Achieving CAD Interoperability in Global Product Design Environments

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Introduction

Globalization in the manufacturing sector is increasing the need for more effective means of collaboration and communication among extended product development teams - including the ability to share product data. But sharing product data between OEMs, suppliers, contract manufacturers, and other partners is characterized by data translators, neutral files formats, and remodeling efforts - impacting cost, product quality and time to market.

This whitepaper examines the challenges to global product design due to lack of product data interoperability and takes a prescriptive look at how a CAD-neutral modification system provides a solution that addresses these issues.

You'll learn how to:

✓ Share critical product data more effectively among various production activities in extended development organizations and supply chains,

✓ Achieve interoperability among disparate systems,

✓ Enable individual contributors throughout the process to accurately import and modify precise 3D product models - regardless of how they were built or what system they came from.

Interoperability: A recognized problem in search of a solution

The need for effective collaboration throughout the extended product development team is critical in today's global manufacturing arena, as outsourcing and offshoring large portions of the product development process - even product design itself - becomes routine.

Statistics bear this out. A recent interoperability survey[1] found that *87% of OEMs surveyed outsource some portion of their engineering*. Offshoring product development functions complicates matters even further, creating extended teams separated by geography, time zones, and language, as well as organizational boundaries.

In this environment, the ability to share valuable product data across the different production activities is critical. Product data interoperability between the disparate software systems utilized by the extended teams of stakeholders - and the coordination of the many different participants and processes that use digital product data - is vital for efficient product design and delivery.

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1 May 18, 2007 press release issued by CADCAMNet and Longview Advisors announcing the results of their 2007 Interoperability Survey.

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But anyone involved in product development knows that interoperability is a major issue for today's manufacturers. Just consider the abundant varieties of CAD systems and file formats that are woven into most development chains. While a few large OEMs may dictate a master CAD system for their internal product design team, the majority of extended development teams and the companies that make up those teams are riddled with different CAD systems.

Further complicating the environment is the prevalence of many other software applications used downstream to bring a product to market; solutions for stress analysis or NC toolpath generation for example, which leverage the digital design data from CAD systems.

Given this multitude of specialized resources and associated software applications involved in today's product development processes, our extended product development teams are teeming with models in different data formats - without the ability to use them efficiently.

Interoperability: How it impacts the bottom line

The cost attributed to lack of product data interoperability is difficult to quantify, but universally regarded as "significant." An often cited NIST (National Institute of Standards) study[2] of the U.S. automotive supply chain put the number at *$1B per year* just for that industry sector alone.

In addition, most interoperability cost studies (like the NIST example) only account for the tangible costs associated with lack of interoperability - the rework, remastering or translation costs for example. They don't account for the penalties related to issues such as longer product development cycles, inefficient reuse of designs, or wasted opportunities for innovation.

Why is it so costly?

Why is the lack of interoperability so costly? Interoperability issues exist between many of the steps and activities in the product development process, but the thorniest of these issues is the inability to effectively share CAD-based product models amongst all the participants.

Indeed, the authors of that NIST study pointed out that the greatest component of the interoperability costs identified in their research were the resources needed to repair or recreate data files that weren't usable or suitable for downstream applications.

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2 Brunnermeier, S.B., & Martin, S.A., *Interoperability Cost Analysis of the U.S. Automotive Supply Chain*, prepared for the National Institute of Standards and Technology, March 1999, http:// www.rti.org/pubs/US_Automotive.pdf

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Within an extended product development team, the overhead associated with CAD interoperability can be attributed to time and money spent:

- Investing in specific CAD systems and qualified personnel to match client requirements,

- Investing in data exchange processes (translators, etc.) to transfer product information from one design system to another, or from a design system to a downstream manufacturing or analysis system, and then revising the product data to make it useful for their specific purposes.

- Investing time to remodel product information in cases where the data exchange processes are unsuccessful.

In that same CADCAMNet survey cited earlier, 100% of OEMs indicated that they exchange 3D CAD data with their outsourced engineers or their suppliers, but on average, respondents reported that they receive CAD data in their *preferred format only 34% of the time*. Do the math and it's clear that there's a digital disconnect; companies and individuals use systems and formats based upon their own needs and are forced to import and modify incoming product design data to get their job done.

Interoperability: How to overcome its challenges

Interoperability issues have existed since draftsmen began replacing their drafting boards with CAD and since the advent of NC programming, finite element analysis, and other specialized software. There have been many strategies, methods and tools aimed at solving data-exchange problems: neutral data exchange standards such as STEP, product-specific data translation software solutions, design review/markup products, etc.

Some of these approaches have been advanced by industry organizations - collective user bargaining groups if you will. Some have been spearheaded by government agencies, who have a vested interested in keeping the manufacturing sector strong and are software users themselves. Some are market-driven commercial offerings.

For many years, large CAD vendors turned a deaf ear to the pleas of their user base for improved interoperability capabilities, partly due to the complexity of the problem, and partly for self serving reasons. CAD vendors have benefited from their larger customers dictating CAD requirements to their respective supply chains, creating new revenue opportunities for the vendor while attempting to obviate the need for data interoperability.

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A new approach for interoperability

Recently, new software has emerged that offers revolutionary technology for the precise, unambiguous product communication needed to overcome these interoperability challenges.

SpaceClaim Corporation has developed a *CAD-neutral modification solution* that allows an extended development team to modify CAD models regardless of the originating CAD system. A CAD-neutral solution permits team members to use their preferred systems, for their specialized needs, and work with the existing design models, as easily as if they were all standardized on a single system. SpaceClaim is liberating the participants in the chain to finally utilize "best-of-breed" systems without incurring the usual friction and penalties associated with interoperability.
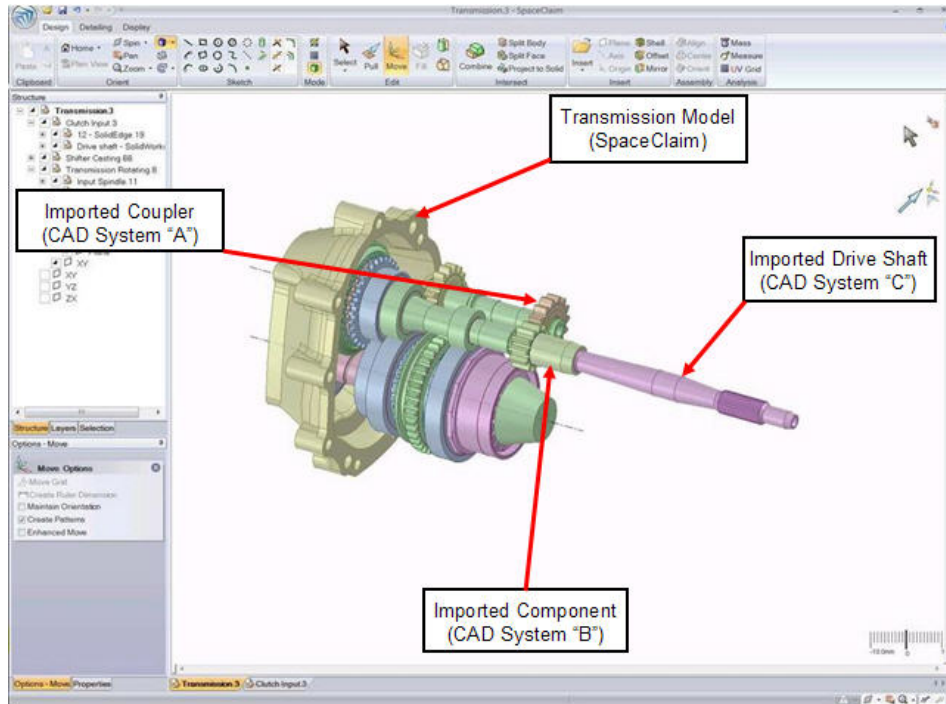

Figure 1: CAD-neutral modification solutions allow an extended development team to modify CAD models regardless of the originating CAD system.

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Lack of interoperability between software systems is more than just a data translation issue. This is why the industry standard formats mentioned above, like STEP, haven't adequately solved the problem. These formats often successfully translate a model from one system to another, but once the model is in the other system it's difficult or impossible to modify the model. The receiving systems are not purpose-built to open and modify non-native CAD files.

Whereas SpaceClaim is not only CAD neutral, it's also "method neutral" - enabling users to open and change a CAD model irrespective of its origin or how it was built. This is a particularly important trait in product development workflows that use parametric feature-based design models: models that are difficult for anyone but the originating CAD specialists to work with.
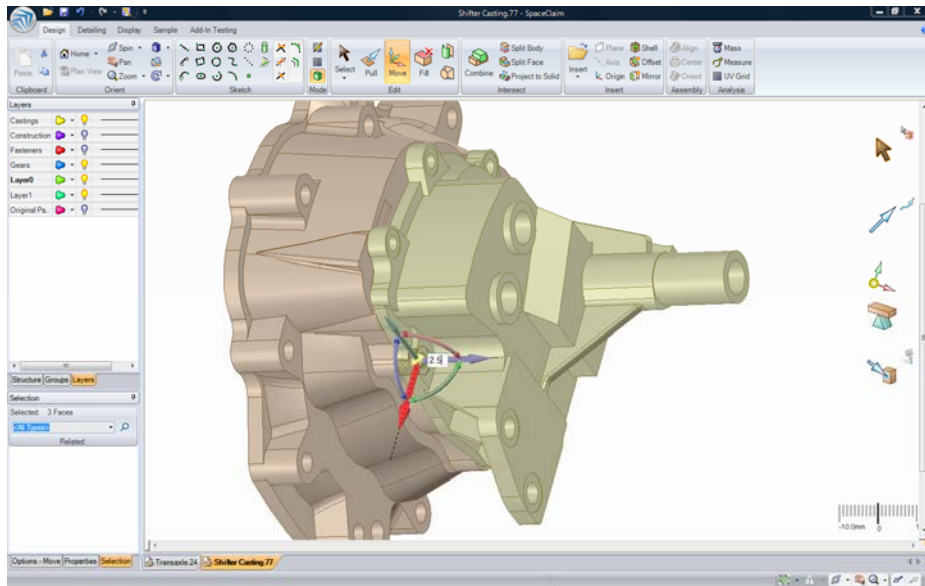
Figure 2: Successful interoperability requires product models to be opened, *and modified*, without requiring the user to understand *how* the model was built.

The success of this method neutral approach is based on SpaceClaim's intuitive 3D modeler, which understands how a change is to be made without the model "knowing" how it was put together and without requiring the user to explicitly define every aspect of the modification or its creation.

Interoperability: The impact of CAD-neutral technology

By enabling interoperability between the disparate product development systems, SpaceClaim increases the overall efficiency of the product development process. Design contributors using SpaceClaim are able to modify and evaluate designs by using CAD models from different systems; adding more value to each design iteration and ultimately improving product quality. In turn, changes are clearly communicated in a precise 3D format, minimizing the opportunity for errors in translation or miscommunication.

Automotive supply chain example

To better understand the ramifications of *lack* of interoperability in a CAD environment, consider the following example (shown below in Figure 3).

An OEM in Michigan has outsourced the design of a new component to an engineering services firm in Germany. The firm is a long-time partner of the car manufacturer; so to avoid interoperability problems it has the same parametric feature-based CAD system, even the same version, as the OEM.

The engineering firm designs the new part in that CAD system and sends it to an internal analysis group for FEA. The analysis engineer needs to simplify the model before meshing it, removing fillets for example, but it's difficult for him to work with the original design part so he's forced to rely on the design group to make the changes for him - lengthening the cycle of the analysis process and limiting the amount of design iterations. Eventually the design and analysis of the part is complete and the engineering firm sends the resulting CAD file to the OEM.

The OEM designer needs to make a slight modification to the design but because the complex part has many hidden relationships and feature dependencies, it takes three days to understand how the model was built and make the change. Finally, the OEM designer incorporates the desired changes and ships the CAD file to its foundry in Portugal for manufacturing.

The foundry uses a different CAD system - one that works better for its casting design applications. So when the foundry gets the component, special software is used to translate it into the format of their system and they make the minor modifications; to clean up some errors introduced during the model translation and to add new features such as draft to accommodate their casting process. The foundry relies on a machine shop in Brazil to create the specialized dies, so it saves the component model in the neutral STEP format and sends it off.

The casting dies come back, the foundry casts a part, machine finishes it, and sends it back to the automotive OEM for approval. If there is a problem, there is no easy way to diagnose it - because the design underwent so many transformations - and no easy way to communicate the solution because the final model format, used to create the actual part, is in STEP. So the process begins again.

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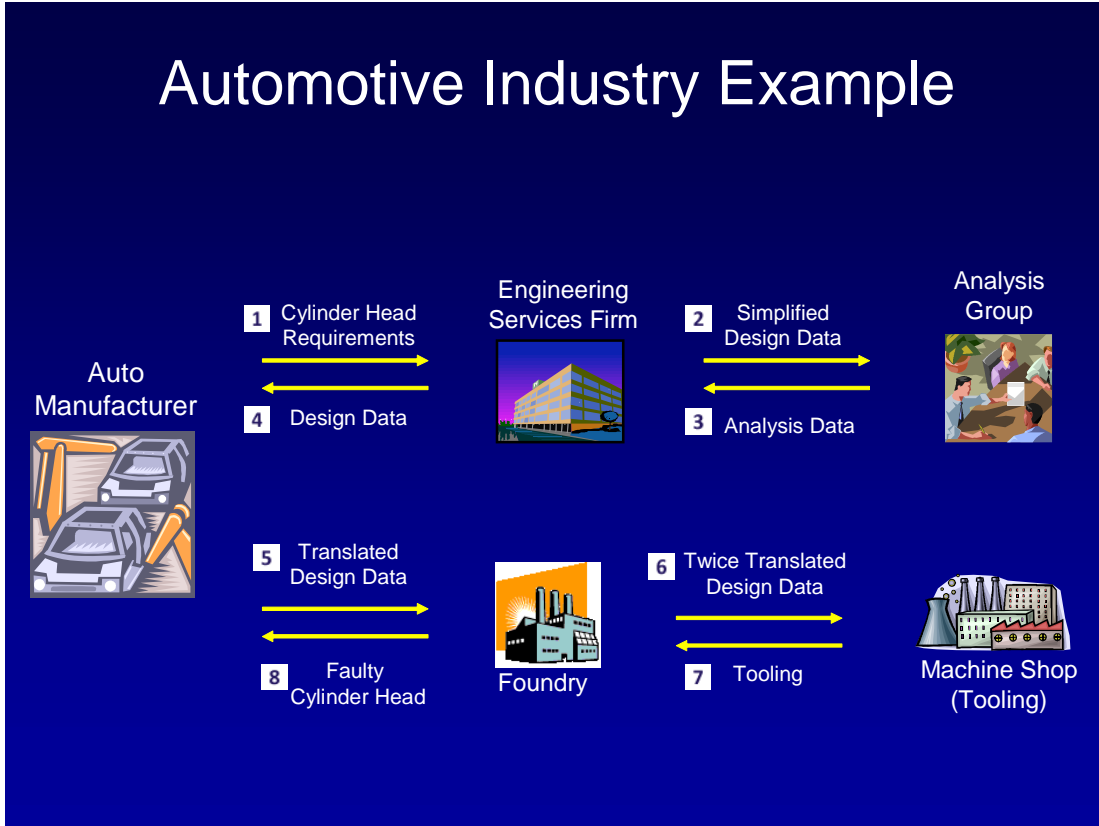
Figure 3: Lack of product data interoperability results in unnecessary costs and numerous delays, particularly in today's global manufacturing environment.

In this example, there were numerous costs and delays stemming from lack of product data interoperability. The component model was translated numerous times and required modifications at every transition point of the process. Yet the tools used at each stage in the process were not designed to support CAD-neutral modifications. Unfortunately, all of the effort expended - to get the model from person to person, from company to company, from system to system - introduced delays and added costs to the product development process.

CAD-neutral modification example

Now let's look at the same automotive example, but this time the various participants in the product development and manufacturing chain are leveraging SpaceClaim's CAD-neutral modification solution.

The OEM in Michigan requires a new component and is responsible for developing the concept design. The designer starts by opening a legacy 3D design model in SpaceClaim that originated in the manufacturer's CAD system. Working within SpaceClaim, the designer is able to freely modify the model without regard to the original model constraints, which do not easily lend themselves to the new variations. Once the concept is complete, the final concept design is sent to the engineering services firm in Germany for detailed design. The firm receives an unambiguous, precise 3D model, along with a clear description of the changes from the legacy design. The services firm then details the new part in the same CAD system as the OEM.

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Their analysis group opens the native CAD file in SpaceClaim to modify the model for their own needs. The analysis engineer doesn't need to rely on the designer to make the changes, or struggle with the parametric system of the designer to make the modifications. By moving the model to SpaceClaim, the history and constraints of the original design model are removed, and the model can be easily modified, to remove fillets before meshing for example, saving time in the process, and freeing the designer to work on other projects. If the analysis runs suggest changes, to the wall thickness or to add ribs for example, the analyst can easily make these changes in SpaceClaim and re-run the analysis without requiring cycles from the designer. Once the analysis of the component is complete, a set of well documented, precise 3D design suggestions are sent from the analysis group to the design group, where the model is updated by the original designer in the original CAD system, and then sent to the OEM.

A manufacturing engineer at the OEM needs to make a slight modification to the design. Although both firms used the same CAD system, the modification could still take several days to complete due the complexity of the part. So the manufacturing engineer imports the native model file into SpaceClaim, where the parametric relationships and constraints are relaxed, as are all the feature dependencies. Instead of taking days to modify the part, the manufacturing engineer makes the changes in a few hours, verifies the geometry of the modified part in the larger assembly, documents an ECR and ships the SpaceClaim model to its foundry in Portugal for manufacturing.

The foundry uses a different CAD system than the OEM. Instead of struggling with translators and poor interoperability between the systems (regardless of whether they receive the model in the format of the originating CAD system or in SpaceClaim format) the tool designers are able to open the model and directly edit it in SpaceClaim - making the modifications they need to accommodate their casting process, such as adding some excess material on a critical interface that will later be machined away. The foundry then sends the SpaceClaim model to their machine shop in Brazil to produce the tooling. The machine shop uses SpaceClaim to create the tooling, referencing existing geometry from the casting design.

With this new mold, the foundry casts a part, machine finishes it, and sends it back to the automotive OEM for approval. If a problem is found with the finished part, SpaceClaim can be used to quickly and easily make the needed modifications by the appropriate group, reducing additional delays.

In this example, the numerous costs and delays stemming from lack of product data interoperability were minimized by using SpaceClaim. There was no need to translate or rework the component model to get it from system to system, company to company. The time needed to simplify the model or modify it for application-specific purposes was minimized. The interoperability between the OEM, the engineering design firm, the analysis group, the foundry and the machine shop made the process more efficient, improving product quality and decreasing overall time to market.

Summary

The extended enterprises involved with product development processes are heterogeneous environments beset with disparate CAD models. There's no changing that situation. In fact, the trend towards global manufacturing exacerbates it - producing a constantly shifting web of product development and delivery partnerships. The lack of effective interoperability among the extended enterprise threatens product quality, drives up costs and lengthens time-to-market. Outcomes that no manufacturer is satisfied with.

SpaceClaim's *CAD-neutral modification solution enables interoperability* between disparate systems. With SpaceClaim, participants throughout the extended team can more easily collaborate regardless of what individual systems are being used - increasing product quality, lowering the cost and improving time to market. Results which should satisfy everyone.

About the Author

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Howie is responsible for marketing and product marketing at SpaceClaim Corporation. Previously, Howie held senior level product management and marketing positions in several technology companies including Parametric Technology Corporation (PTC). Prior to PTC, he spent 5 years as a mechanical engineer at Raytheon Corporation. Howie holds a bachelor's degree in mechanical engineering from the University of Colorado and a master's degree in business administration from Northeastern University.

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