A Review of the Concurrent Product Modeling Capabilities of ImpactXoft's IX SPeeD

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ImpactXoft enables concurrent modeling -- changing the mechanical design engineering paradigm!

Functional features allow large scale changes in real time

Most MCAD software was originally designed for single user workstations

Virtually all of today's MCAD systems were originally designed as workstation based solid modeling systems. Within the past twelve years, little has been done to re-architect such systems. Following the lead of Pro/ENGINEER in the late 1980's, with few exceptions, solid modeling systems are all history-based (often called parametric) systems. Being history-based implies that such system apply features, constraints, and parameters in an ordered fashion to compute the resulting solid models contained in a completed design.

Today's systems are architecturally deficient for concurrent modeling

Much discussion has gone on during the last decade or so about two key areas that have proven to be difficult to implement: top down design and collaborative design. Both allow multiple designers to simultaneously work on complex designs early in the design process, the goal being better, faster, and cheaper designs. Small companies, with their designers co-located, can manage the necessary human communication and design processes manually. However, as the number of designers and their geographic locations become more dispersed, such communication and coordination becomes exponentially more complex. Today's systems try to manage this by controlling the processes (who works on what, in what order, what changes can be made and how, etc.). IX SPeeD's approach is unique in that the software is designed to operate successfully and allow rapid designs and design changes without the need for rigid design processes!

Top down design cannot effectively be supported by history based systems

Top down design is the way all engineering projects are designed. If not by computer, then manually. An overall design is committed, knowing perhaps the specifications and some geometric information, perhaps only a crude geometric layout with some spatial reservations. As the details are developed for the parts and assemblies, more information becomes available for the design. Since many of the parts and sub-assemblies interact with other parts and sub-assemblies, top level checking and analysis (often called systems analysis) must frequently be done to ensure that the overall design functions properly as more and more design details are added. Such analyses might include interference, movement of mechanisms among and across assemblies, structural analysis, weight, size, air flow, etc.

It is my contention that the primary systems in use throughout the MCAD industry do not and cannot effectively support either top down design or collaborative design. This includes Pro/ENGINEER, CATIA, Unigraphics, SolidWorks, and Inventor. How I come to this conclusion is discussed in the following pages.

IX SpeeD's architecture allows large changes

Instead of supporting top down design, today's MCAD systems support only bottoms up design.

Such systems are history-based and thus control parts and assemblies using geometric variables (see the sidebar on the right), requiring that their details be known before the next higher level part or assembly be known. Why must they be known? *Because today's systems cannot survive large changes.* Large changes almost always require substantial re-design to accommodate them. We can provide many examples of this. As we will explain, *this is not so with IX Speed*, because parts and assemblies interrelate using shapes instead of parameters and assembly operators (called functional features) that use their shape to, in turn, design other parts and assemblies. Changing one part automatically ripples the change throughout the system by changing the shape of "connecting objects." Thus, true top down design can now be supported, because not all detail need be known in advance. As an example, current systems often assemble parts using mating conditions that require the selection of faces, centerlines, or points. If any disappear the model will not compute. Contrast this to IX SpeeD's use of fit, pull, and push functions that can be recomputed based on changes. *And here is the best part -- eliminating the use of dimensional and geometric constraints allows models to survive large changes.*

In the case of top down design, many of today's systems have cobbled on all sorts of add-ons. But they don't work across the board; only in certain situations. UG/WAVE (a Unigraphics option), for instance, extracts a few key parameters for a complex model that may allow large changes, BUT this often requires substantial additional programming and cannot react to shape changes.

Collaborative modeling built into IX SPeeD

Collaborative modeling, now in its Nth industry iteration, following the failed simultaneous engineering and concurrent design paradigms invented by the industry in the past, involves the successful installation, use, and training of and for PDM systems, MCAD systems, digital mockup, and workflow management. This has become so complex that the industry has now adopted the term PLM (product lifecycle management). Few customers have the resources to select, install, and maintain this complex environment that requires engineering,

History based design causes problems: details need be known first

Most system have two modes of operation: part design and assembly design. History based systems work fairly well for part design. Changing parameters allows changes to the part. However, large changes often cannot be computed. Most part models begin with a two dimensional sketch (often called a profile). The profile generally consists of lines, arcs, curves, or other 2D geometric elements, possible interconnected using variables such as dimensions, parameters, and constraints (such as concurrent, parallel, etc.). Changing the variables causes the sketch to change. This sketch can then be "extended" into 3D using commands such as extrude and rotate to develop a solid model, most often related back to the original variable sketch.

Typically a solid part is then further developed using features to complete the part. The sequence of events to develop the part is recorded as the user proceeds with the design, and is called a history tree. More advanced systems allow changes to the part to be made either directly on the part or by modifying the history tree to change its order of execution, replace, edit, or add features. During the construction of the part, additional variables such as feature parameters, are also recorded and become part of the history tree. Additionally, extensive editing, such as sewing or unsewing of specific faces, and surface features may also be included.

But, seldom is a part, in and of itself useful. Users generally need to build assemblies of parts to arrive at a final design. This is done by "mating" parts together to form assemblies and sub assemblies. Here is where it gets tricky, because parts can be used in many assemblies. Also, when part definitions change, does the change effect all uses of the part, some, or none? (For instance, if a change is made to notes on the drawing of a part, no other parts in the assembly is effected). These type controls cannot be managed or controlled by the limited assembly capabilities in today's MCAD systems.

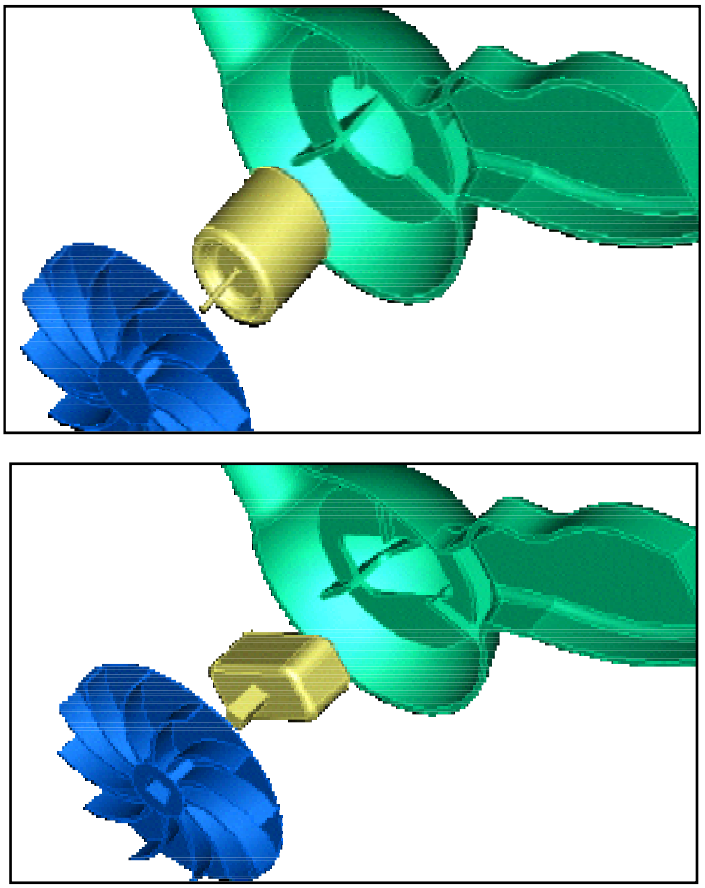
the involvement of the Information Technology department (IT), web resources, and suppliers/ customers to work together, often involving heterogeneous software and data. Perhaps this is why the growth rate of the collaborative systems market seems to now be slower than had been expected.

In its first incarnation, IX SpeeD solves the collaboration issues for engineering teams, before designs are committed. Many designers that are globally dispersed can work together in an independent fashion to rapidly complete the design. Each designer works on his own, yet is able to access and change all or some of the team's design, and when ready, send the new designs to others collaborating on the same design. Filters and controls allow the data to be managed similar to publish and subscribe paradigms.

IX SpeeD also resolves the issue of how to perform and retain knowledge of the steps during conceptual design, using its object identity management subsystem, which tracks the life and history of each object. The beauty of this subsystem is that it knows which objects have changed and communicates that when changes are "published," thus eliminating the need to send and (possibly manually review) entire assemblies.

IX allows the simultaneous development of a product, be it a single part developed by several designers or a multi-part assembly; it has no specific context (part or assembly), it doesn't have the traditional limitation file=part, assembly=multiple files, therefore relations can be established at the individual object level. The overall design of parts, assemblies and subassemblies interact through a collection of design objects that evolve and synchronize automatically throughout the distributed design work; and the reconciliation of the design objects designated for the interaction is performed by ImpactXoft's Design Intent Merge (DIM) technology at any time.

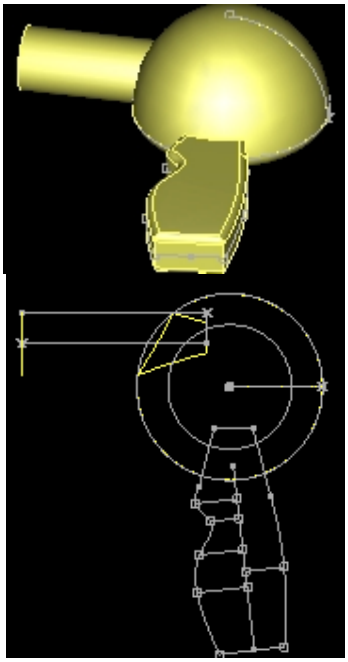
Because of its functional modeling architecture, IX SPeeD is the only system that allows models from different designers, with unknown design alterations to be merged with other models. Users can thus download early designs to other collaborators and later send their changes to a previous desing. Other systems, since they typically base designs on specific geometry (for example - distance from an edge) too often, are plagued by the "cannot compute the resulting geometry" message or "missing constraints." *Functional modeling avoids this paradox by encapsulating within its features, the intelligence about how to interact with other features.*



The images above illustrate a few of the concepts. Note how a simple replacement of the round motor in the first image with the square motor automatically changes the related components. The round motor used a "fitting" feature. When replaced, the new component interacted with other components to retain the same "fit."

Compared with other collaborative systems such as folder sharing technologies like Groove, IX uses

embedded technologies that may run on any communication infrastructure (HTTP/XML, VPN…) with very low bandwidth requirements. Its web based infrastructure to support collaboration is easy to install and maintain, requiring minimal IT involvement.



In this example, a simple network of curves defines the shape of the working design. All parties, if allowed, have access to the driving curves, and may use them in their designs. History based systems need tight control over how these curves interrelate and must limit the way they change and interact. Functional modeling eliminates the need because the resulting shapes "know how to change other shapes."

While IX SPeeD handles team level collaboration unlike any other system available today, enterprise solutions for ERP, PDM and PLM solutions will still be necessary for archiving and managing the team's design as well as downstream uses of the design.

How extensible is the system?

IX SpeeD appears to be modeling extensible to specialty markets that might need specific functional modeling extensions. ImpactXoft is currently evaluating the performance of large assemblies. With little or no change, the developers expect to be able to support collaboration across assemblies with about 1000 parts. Beyond this, additional development is necessary to provide optimum response. Since the amount of normally bulky design data is automatically minimized with ImpactXoft's patent pending Functional Object Represebtation (FOR), IX should be able to support large numbers of users with each collaboration server. Future volume tests will be needed before exact statistics are available.

Where is IX SpeeD today?

ImpactXoft is exiting a 2+ year initial development and is beginning to find tremendous excitement among its initial target market – consumer design companies, typically those with short design cycles and a large percentage of plastic molded parts. A great deal of interest is also being shown by automotive companies. These might require the development of specialty functions, as is now being done for surface modeling.

What is required

All software is Microsoft Windows based. At least one company hosted IX Collaboration Server is needed to manage the interactions for publish and subscribe as well as security, chat, etc. Multiple licenses of the IX Design software are required, as needed.

About the author

Raymond Kurland is president of TechniCom and the editor of the TechniCom eWeekly. His firm specializes in analyzing MCAD systems and has been involved in reviewing and comparing such software since 1987.

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