The State of the Industry – CAD Interoperability Challenge

You would think after many years of attempts to correct the interoperability challenge, most CAD/CAE/CAM software applications can read their competitive products removing the need to translate CAD models to a neutral format. Yet these reading CADx files fail to bring into the interfaces a solid model or missing elements like PMI (Product Management Information) assemblies and metadata correctly. PMI is currently replacing the 2D drawing with semantic representation. Within this paper, you will learn about what the industry is needing to effortlessly share CAD data, known as the digital twin/thread, and its relationship to ISO standards, visualization of large file sizes, and validation. Most interesting is that the subject of validation is such a wide topic, that I will simplify the solutions that companies around the globe are requesting from SME and interoperability companies like CoreTechnologie. Lastly, I will touch on the fastest-growing industry as it related to 3D printing, known as "additive manufacturing", and its moving target of what the solutions will look like in the next 12 months. The importance is the ability to collaborate between OEM, suppliers, and software solutions for downstream applications in the space of CAD, CAE, and CAM.

Barriers to Model-Centric Data Interoperability

- The 2D drawing is still considered the master versus the 3D model by many in industry
- There is a significant learning curve to effectively embed PMI into a 3D CAD model
- Many Application Program Interfaces (APIs) do not adequately support downstream processes due to a lack of PMI
- Major Product Lifecycle Management (PLM) suppliers are concerned with losing market share due to the ease of model transportability with standards-based data exchange
- CAM and CMM markets are distributed across many SMEs

Motivations

- Eliminate or significantly reduce the need to re-create downstream models
- Reduce cycle time and cost
- Reduce the risk of introducing downstream errors
- Increase part yield
- Produce higher-quality parts

Security - I cannot leave out the fact that our current customers and buzz in the software industry are requesting to have vulnerabilities checked on the .exe file for all software installed within an organization. As simple as this may seem to run a vulnerability check on a .exe file, all software comes with many DLL within its installation, and each need to check for any vulnerabilities. Most importantly, the increased dependencies on 3rd party partners create greater complexity for solving vulnerability issues. Moving forward, software companies must run these checks prior to releases, and companies working with DoD require even more scrutiny.

For more information on other requirements regarding the supply chain, you can contact the University of Maryland's Applied Research Laboratory for Intelligence and Security (ARLIS), Thomas Hedberg, Jr, Mission Director. The mission objective of the Acquisition and Industrial Security (ARIS) is to support the safety and security of both the delivered and delivering systems. This requires assuring sociotechnical risks and threats to the supply chains are mitigated, while also protecting the technologies used in, and coming, from supply chains. In addition, supply chains require the exchanging and sharing of information

effectively through common languages that are standards-compliant and can be tailored contextually to compensate for errors and deficiencies in the information

Sharing CADx file - The digital twin is the duplication of a physical 3D model, whereas the digital thread is the process of the product definition of the 3D model, the design documentation, manufacturing models and machining, inspection, and service and maintenance, as noted by Chad Jackson, Chief Analyst and CEO of Lifecycle Insight. The data that we are challenged with is the mechanical, electrical, electrical distribution, software definition, and lastly system definitions. Collectivity, most are interested in the technical data package. Companies do not want to be finding issues with the design once they arrive at the prototype and testing phases. Thus, CoreTechnologie has enhanced the 3D Evolution software to meet the demanding needs for CADx-to-CADx translation with the ability to validate the integrity of the CADx model.

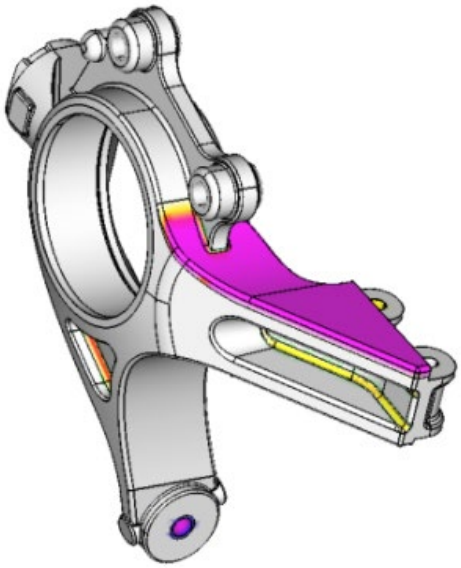
Visualization – It is no secret that CADx files are getting larger and more complex. In the case of Boeing or the US Navy, the average file size has increased by 1 GB in the past few years. Users in visualization are requesting the ability to read 5 GB files in minutes, not hours. This has been completed by OEM's own property-developed patient applications with connections to CADx libraries like those developed by CoreTechnologie.

In addition to the above, the need for visualization for downstream applications and resources within an organization to view 3D models as they may not have access to the CADx application. Most interestingly, the ability to read CADx files without access to the API of the CADx application and to analyze CADx files by computing mass properties, comparing for revisions, and collision detection. CoreTechnologie has a solution for completing this task. In some cases, companies are using the JTOpen for viewing and sharing the data with suppliers, and partners alike.

Validation – The existence of countless proprietary file formats and the exchange of 3D CAD data has been a significant problem since the beginning of 3D CAD modeling. CAD applications and methods using digital data are constantly changing, which predicates the need for a solution to share validated and accurately translated in the industry. Companies who are adopting Mode-Based processes & tools within their organizations are using ISO 10303 STEP Application Protocols AP242 and AP239 for both exchanging data as well as maintaining data for archival and retrieval. Long Term Data Archival and Retrieval (LOTAR) http://www.lotar-international.org, is a multi-party international consortium for the standardization of the archival and retrieval of digital products and technical data. This consortium is working with ISO and other standardization bodies to standardize across multi-CAD environments enabling them to share 3D data within a Model-Based Environment (MBE) or a digital enterprise. To ensure the preservation of design intent, validation properties, which include geometric shape representation, assembly features, saved views, user-defined attributes, color, visibility, and Product & Manufacturing Information (PMI) need to be verified and validated for compliance. The consortium, along with the standards community, is continuing to add new requirements to ensure that specific product domain information is captured to meet product life cycle maturation. The culmination of these standards is allowing companies around the globe to deal with interoperability with fewer challenges.

Advance Attributes Validation - As part of the GVP check, it has been requested by many industries to read and write the correct attributes and the ability to check to ensure that the attributes are in their neutral file format.

Compare (geometry, assembly, and PMI) - Above and beyond the validation property checks already mentioned for STEP242, CT has been asked by its customers to provide a direct geometry validation method utilizing model comparison which is available for all supported file types. Models are compared for geometric likeness, assembly structure, and PMI data. These are separate modes of comparison. These are defined as follows:



- Compare Geometry – Compare and display geometric deviations at a tolerance defined by the user. With an assembly, the function identifies parts considered identical and compares their geometry.
- Compare Assembly Structure – Identifies parts considered identical and compares their positions.
- Compare PMI – Used to compare fully semantic 3D annotations located in models including Name, Value, and Attributes.

Additive Manufacturing - Software requirements are a moving target, with innovative technologies both on the software side as well as hardware (printers) with the ability to bring products being made quicker without tooling and major cost saving. One of the issues related to AM compared with "traditional" manufacturing is techniques that are problematic, due to not needing support structures, texturing and precise nesting says Gauthier Wahu, CTO at CoreTechnologie France, is the use of tessellated models: "AM has a particularity that is almost never questioned: the exclusive use of triangulated models. Tessellated (STL) models are in the end heavier to handle and less accurate because they are approximations of the original exact models." To get around the problems of tessellated models, CoreTechnologie developed its own CAD kernel capable of reading and importing binary code, including BREP geometry and product manufacturing information (PMI) from all the major CAD packages—without going through an application programming interface (API). These CAD packages include Autodesk Inventor, Dassault Systèmes CATIA and SOLIDWORKS, PTC Creo, and Siemens PLM Software NX, as well as ACIS, JT, and STEP file formats.

Reading and manipulating the native files directly saves time. Instead of waiting for the binary code to pass through an API, 4D_Additive "can quickly extract the information that's coming as a boundary representation—the original geometry—versus as a tessellated file. With tessellated data, you're dealing with a small [solid model] representation, and you're going to get a lot of false positives and different results every time you run [for example] collision detection.

Manipulating the model in a [BREP] preprocessor allows you to do a lot of things that can't be done with tessellation." It is a benefit to make changes to a solid model.

Due to the moving target, the most important role is to listen to the customer and understand their requirements and enhance the software to exceed expectations without a development cost and with an approach that is in the best interest of all the users. This is a bold move in the software business, that has worked well!

The Terminology for Digital Transformation:

It is essential to know the terminology going around the globe as buzzwords and the newest and most significant inventions, ideas, and the meaning of these terms.

Model-Based Enterprise (MBE) - Advanced model-based solutions emerged for digitally supporting collaborative industrial needs. In this context, a Model-Based Enterprise (MBE) represents an organization that adopts modeling technologies. MBE is a business practice primarily focused on using digital data and subsequent datasets. To support MBE, numerous model-based activities (MBx) are implemented such as model-based definition (MBD) or model-based systems engineering (MBSE). The goal of producing, consuming, and utilizing secure digital data upstream and downstream while meeting all industry and government standards can be achieved with proper implementation and preparation.

Model-Based Definition (MBD) - solutions integrate and manage technical and business processes related to product design, production, support, and retirement for long-term retention. The approach is to complete the task on 2D drawing and effectively contain all the data needed in a defined 3D model for downstream applications. The PMI (Product Management Information) and GD&T (Geometric dimensioning and tolerancing) are stored in the 3D model for extraction.

Geometric Dimensioning and Tolerancing (GD&T) - is a symbolic language used on engineering drawings and models to define the allowable deviation of feature geometry. The language of GD&T consists of dimensions, tolerances, symbols, definitions, rules, and conventions that can precisely communicate the functional requirements for the location, orientation, size, and form of each feature of the design model.

Digital Twin - A fit-for-purpose digital representation of some realized thing(s) or process(es) with a means to enable convergence between the realized instance and digital instance at an appropriate rate of synchronization. Note: The Digital Twin may exist across the entire life cycle and can leverage aspects of the virtual environment (high-fidelity, multi-physics, external data sources, etc.), computational techniques (virtual testing, optimization, prediction, etc.), and aspects of the physical environment (historical performance, customer feedback, cost, etc.) to improve elements of the overall system (design, behavior, manufacturability, etc.).

Digital Thread - A framework connects data flows and produces a holistic view of an asset's data across its product life cycle. This framework needs to address required ISO AP protocols, security, and standards. The digital thread connects digital twins, digital models of physical assets, or groups of assets. (Wikipedia)

Technical Data Package (TDP) - A technical description of items adequate for supporting an acquisition, production, engineering, and logistics support (e.g., Engineering Data for Provisioning Training and Technical Manuals). The description defines the required design configuration, performance requirements, and procurements required to ensure the adequacy of item performance. It consists of applicable technical data such as models, drawings, associated lists, specifications, standards, performance requirements, QAP, software documentation, and packaging details.