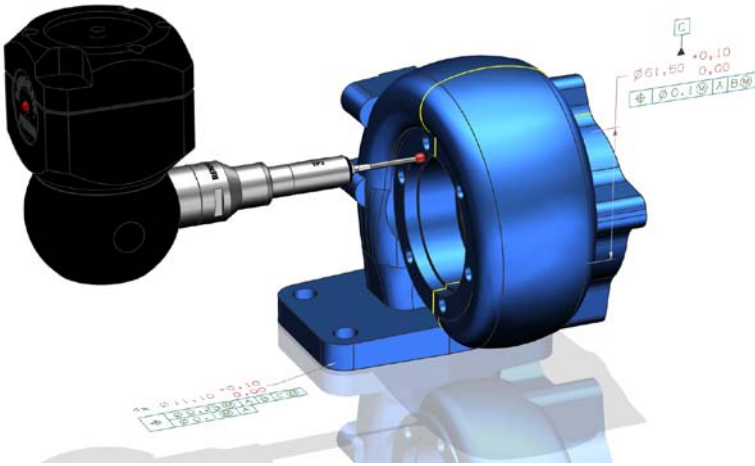
Siemens PLM also note that more of their customers are going for a full 3D product definition in the CAD system. In addition to the part geometry, this includes all the other manufacturing information, which is captured as product and manufacturing information, or PMI, attached to the 3D model. For inspection purposes this can include the tolerance requirements - like those on dimensions, and on the relative positions of physical features with respect to the overall geometry. If the downstream tools can take advantage of having all this information added to the design model, then you have a better chance that your product requirements are actually being met when you inspect against them, not only geometrically but also from a manufacturing point of view.

When talking about CMM inspection programming, Siemens PLM have some unique and novel ideas, not only to significantly automate the process, but to integrate it into the overall PLM backbone.

Another issue is the isolation of CMM programming, execution and data collection from mainstream design and manufacturing processes. Customers want this to be integral to their overall PLM workflow and for the data to be stored in their PDM system. On the shop floor they want the measurement systems to be able to access the right inspection program from PDM, and then when they collect all the measurement results, they also want to be able to put this data back into the PDM system so that manufacturing engineers and designers can look at it.

From earlier acquisitions Siemens had a lot of expertise and some products in this space for doing CMM programming, some of them were embedded inside NX but they weren't really very well integrated, certainly not to the level required today. Today when talking about CMM inspection programming, Siemens PLM have some unique and novel ideas, not only to significantly automate the process, but to integrate it into the overall PLM backbone.

A new approach to CMM inspection programming



Example of a CAD model with PMI (Product and Manufacturing Information) that drive the automatic programming within NX CMM.

Siemens decided to build the new CMM inspection programming product inside of NX, because NX is a full 3D model based system and it has all the CAD tools for geometric manipulation, as well as those for PMI authoring and PMI integration. In NX there is also proven technology that's directly applicable to inspection programming such as the machine tool simulation software. A key objective in building the new application was to provide a high degree of automation and to drive the programming from the model based PMI data as much as possible.

The application in use

The user can start by selecting a target measuring machine (just like an NC programmer would select a machine tool in NX CAM). You can select a pre-defined inspection process from a template library that sits alongside similar template libraries for other NX applications.

The part to be inspected is brought into NX (there is a wide range of NX model translators if the source was other than NX) and it is positioned on the inspection table for the target CMM.

The initial version of the software addresses 3-axis scanning and up to 5-axis touch-trigger probing. Siemens say that 5-axis simultaneous scanning will be added later.

NX CMM Inspection Programming is a new module with NX 7.5. It's fully integrated into NX so the user interface looks like any other NX application, and for NX users this will be a real bonus. New users to NX will find that the latest ease-of-use developments and the graphical interaction with the model, that Siemens has been perfecting, make this a nice system to work with.

Automatic inspection programming

At this point the application exposes one of its real wow factors. Siemens PLM has a unique function which they call “Link PMI” – a seemingly innocuous little button on the top menu bar but one that does a lot very quickly. The Link PMI command actually takes 3D part geometry, and the PMI attached to the model, and from that the software extracts all of identified features and tolerances and creates all the inspection operations necessary to inspect the part. It’s one of those “click one button and it’s done” scenarios.

You have to open the information navigators in the software to see that instead of the blank structure brought in with the inspection template, these are now

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extensively populated with a hierarchy of inspection features, inspection data and inspection operations read from the part and translated into an inspection program. The inspection paths are generated based on the inspection feature type and the PMI attached to it. Siemens uses pre-defined concepts for capturing inspection knowledge. This knowledge provides the

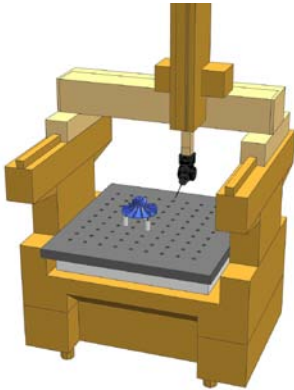
basis for automatically calculating the inspection paths based on the feature type.

For some parts that have accessible PMI data on the model, simply applying the Link PMI command can save about 80% to 90% of the traditional programming time. Of course for parts that don’t have working PMI data attached, or where it’s incomplete, or where the inspection programmer wants to add extra measurements, there is a menu section that covers manual creation of inspection features and operations. You select from a number of pre-defined inspection methods, then the pick points or features on the 3D model geometry on the model. Then NX generates the appropriate path.

Program output and validation

Once you have the CMM program, NX CMM has an ability to create the output that can be read by the software that drives your measuring machine. You simply select the appropriate postprocessor to create the machine instructions in DMIS (Dimensional Measurement Interface Specification) or a native programming language such as GeoMeasure or Calypso.

However, before you send the program to the shop floor it’s likely that you will want to check it out – to make sure it’s inspecting the way you expected or wanted and that there are no impending collisions. In fact, for complex tasks you will probably want to make these checks as you develop the inspection program, in case you need to make some changes.



Example of a CMM machine model used to program, simulate and verify inspection programs.

For this capability Siemens provides multi-level tool path verification and full machine simulation. A number of standard CMM machine models are provided with the standard NX CMM software. 3D models of CMM machines can be imported or NX CAD can be used to create your own. The Machine-tool Builder module in the software allows you to add the necessary kinematics and limits of travel for each CMM machine you have. The simulation is driven by the DMIS output so it's a good representation of what's sent to the shop floor.

Data Management

Because the CMM application is built inside of NX, it takes advantage of all the NX integration with Teamcenter, the PDM system that underpins the PLM solution from Siemens. Inspection data is automatically stored under an inspection process item in Teamcenter. For customers using Teamcenter, the ability to store templates, tools and probes, and inspection rules is also available, as well as inspection programs and output files linked to the correct revision of the part.

The ability to manage the inspection data and to link it to the master records of the part data may address one of the biggest challenges in this business. That is, to ensure that the CMM geometry matches the design model and the released manufacturing geometry. Teamcenter can notify downstream functions of any changes that may affect them. The associativity inside NX can also play a role here, since it facilitates updates to the related part models if the design input changes.

The positioning of CMM within an overall manufacturing solution

Siemens say that they predict that the new NX CMM Inspection Programming application will be adopted by a wide range of companies. The smallest shops that often buy one license of NX CAM or NX for tool design are expected to value the benefits of doing more in the same system based on the same model.

The larger companies with broader systems are expected to see the additional value in being able to integrate the quality process better into an overall PLM process, taking advantage of the Teamcenter integration. To this end Siemens shows the new application within their part manufacturing solution set, extending NX in its role in the virtual world of manufacturing engineering, alongside NX for NC programming, NX for part model preparation and NX for tool and fixture design. All these components can be fitted together quite readily, as they're all part of the same suite.

One value of the NX architecture that is not very often promoted, but is a huge benefit to some companies, is that NX is arguably one of the most customizable CAD/CAM/CAE systems out there. In this case, that same NX architecture will allow customers to build their own automation programs that work with NX CMM to perhaps achieve levels of automation and repeatability that's only possible with that extra investment.

Conclusion

The current methods of creating CMM programs are too expensive, take too long, are error prone, require scarce, highly skilled resources and are not integrated with the PLM workflow.

NX CMM is an NX module based on NX CAM that enables the user to use PMI to produce fully associative inspection programs for Coordinate Measuring Machines in a highly automated manner. If you don't have the PMI, you can create the inspection paths interactively.

NX CMM makes inspection programming an integral part of the PLM process, fully automated by NX geometry and PMI, and managed in Teamcenter using the best in-class NX user interface.

This is a new product, but it shows the inspection application experience of the same team that built the Valisys and Tecnomatix inspection software at Siemens PLM and that now has created this NX CMM product. There are some functions still to come, especially in the area of multi-axis inspection but Siemens point to a roadmap that looks as though this product is one that should be considered, if solid model based, faster inspection programming is on your wish list. For existing Siemens customers, it's got clear advantages and it might be enough to start new customers out on the Siemens and NX track.

But perhaps what's really significant here is the roll through of non-geometric data (PMI) attached to the model and its practical value in driving product requirements down to the shop floor. After many years it looks like some of the higher expectations of computer integrated design and manufacturing are becoming a reality with some tangible benefits for those that adopt these systems.