Siemens PLM Software

Advanced tooling solution

An advanced solution set for tooling design and manufacture

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white paper

Combining the latest tool design and manufacturing software applications with a specialized data and process management environment to provide an advanced, collaborative tooling solution.

PLM Software

Answers for industry.

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Table of contents

Abstract

Tool design and manufacturing for the high tech and consumer products industries is typically separated from product development, is outsourced and often geographically dispersed. To meet increasing rates for new product introduction and time-to-market reduction pressures, there is a need for efficient information and process management across and within remote operations.

A possible trend to consolidate tool design and product manufacture into more tightly integrated organizations may lead to larger, more complex operations that require effective information and process management in order to perform effectively.

Within this context, this paper considers the value of combining the latest tool design and manufacture software applications with specialized data and process management environment to provide an advanced tooling solution – a fast, complete and repeatable design-through-manufacture system.

Introduction

The Siemens PLM Software advanced tooling solution was developed with companies in the consumer products and high tech electronics industries; key concepts may also be extended to the medical device and automotive industries.

An advanced tooling solution integrates product and process data management with specialized domain applications to deliver greater business value than the implementation of CAD/CAM applications alone.

The manufacturing of high tech products for the consumer industry is at the forefront of fast-moving, global businesses. Technology and product innovation in this industry is advancing at an unprecedented rate. Significant value can be won or lost based on the speed and efficiency of the new product introduction process, and the creation of tooling is typically on the critical path. In some cases new production-ready tooling must be completed within a timeframe measured in hours rather than days or weeks.

Driven by a desire to utilize low-cost resources, many companies in this industry rely upon the use of relatively small, often outsourced and widely remote suppliers to address critical elements of the design, creation and use of tooling. Yet this arrangement, with its separation of people, resources and process steps, can become an impediment to fast, effective new product introduction and the necessary high-speed tool design and manufacture. Across this separated environment, OEMs need to be able to manage change and the distribution of product design data. They need to be able to collaborate effectively and in realtime, if there is to be any chance of delivering tooling within the aggressive timeframes and at the requisite quality.

As an alternative, we see the emergence of an approach that is less geographically dispersed, that brings together resources into larger, more closely knit operating units. This arrangement can offer more control, faster response to changes in design or demand and higher product and process quality. In return, it demands the effective management of information and process. One way to address this requirement is to utilize software technology that can support the tool design and manufacturing information process, and manage the associated data across the operation.

When coupled with the latest CAD/CAM applications for tool design, machine tool programming and shop floor connectivity, the addition of effective information and process management can deliver a key business differentiator. This complete set of capability represents an advanced solution for the design and manufacture of tooling that can be an enabler for faster, more efficient new product development and introduction, and provide essential support for less dispersed, larger operating groups.

The concept of this advanced tooling solution is very different from the separate selection and implementation of the best-in-class CAD/CAM and shop floor connectivity applications by themselves. The latter approach provides localized business improvements at specific points in the overall process. Moreover, while it is well accepted that these benefits can be much greater where the applications are effectively interconnected, it is proposed that the value of the best applications in key functional areas such as mold design, machine tool programming and creation of shop floor instructions can be much greater when linked to an effective data and process management environment.

The design and manufacture of tooling is typically on the critical path of any new product introduction cycle. This is especially true for industries where time-to-market is super-critical and the tooling creation element of the process is targeted to be measured in hours.

Part production includes die-stamped and plastic injection/blow-molded components.

In many cases, historical factors and the massive trend to utilize lower-cost offshore companies, has meant that the process of tool design, manufacture and production of parts has been remote from the product OEM. This separation between the various functions immediately adds a layer of complexity in terms of communication and collaboration, process management, data transfer and access, data accuracy and the propagation of changes.

Complexity of the process

The overall set of functions or roles involved in the creation of tooling has many elements, and the interactions can be complex. The diagram below shows many of the key process steps typically involved in the design and manufacture of tooling. The exact set will vary according to the type of tool and some steps may be omitted, say where the data transfer is purely by 3D data model and drawings are not required.

This complexity points to the significant number of information transfer points within the overall process. In many cases each step is performed by separate people, typically specialists in aspects such as core and cavity design, mold structure design and detailing or NC programming. In some cases these tasks will be carried out in one multipurpose office; in others the functions could be distributed across separate contractors.

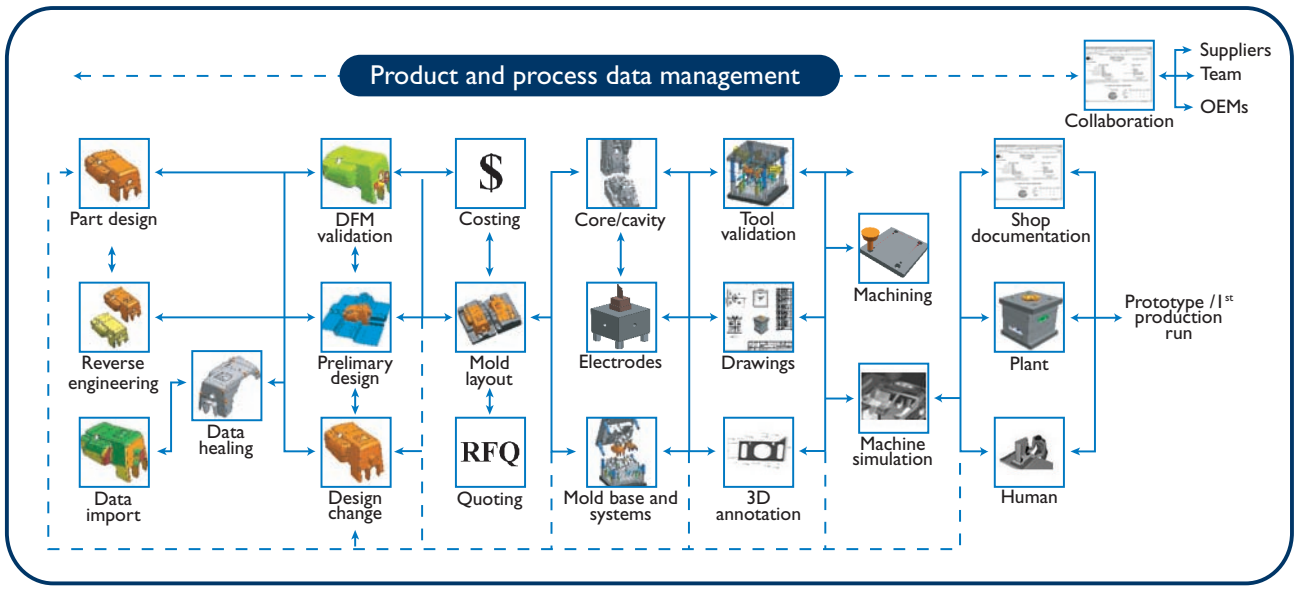
Typical problems

The following is a list of some of the typical problems that can be encountered in the classic distributed toolmaking arrangement:

Problem	Effect of problem
Data transfer errors/data quality issues	Mistakes in downstream processes
Data translation times	Wasted time
Lack of automatic updating during changes	Significant time wasted in manual updating
Miscommunication, misunderstandings	Costly errors and delays, disputes
Lack of control over changes	Costly errors – wrong data can be used
Lack of effective, realtime communication	Assumptions made in lieu of definitive answers
Limited data configuration control	Not easy to ensure all are using correct data
Contractor may not be dedicated to one OEM	Not always available for instant response

"Tooling suppliers incur significant costs for re-entering and reworking data because the product data they receive from their customers usually do not meet the needs of tool design."

Interoperability Cost Analysis of the U.S Automotive Supply Chain, NIST



The typical data and communication flow scenario within a component manufacturing organization is tremendously complex, which can cause design changes to become tedious and time-consuming.

Many of these relate to data transfer between roles and between applications. Others relate more to the management of data throughout the process. The diagram below shows the typical point-to-point level of communication that's found even where all of the players and applications are operating in the same organization or the same shop. The arrows show the need for information exchange and communication. The number of point-to-point links is one indication of how complex and ad hoc this interaction can be. Another issue that this diagram illustrates is that many players interact with numerous other roles in the process, indicating that communication and flow of information is far from serial throughout the process. In a later diagram, we show an alternative arrangement to be provided by a key element of an information and process management solution that addresses many of these issues.

Increasing demands from product OEMs

Faced with the overall business objectives referred to in the introduction, OEMs are adding more demands upon their tooling and part production supply chains.

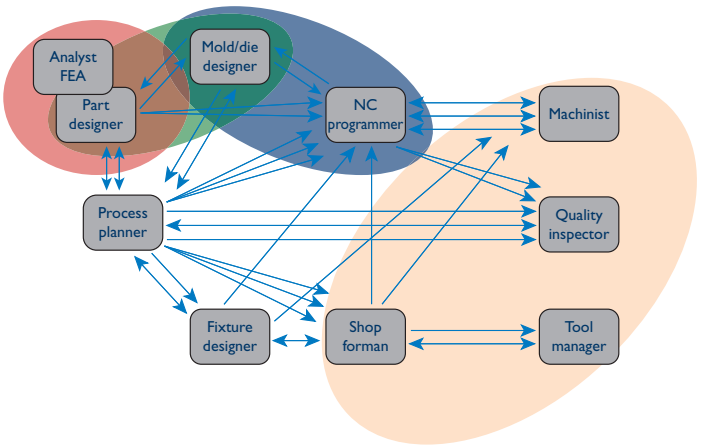
Collaboration

First, there is a growing trend for OEMs to require toolmakers to first participate in "early involvement programs". Significant value can be added and lead times reduced by having program stakeholders participate in early design decisions. This requirement adds to the need for effective communication and collaboration across the range of functions. However, effective collaboration is difficult to achieve. In order to collaborate effectively, constituents are challenged to find more effective means to exchange data with high quality, perform design reviews, manage schedules and track/resolve issues.

There are many more challenges discussed widely in various trade journals, forums, conferences and industry analyst reports such as:

- *Aligning processes with technology to achieve greater levels of efficiency*
- *Resolving costs of data exchange*
- *Reducing machine tool wear and tear*
- *Supporting rapid skill development*

(See references section for more information.)

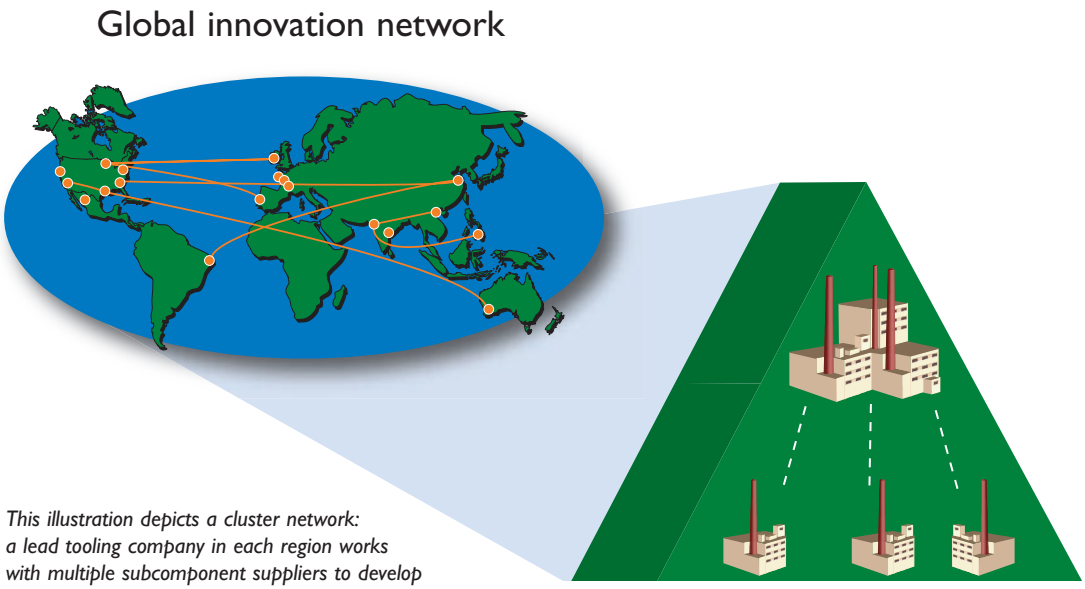


Supply chain management strategies

Second, many OEMs require toolmakers to cooperate and participate in extensive supply chain management strategies. Clustering – a strategy to organize regionally independent product development and production companies into clusters – is one approach that enables OEMs to meet rapidly changing consumer demands on a regional basis. In order for toolmakers to successfully engage in strategies similar to this, it is important to implement a product lifecycle management (PLM) environment that connects and manages product and process data among all constituent parties.

Increase standardization and re-use

Third, toolmakers must increase standardization and re-use to minimize negative cost, quality and time consequences related to original tool design and repetition. Defining, capturing, managing, versioning and sharing standard designs, knowledge and components are some of the challenges that toolmakers face. For geographically distributed toolmaker groups the challenge of standardization is even greater. This is because the standardization requires a global infrastructure, more layers of control and involves more administration to enable consistency and flexibility across geographies.



This illustration depicts a cluster network: a lead tooling company in each region works with multiple subcomponent suppliers to develop and manufacture the tools required to produce and then assemble the end product.

An advanced solution for tooling design and manufacture

Having looked at some of the typical challenges for the toolmaking industry and considering some of the additional pressures being applied by OEMs, we will look at the outline for an advanced tooling solution that can address some of these key issues and requirements.

In terms of the solution, this paper focuses mainly on an advanced software set that can be implemented to provide the necessary application capability and address the overall process and information management issues. The paper does not consider in detail the organizational and business structures that are referred to in some sections as these are outside the scope.

Some applications may function less than optimally in an integrated environment when they are from separate suppliers and built upon different technologies.

A greater gain through unified applications

Instead of simply selecting individual, best-in-class applications as point solutions, the greatest gains can be achieved by selecting proficient applications that are designed to be connected. Having mold tool design and NC programming applications that share the same technology platform can enable a much higher degree of interoperability than is possible by using even the best applications that are operating as separate applications.

The integration of highly effective domain applications within a single product and process data management environment forms the technology cornerstone of an advanced tooling solution. By employing such an integrated environment, companies can effectively integrate and manage the BOM, drawings, related manufacturing information, processes, resources and reports. It becomes feasible to capture, manage and share standard part libraries, templates and designs on a global basis. Complex design changes and manufacturing process plans can also be managed and integrated among tool design, machining, manufacturing process planning and the shop floor while controlling versions and configurations of tools.

Companies also benefit from improved collaboration. Product and process information becomes shared within and across the design team, shop floor and the extended enterprise. Globally distributed concurrent team design helps eliminate wasted time and effort due to data translation. Quoting and projects are managed while design reviews can be performed visually and in real time.

Advanced applications for tool design and manufacturing

The other area to consider is that of key applications. These include the latest software packages addressing a range of the functions shown in the diagram on page 3. The following describes some of the key application areas that would typically be available.

Applications for tool design and manufacturing leverage specialized automation technology to accelerate injection mold and stamping die design tasks by encapsulating expert knowledge and best practices. This technology can also automate downstream processes such as CAM process selection based on intelligent design attribute and can use attributes to build custom costing profiles and automate roll-up calculations.

Mold design

Split the core/cavity, leverage cataloged mold bases ensuring the use of standard parts and preferred suppliers, design the molding systems and create full documentation.

Die design

Build the strip layout and simulate, leverage cataloged die bases, design insert groups and fully document.

Electrode design

Streamline modeling and design of electrodes for any tool project that requires EDM. Effectively design, validate, document, manufacture and manage the entire EDM process from design through production. Manage electrode information within the process to achieve concurrent design and automate manufacturing process planning.

Tool validation

Digitally simulate, validate and optimize tools for their design and production processes. Simulate performance digitally and earlier in the development cycle to improve product quality while reducing or eliminating reliance on physical prototypes and costly, time-consuming design/build/change cycles.

NC programming applications

These applications allow programs to be created to drive CNC equipment to machine mold and die faces, and the associated structures and bases. A range of techniques are employed and the best software is able to maximize the value of the latest machine tools. For example, five-axis milling for high-speed milling machines to cut hard mold and die steel is becoming common in mold and die machining. To make the process faster, more repeatable and easier for the less experienced programmer, the latest software offers a range of automation and process capture capabilities. Toolpath and machine simulation and verification help manufacturing engineers quickly improve NC program quality and machine efficiency.

Shop floor/plant
These applications integrate planning, CAM data management and resource management with the shop floor. NC programs to the NC machine and back optimize programs. Take advantage of tool setup sheets and work instructions. Connect with ERP for order-related resource request.

These descriptions address a number of the key capabilities required. Toolmakers often attempt to achieve greater efficiency through the application of new technology to point requirements, and will employ the applications listed above as well as others. However, as valuable as they are, these applications only provide specific return on investment for the targeted task. In fact, the gains over the existing methods in use, or the older applications that are replaced, are often relatively small when compared to the overall process improvement requirements. Thus, it is important to leverage these applications within an integrated product and process data management environment.

The key advantage of the advanced tooling solution

None of the above concepts are unique. A number of software vendors are able to offer a range of tooling applications that share the same CAD/CAM even CAE framework and which allow a high degree of interoperability and associativity.

The biggest opportunity for significant advantage, and one that addresses some of the key challenges outlined above, is in the area of data and process management. All of the above applications, including each of the steps identified in the figure on page 3, take data from other applications or create their own data, and provide editing capabilities, often across a range of data formats. Few of the applications have an effective data management capability – if they do it's often proprietary and not accessible by other applications.

The basis for the advanced tool solution is an area of software technology that can address the issue of data management and provide process support and integration. Siemens PLM Software has addressed this by developing extensions to proven product data management (PDM) technology. Traditional PDM systems have been designed to manage product data and are typically implemented to manage data that relates to a definition of a part, many parts or an entire product.

They normally do not have the capability to manage manufacturing process data or to put this type of data into its correct context as elements of a manufacturing plan. Data in context becomes valuable information and nowhere is this truer than in the correct management of manufacturing process data, linked to a definition of the part, its tooling and the resources required for that process. A further element of information is the definition of where the process will take place, in which location, shop, workcell, on which machine tool etc.

The use of extended PDM technology – with a product, process, resource and work area data model – also provides key capabilities for change control, configuration management, access control and security. The Siemens PLM Software system provides integrated technology for 3D visualization using the increasingly standard JT™ file format. Many of the best CAD/CAM applications either use or create JT files to allow easy access to their models for 3D viewing. This can provide a key step in establishing the basis for collaboration among multiple roles across the process. The generic name Siemens has adopted to refer to this extended information and process management capability is the managed development environment (MDE). It can be applied in other industries, but here it as a core capability to underpin the Advanced Tooling Solution. The MDE provides the software framework that enables managed interaction between the key roles in the process and the digital applications used in those steps.

All participants in the process may not be co-located; as a result, the managed development environment (MDE) supports globally distributed teamwork.

The earlier, somewhat complex interaction diagram on page 4 can be redrawn as in the figure below.

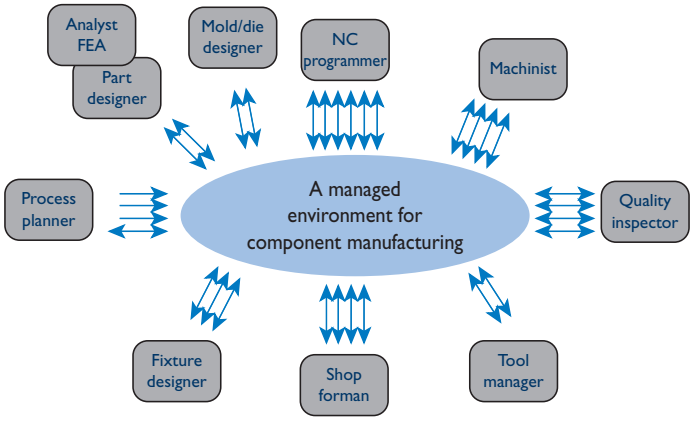
The four major solution elements that characterize the advanced tooling solution are as follows:

1. **Single integrated environment that manages product and process data**
   The greatest contributing factor to the success of an ideal tooling solution is to implement a single system that enables the entire team to access the right data at the right time for the right job. This system must: manage versioning and configurations; control access to components; manage workflows; and effectively manage and control design changes; help search for and coalesce data into reports; and enable process; planning.

2. **Effective digital collaboration**
   Effective collaboration is the second most important factor in enabling an ideal tooling solution. In order to effectively collaborate, OEMs, suppliers and internal teams must be able to access, communicate and visualize information digitally. Another critical aspect of this shall provide effective means to share and consume data produced in different authoring systems. The ideal solution also supports concurrent team design.

3. **Easy-to-use, fully-capable and automated discipline applications**
   Individual applications within the solution need to be consistent, easy-to-use and fully-capable and enable productive workflows for all aspects of the process.

4. **Effective software and service provider partnerships**
   The ideal solution needs to include a strong vendor relationship with the lead provider/partner ensuring that all elements of the solution set are delivered as required and that the defined inter-application functionality and data management integration is operational as expected.



Summary

Siemens PLM Software is able to offer the functional applications for tool design (injection mold, stamping die and progressive dies) and NC programming (CAM) that compete with the best in the world. These Siemens applications are all built on the same software platform offering the benefits of a unified application set – data interoperability, easy change propagation, common style and one vendor to work with. Siemens, as a major supplier of PLM solutions, is able to complement these best-in-class applications with proven data and process management software. Extended from product data management (PDM) technology developed in the 1990s, the latest generation of software in this area is specifically created to manage the tooling design data and machining process data, while providing all of the appropriate tools for change management, configuration control, access management, connection to production and the shop floor.

References

Alan M. Christman, May 2004, "NC Software and Related Services Market Assessment," Version 13, CIMdata

Christina Fuges, April 2005, AMBA-sponsored panel discussion (Steve DeHoff, Roger Klouda, Stuart Oxer, Steve Rotman), "An Examination of the OEM/Mold Manufacturer Relationship to Better the Moldmaking Process" <http://www.moldmakingtechnology.com/articles/060505.html>

Edwin Gasparraj, October 2004, "Is Your HSM Investment Paying You Dividends?" Tooling and Production

HBS Publishing, 1998, "Nokia Mobile Phones: Supply Line Management," IMD Multimedia Case, IMD-701, Boston, MA

Research Triangle Institute, March 1999, "Interoperability Cost Analysis of the U.S. Automotive Supply Chain," 99-1 Planning Report, NIST (National Institute of Standards & Technology) U.S. Department of Commerce Technology Administration

Sherry L. Baranek, June 2005, "Conquering CAD/CAM Challenges," Moldmaking Technology

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Siemens PLM Software

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