VCollab Drives CAE Productivity and Engineering Collaboration

CAX: A Unifying Language for 3D Simulation

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The need for innovative model-based design and analysis technologies that can connect performance analysis data, processes, and knowledge across functional domains is becoming critical as product complexity continues to grow even while product development cycles continue to be shortened by competitive and regulatory requirements. VCollab is one such innovative technology.

Introduction

Product development is increasingly complex, requiring performance analyses and validation across multiple engineering physics (structural, thermal, fluid flow, noise, crash/impact, durability/fatigue, etc.), often at globally distributed sites in virtual enterprises including supply chains.

- Product simulations span multiple physics domains and each domain can require multiple 3D modeling, results post-processing, and solver applications. As such, CAE users need to deal with different and often incompatible input and output data formats. In addition, file sizes have dramatically increased making it more difficult and costly to process, transmit, and store the large 3D CAE models and results files that are generated by today's CAE activities.
- New modeling and simulation tools in the areas of multi-disciplinary optimization (MDO), robust design, model-based systems engineering (MBSE), and big data analytics are compounding data complexity. Even with the new tools available in the Simulation Data and Process Management (SDPM) area, there is often no easy way to visually share, manage, and track 3D analysis results and visually evaluate performance simulation results for design alternatives vs. requirements, especially across multiple simulation tools and domains. Implementing effective simulation data management processes is a significant engineering productivity challenge today as well as a significant business opportunity. Too often today, there is limited design and analysis collaboration in project teams consisting of multiple physics disciplines as well as functional domains that span organizational silos.
- Widespread access to powerful 3D simulation tools is continually expanding via high performance computing (HPC) and Cloud access, not only for dedicated CAE specialists as both creators and consumers of 3D models and results information but also for design and manufacturing engineers as consumers of CAE data.
- There is an increasing need and desire to "democratize" simulation and make the 3D analysis results available to a much wider audience than only the CAE specialists. This includes the communication of analysis results in ways that retain as much critical engineering information as possible. These CAE results are often time-dependent and comprise both 3D data fields with directional information. Such tensor data cannot be transmitted or represented in standard 3D formats such as JT or 3D PDF.

Today's 3D multi-physics performance simulations generate vast amounts of engineering information that needs to be rapidly analyzed, visualized, and shared with other key members of the product development team; engineers that are often working virtually in multiple R&D locations around the globe

VCollab's Business Value for Engineering

A proven and innovative technology experiencing rapid adoption within the 3D physics-based simulation and analysis domain is VCollab, developed and supported by Visual Collaboration Technologies, Inc. of Troy, MI-<u>www.vcollab.com</u>. As shown in Figure 1, the VCollab product suite provides tool-independent and web-deployable 3D CAE results processing, visualization, interrogation, and reporting for engineering analysis collaboration.



VCollab provides a single tool for rapid analysis and sharing of simulation results and models that integrates data from many CAE tools and can work with many other 3D data standards

Figure 1—VCollab Technology Integrates Data from many Widely-Used Engineering Tools and 3D Data Interoperability Standards to Enable Productivity and Product Development Collaboration (Courtesy of VCollab)

Multiple business benefits can be realized from deploying the VCollab technology, either stand-alone or as a component technology within other CAE, MDO, and PLM/SDPM software applications:

- Enhances productivity and efficiency of dedicated 3D CAE analysts to improve the timeliness and design impact of performing modeling and simulation activities throughout the product development lifecycle.
 - Enables CAE analysts to rapidly view complex and very large sized 3D analysis results (50 to 100GB+) in VCollab's lightweight visualization format without requiring licenses for the CAE applications that created the bulk output files (e.g. MSC Patran, Altair Hypermesh, ANSYS Workbench, etc.). The significant size reduction in CAE results files typically ranging from 85% up to 99% enables global mobility of and access to the CAX-based analysis file information via the web.
 - "Viewpoints"—This extremely useful VCollab capability, as illustrated in Figure 2, enables the CAE analyst to automatically create and store important interactive views with key results and annotations as pre-defined Viewpoints within the VCollab CAX file. This automates the work-in-process (WIP) simulation results visualization and report generation process to improve the productivity of both individual CAE analysts and analysis teams.
 - Sharing of standard analysis reports enables improved design understanding and decision-making via direct comparison of the CAE results across many

The CAX technology processes the CAE results based on templates defined by CAE experts, and compresses the 3D visualization data, greatly reducing the size of files that need to be transmitted, displayed, and stored different load cases and design variants. This capability also offers a powerful CAE story boarding facility for CAE analysts.



VCollab "Viewpoints" automate the work-inprocess simulation results visualization and report generation process to improve the productivity of both individual CAE analysts as well as analysis and design teams

Figure 2—VCollab Helps CAE Analysts Evaluate and Share Results of Complex 3D Simulations (Courtesy of VCollab)

- Enables better collaboration across global product engineering teams and suppliers via a common tool and standard data format for visualizing, comparing, interrogating, and documenting CAE results across multiple 3D physics domains including the support of multi-disciplinary design and optimization activities.
- Maximizes the utilization of existing CAE application software licenses and related enterprise IT software investments since VCollab can read and write other widely-used documentation and collaboration formats such as JT, VRML, and 3D PDF as well as leverages the widely used Microsoft Office suite of tools as shown in Figure 3.
- Enables design collaboration among CAE analysts, engineering managers, and design engineers via the VCollab 3D viewer.
 - A single common interface for multi-physics CAE results interrogation and visualization enables improved decision making by product design engineers, engineering mangers, and suppliers (Democratization of CAE).
 - Viewpoints are again highly useful in collaboration by facilitating the experienced CAE analysts to automatically create and store important interactive views with key results and annotations as 3D viewpoints within the VCollab CAX file. CAE analysts can automatically create interactive CAE reports using these viewpoints and share them via the web with designers and managers leading to better product designs.
 - Real time interrogation and annotation of 3D CAE models and processed sets of the CAE analysis results most relevant to making critical design trade-off decisions.
 - Single view or multiple associated views of the "validated" analyses in a single browser UI.



VCollab CAE results and models can be directly embedded within the Microsoft Office suite of applications for interactive 3D design reviews and project documentation

Figure 3—Conduct Interactive 3D Design Reviews Within the MS-Office Suite (Courtesy of VCollab)

- As illustrated in Figure 4, design hot spots can be graphically identified from the analysis results and overlaid on the corresponding 3D CAD geometry during web-based design reviews. Engineering notes and labels can be attached to the CAE models and results images at specific locations of interest or concern to the design team, aiding in communicating and documenting key design findings and decisions.
- Minimizes overall CAE software license costs since consumers of the webdeployable VCollab CAE results can use the free VCollab Play viewer and do not require access to licenses of the native CAE applications that generated the original CAE models and results.
 - There is no need for CAE software licenses to be purchased for design engineers, engineering managers, and others who only need to see and interact with the analysis data that is generated and shared by experienced CAE analysts using the VCollab Presenter or VCollab Professional authoring products.
 - The VCollab CAX format can be used as a standard for storage and long-term archival and retention of the processed CAE models and results. This saves significant disk storage space and provides a common tool for accessing and viewing that data that is independent of the CAE software tools used to create the original CAE models and analysis results.

A wide range of users within the enterprise can visualize and analyze CAE results via the VCollab viewers without needing to have access to additional CAE software licenses



Figure 4—VCollab Offers Multiple Display Options in its Web Viewer (Courtesy of VCollab)

- Enables enterprise-wide collaboration in support of the overall product development process when deployed within PDM, MDO, and simulation data and process management solutions to support automated 3D CAE metadata extraction and indexing, automated CAE reporting, and long term archiving of lightweight CAE model representations and analysis results (providing a single source of truth).
 - VCollab currently has integrations with the following commercial SDPM, MDO, and PLM software solutions:
 - ANSYS Engineering Knowledge Manager (EKM)
 - o Dassault Systèmes SIMULIA Simulation Lifecycle Manager (SLM)
 - o Dynardo optiSLang
 - o JOTNE OpenSimDM
 - o MSC Software SimManager
 - o Noesis Optimus
 - o Phoenix Integration ModelCenter Analysis Library
 - Red Cedar HEEDS (formerly CD-Adapco, now Siemens PLM)
 - o Siemens PLM Teamcenter For Simulation
 - VCollab can also be deployed within corporate IT platforms to support inhouse developed CAE and SDPM applications such as Microsoft SharePoint leveraging shared network storage.
 - VCollab's CAX Writer API enables rapid integration with many types of 3D CAD and CAE modeling and simulation applications including in-house developed simulation software tools.

VCollab's technology is integrated with other commercial CAE tools for SDPM and MDO and can also be integrated with most in-house CAE codes via the use of the CAX Writer API

VCollab Use Case Examples

CIMdata senior analysts interviewed several current VCollab customers to get their real world perspective on the application of the VCollab CAX technology and the subsequent business value realized. VCollab supported customer introductions and market research for this paper.

VCollab Application for Powertrain Development

A large North American powertrain manufacturer uses VCollab in their design and analysis process for engine heads and blocks. CAE specialists use VCollab to share detailed information with design-responsible engineers and decision makers. Significant time is saved by CAE specialists in generating standard structural and thermal analysis reports, and there is a strong belief that ready access to such information enables more rapid development of "product knowledge" among the design teams, which creates a deeper engineering understanding of the performance of the product design.

Similar efforts to deploy VCollab to designers and other engineers have proven less successful due to organizational and cultural issues. "Often, the designer just wants a design change recommendation from the simulation engineer," says a senior CAE manager. "He or she does not necessarily want to understand the details of why. But we still use VCollab to communicate results to engineering managers and other decision-makers."

This points to the overriding issue that the democratization of simulation involves key issues of cultural change and how people do their work. "If we want designers to understand the engineering performance of their designs we first of all need to make sure they have the correct skills, and then we need to give them the tools and the training they need to be successful. Spreading the knowledge of how to better leverage simulation across the organization is a major challenge for us."

CIMdata believes that the 3D visualization and collaboration capabilities of tools such as VCollab will be instrumental in breaking down these cultural barriers and resistance to process changes. As the old saying goes, "A picture is worth a thousand words" and engineers are visual and tactile by nature. Being able to easily share and interact with the 3D design geometry and the associated simulation results will be critical to achieve the goal of democratization of CAE.

Trek Bicycle Corporation

Trek Bicycle Corporation is a major manufacturer and distributor of road bikes, mountain bikes, and city bikes under the brand names of Trek, Electra, Bontrager, Diamant, and B-Cycle. Trek also provides bicycling clothing and accessories such as helmets, shoes, lights, and jerseys.

Headquartered in Waterloo, Wisconsin, Trek bicycles are marketed through 1,700 dealers across North America with subsidiaries in Europe and Asia as well as distributors in 90 countries worldwide.

Mr. Jay Maas is a senior analysis engineer who is part of a team of four CAE engineers that perform product design analysis, verification and test validation activities at Trek. One team member focuses primarily on refining the bicycle airflow and aerodynamics characteristics using 3D CFD simulation tools in conjunction with physical wind tunnel testing. Two of the team members including Mr. Maas focus primarily on structural durability, ride quality, safety and weight optimization using the Dassault Systèmes SIMULIA ABAQUS CAE and ABAQUS Implicit structural FEA software. The final team member focuses on bicycle testing and validation including prototype experiments in the laboratory as well as the collection of in-service operating data for the purpose of developing real world loading conditions used in the analysis process.

Trek uses SolidWorks as their primary 3D CAD tool and also perform some parametric design optimization with the HEEDS software suite as well as some topology optimization with TOSCA. So even though they are a relatively small CAE team, they use a number of 3D CAE tools to conduct the different types of physics simulations required to optimize, verify, and validate their products.

The Trek CAE team works closely with the various bicycle product line teams who are located in several offices in North America and Asia. The team also works with suppliers of key bicycle components and subsystems, most notably the drivetrain manufacturers today. The team's role is to use simulation and test data to assist the design engineers in understanding critical design parameters that influence design trade-offs with respect to bike styling and configurations, performance characteristics, and new materials selections. Structural analysis and optimization has been instrumental at Trek in developing innovative new bike designs with composite materials for strong yet lighter weight frames in their high performance racing and mountain bikes (see Figure 5 below).



"Our internal customers" love VCollab, says Mr. Maas. "They are empowered to use the 3D viewing and CAE results animation to better understand the performance of these new composite bike frame structures. The VCollab capability is very useful for us in communicating to the design engineers the view / areas of most *interest for increasing the* stiffness of the frames most efficiently."

Figure 5—VCollab Viewpoint Analysis Results for a Typical Mountain Bike Load Case (Courtesy of Trek Bicycle Corporation)

Trek Bicycle uses VCollab to better leverage their limited CAE expertise and resources and to enable better collaboration with product design engineers

The Trek CAE team performs a large number major design analysis projects in a typical year leveraging the VCollab technology. They use VCollab's template capabilities for generating automated design analysis reports containing a series of standard views of the CAE results. The CAX files containing the CAE results are stored on a shared drive where the SolidWorks 3D CAD data is also stored. This process enables the design and CAE teams to collaborate using the common VCollab viewer and it also allows the design engineers to interrogate the analysis results on their own schedule with their management and supplier teams using the free VCollab viewer.

According to Mr. Mr. Maas, the use of the VCollab technology has resulted in significant time savings in reporting and documentation of results for each CAE project and, even more importantly, the single common tool for visualizing, sharing and reviewing the 3D CAE results has led to a significant increase in collaboration and productivity among the bicycle design teams. "Our internal customers love VCollab", says Mr. Maas. "They are empowered to use 3D viewing and CAE results animation to better understand the performance of these new composite bike frame structures. The VCollab viewpoint capability is very useful for us in communicating to the design engineers the view and areas of most interest for increasing the stiffness of the frames most efficiently". Mr. Maas concluded by saying, "Based on the success with VCollab within parts of the Trek global engineering team, our plan is to extend the use of VCollab to more of our component designers and suppliers worldwide as well as to our manufacturing engineering organization in Taiwan."

The VCollab CAX Technology

VCollab Inc. is a privately owned software company based in Troy, Michigan that develops, maintains, and supports a suite of high performance, processing, visualization, and collaboration tools for use with 3D simulation and analysis data as well as associated 3D CAD geometry information.

In addition to the free VCollab Play viewer (formerly called Presenter Lite), the company licenses its software technology directly to engineering organizations through sales channel partners (see Figure 6). VCollab technology components are also often embedded within the suites of the larger CAE software solution providers offering MDO and SDPM products such as Phoenix Integration ModelCenter, CADFEM C.A.V.E., ANSYS EKM, CD-adapco HEEDS, Jotne SimDM, and MSC SimManager. The VCollab technology is deployed across a number of industry segments with the largest number of users in automotive, heavy vehicle, aerospace and defense manufacturing, and government R&D organizations.

The VCollab product suite is based on the CAX data compression and data filtering technology and the associated .cax file format developed by the VCollab founders who continue to develop the products and run the company.

"Based on the success with VCollab within parts of the Trek global engineering team, our plan is to extend the use of VCollab to more of our component designers and suppliers worldwide as well as to our manufacturing engineering organization in Taiwan," stated Mr. Mass



VCollab provides multiple levels of solution capabilities including a free web-based viewer

CAX is an ultra-compact, portable 3D format for visualizing, interrogating, sharing, automated reporting, and archiving 3D CAE data and related 3D CAD geometry data.

The VCollab technology provides a number of features for the 3D simulation and design analysis domain that is very analogous to the 3D PDF technology used for viewing 3D geometric data. Specifically, as shown in Figure 7, the CAX-based technology suite enables:

- A single standard file format (.cax) and single common lightweight viewer for all 3D CAE simulation models and analysis results.
 - The common .cax format enables multi-physics visualization and postprocessing within a single web browser application. It is a single application that can be used to process and share information generated in different physics domains (e.g., fluids and structures) and by different software applications (e.g., Abaqus, Ansys Fluent, and NASTRAN).
 - CAE analysts as well as other consumers of simulation information do not have to learn how to use multiple post-processing tools or have access to native CAE licenses for those tools.
- Smart, context-based extraction via data filters and graphics compression of only key information leading to significant reduction in data sizes that need to be processed, managed, shared, and stored.



The CAX technology enables multi-physics visualization and postprocessing of CAE results from multiple solvers within a single web browser application

Figure 7—VCollab Provides a Common 3D Data Model for Visualization and Reporting of CAE Geometry and Results Generated by a Wide Range of Tools (Courtesy of VCollab)

- Ability to automate CAE results extraction, CAX annotations, and the creation of 3D CAE analysis reports by experienced analysts (e.g., viewpoints, multiple views, model comparison, results comparison).
- Direct conversion of CAX data into 3D PDF, STL, VRML, and JT data formats thereby providing a wide range of options for users across enterprise disciplines to share, process, and unlock the potential of leveraging CAE data in many different application domains.
- Collaboration with design engineers, analysis team managers, and senior engineering managers via an easy to use viewer.
 - The VCollab product suite is scalable based on various user roles—from the free viewer (VCollab Play) to a more robust viewer (VCollab Presenter) to an expert CAE results and report authoring solution (VCollab Professional).
 - The VCollab viewers are "CAE smart" and provide capabilities like automatic finding of design hotspots and capabilities to compare two CAE models or 3D CAE results vs. 3D CAD geometry models (compare the differences in mesh/shape, compare the differences in results, etc.
- CAX automatically generates metadata from analysis results and integrates with other enterprise product development solutions (PLM/PDM, SDPM/SDM, SPM, MDO, PIDO, SLA, DMU, etc.).

Conclusions

The effective utilization and deployment of VCollab's CAX technology provides several significant business benefits to engineering organizations:

- Increased productivity, effectiveness, and corporate leveraging of scarce CAE analysis resources and domain expertise.
 - CAX provides a common language for intelligent processing, rapid visualization, sharing, and automated reporting of 3D CAE results data and associated CAD and CAE models.
- Increased collaboration among product design teams in making critical design decisions sooner and faster based on CAE activities.
 - Based on customer feedback, VCollab could minimize the need for CAE analysts and designers to build numerous Microsoft PowerPoint presentations by providing an interactive 3D design review and reporting capability for CAE results that are easily understandable and web accessible.
- Potential cost savings in terms of the number of CAE post-processing software licenses required, especially for collaboration with other engineering team members and managers who can take advantage of the free VCollab Play web viewer.

VCollab's business benefits include improved:

- CAE Productivity
- Team Collaboration
- Software Cost Savings

About CIMdata

CIMdata, a leading independent worldwide firm, provides strategic management consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM) solutions. Since its founding over thirty years ago, CIMdata has delivered world-class knowledge, expertise, and best-practice methods on PLM solutions. These solutions incorporate both business processes and a wideranging set of PLM-enabling technologies.

CIMdata works with both industrial organizations and providers of technologies and services seeking competitive advantage in the global economy. CIMdata helps industrial organizations establish effective PLM strategies, assists in the identification of requirements and selection of PLM technologies, helps organizations optimize their operational structure and processes to implement solutions, and assists in the deployment of these solutions. For PLM solution providers, CIMdata helps define business and market strategies, delivers worldwide market information and analyses, provides education and support for internal sales and marketing teams, as well as overall support at all stages of business and product programs to make them optimally effective in their markets.

In addition to consulting, CIMdata conducts research, provides PLM-focused subscription services, and produces several commercial publications. The company also provides industry education through PLM certification programs, seminars, and conferences worldwide. CIMdata serves clients around the world from offices in North America, Europe, and Asia-Pacific.

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