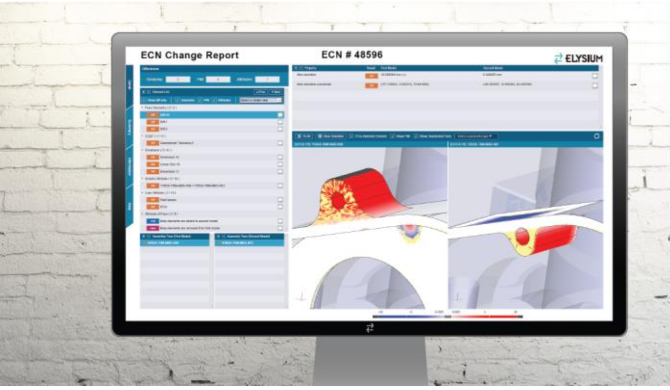
ELYSIUM

WHITE PAPER



CADvalidator™

A Critical Aid for the Model-Based Enterprise

By Annalise Suzuki in partnership with Jennifer Herron of Action Engineering

ACTION ENGINEERING

Abstract

Learn the importance of validation for deployment of model-based engineering practices. In addition, understand what functionality is critical in a validation solution and report for both engineering change and translation scenarios.

CADvalidator™: A Critical Aid for the Model-Based Enterprise

Makers of automobiles and aerospace vehicles and the US Department of Defense are eager to employ what they call "Model-Based Definition" (MBD). MBD refers to a 3D model[1] that includes associative product and manufacturing information (PMI), that defines the product in a manner that can be used effectively without a drawing graphic sheet (Action Engineering). To successfully supersede drawings, models must contain information such as geometric dimensions and tolerances (GD&T), notes, finish symbols, material specifications, and other non-graphic attributes that traditionally appear on manufacturing drawings.

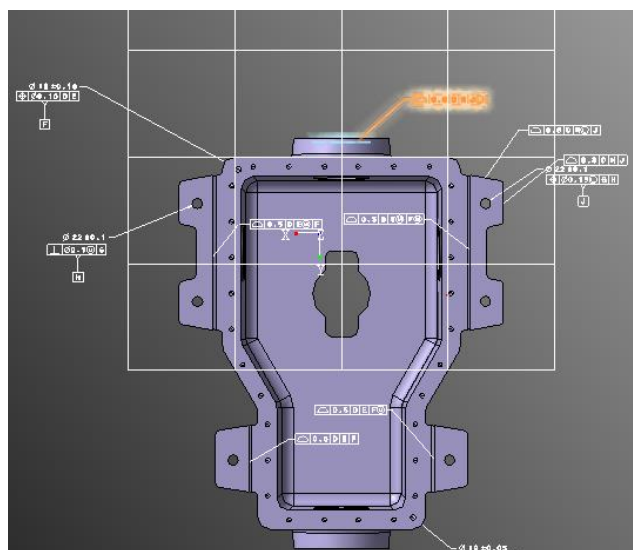


Figure 1 - A view showing an annotation plane and the GD&T symbols planar to that plane on a demonstration part from the US National Institute of Science and Technology (NIST)

[1] Definition of model as defined in ASME Y14.41-2012

ANSI standard ASME Y14.41, Digital Product Definition Data Practices, specifies how 3D annotations and attributes, also known as PMI (Product Manufacturing Information), are applied to models. It calls for annotations to be organized on invisible annotation planes. As defined by ASME Y14.41, annotations are always displayed with the model.

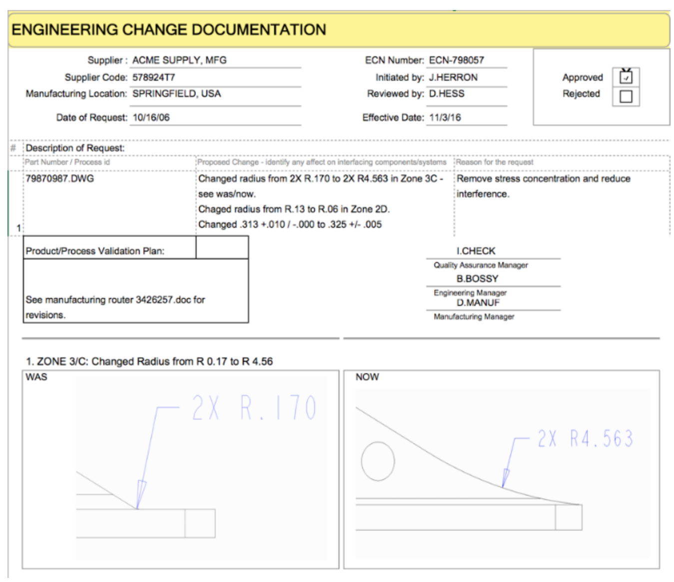
Attributes are “hidden” information embedded in the model, the most common data element is metadata. Upcoming ASME standards will define how annotations are grouped along with saved views (a capture of zoom and orientation) for increased clarification of the 3D model readability. When these grouped annotations and saved views, are selected, only those notes and symbols attached to it become visible.

When CAD vendors first implemented 3D annotations, they were simply graphic images attached to the CAD model. But manufacturers also wanted annotations that were digitally associated with the geometric features they represent, as to be read directly into manufacturing software. This process eliminates the need for humans to read information from models and enter it into other systems, activities that take time, cost money and may introduce errors in translation. Machine- or software-readable PMI is often called “semantic PMI,” or digitally associated annotations.

When dimensions and tolerances appear only on drawings, successive versions of drawings were left to manual interpretation. But with 3D annotations, more sophisticated tools are needed and able to compare models with higher efficiency and quality.

Revision management

One of the challenges many manufacturing companies face today is the management of engineering changes and model revisions. In a drawing-based organization, engineering changes are mostly documented within drawings with no graphical validation or representation of the change. A report that summarizes what “Is” versus what “Was” is described in the text, while zone information of the change location is noted for reference to the 2D view. This process is very manual, time-consuming and relies on the change notice documenter to ensure information is complete. However, the consumer is also restricted to interpret what was documented with limited space in both text and the 2D view. Organizations can suffer a major loss of efficiency by manually reviewing and recording these changes. Furthermore, unintentionally sending defective data for manufacturing is an extremely costly consequence.


ENGINEERING CHANGE DOCUMENTATION

Supplier : ACME SUPPLY, MFG
Supplier Code: 578924T7
Manufacturing Location: SPRINGFIELD, USA
Date of Request: 10/16/06

ECN Number: ECN-798057
Initiated by: J.HERRON
Reviewed by: D.HESS
Effective Date: 11/3/16

Approved ☑
Rejected ☐

Description of Request:

#	Part Number / Process id	Proposed Change - identify any affect on interfacing components/systems	Reason for the request
1	79870987.DWG	Changed radius from 2X R.170 to 2X R4.563 in Zone 3C - see was/now. Chaged radius from R.13 to R.06 in Zone 2D. Changed .313 +.010 / -.000 to .325 +/- .005	Remove stress concentration and reduce interference.

Product/Process Validation Plan:
See manufacturing router 3426257.doc for revisions.

I.CHECK
Quality Assurance Manager
B.BOSSY
Engineering Manager
D.MANUF
Manufacturing Manager

1. ZONE 3/C: Changed Radius from R 0.17 to R 4.56

Figure 2 - A sample engineering change notice form.

Figure 2 demonstrates a typical Engineering Change Notice form, whereas interpretation can be ambiguous, the connecting location of change within the drawing can be time-consuming, and the change may never get updated in the 3D model.

With digital PMI associated with the 3D model that is both machine-readable and human-interpretable, a model-based definition approach provides an opportunity for organizations to be far more effective and efficient with revision management.

Difference-detecting software and optimal reporting

Elysium, Inc., an industry leader in CAD translation and data quality software, has introduced a new tool for comparing 3D CAD models with semantic PMI. Elysium's **CAD**validator™ can detect variance between two models and report the information graphically in 3D with a listing of all changes. Reports are available in both HTML, 3DPDF, and XML formats. Users of the report require no special viewing software—only a web browser or Adobe Acrobat. Using the reports, CAD operators can find and correct defects quickly before releasing the source data for manufacturing, among many other use cases. A report that is easily opened, accessible, and understood by its consumers is critical to the success of deploying Model-Based Definition.

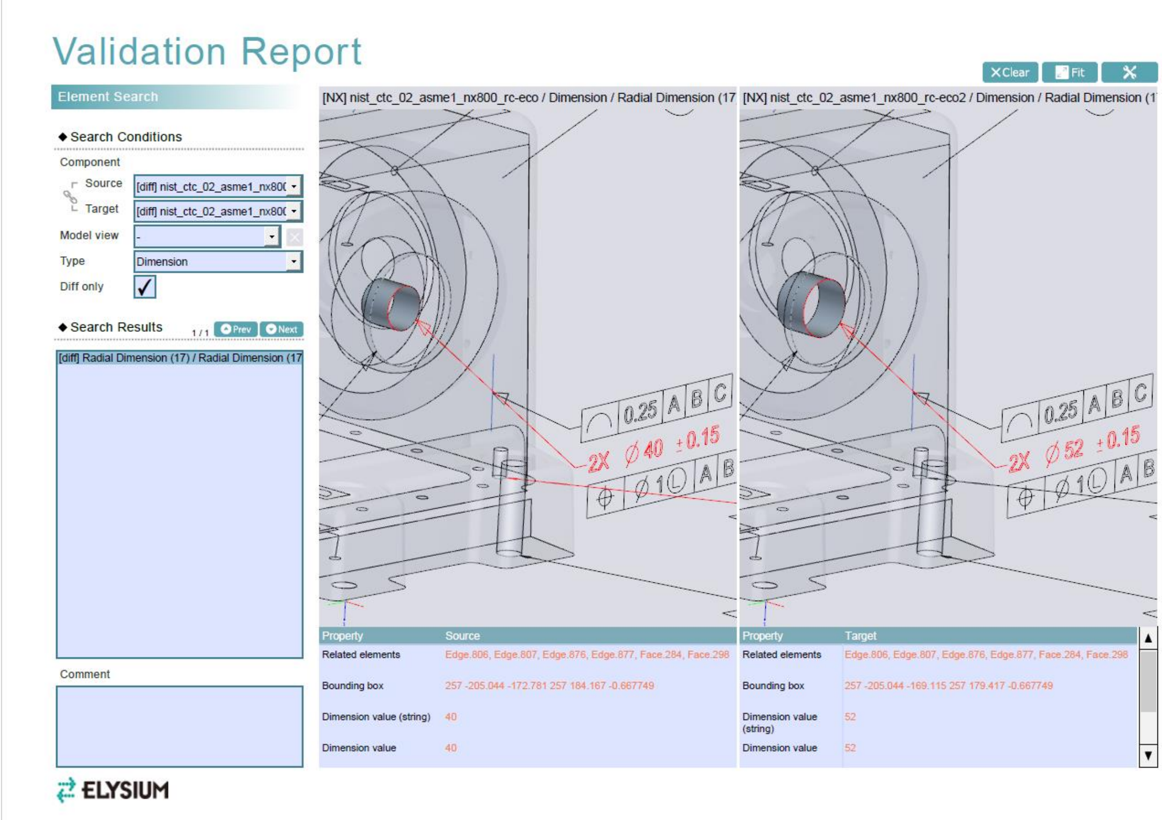


Figure 3 - Elysium's 3D PDF validation report detecting an engineering change in which a hole diameter has been modified from 40 mm to 52 mm. Associative geometry highlights for easy interpretation.

Translation errors

Once model-based practices are deployed within an organization, derivatives may need to be created for effective data exchange and visualization. By extending the Model-Based Definition into these derivatives and allowing downstream or upstream processes to consume the data, an organization is now tapping into a Model-Based Enterprise (MBE). Although achieving MBE throughout the entire product lifecycle is an extreme challenge, benefits can be realized using digital information at a highly connected level.

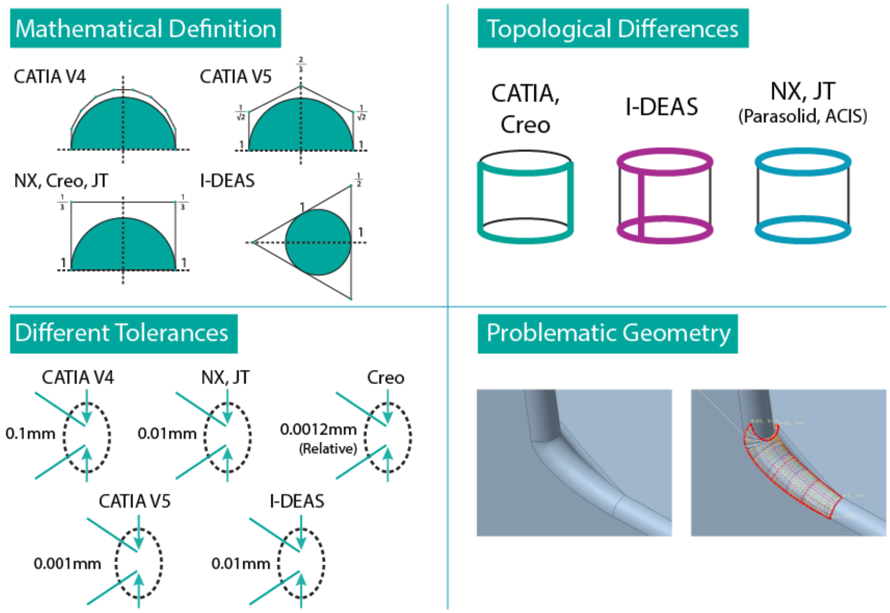


Figure 4 - Unique kernels of CAD packages can contribute to model variance during translation.

Most people are aware that when models are translated from one CAD system brand to another, errors can occur. Errors also can occur when translating to or from proprietary CAD formats to industry standards such as ISO 10303 (STEP) and the Initial Graphic Exchange Specification (IGES). Part faces, data, and annotation planes can shift position. Characters in notes and geometric annotations can change values. Geometric entities and symbols may fail to appear in the target system. Such errors occur due to the difference in mathematical kernels behind the geometry and PMI definition. They also occur due to the level of interpretation when it comes to importing or exporting standard or neutral formats. Different topological rules, tolerances, and even poor design practices may contribute to translation issues as well.

What is less well known is that translation errors can occur within the same CAD system. Models created correctly in a prior software release may contain errors when opened in later releases. API changes can be one factor in such instances. Errors also may occur when models are translated from CAD systems, such as Siemens NX or Dassault Systèmes CATIA, to compact “visualization formats,” such as Siemens JT or 3D PDF. Such errors may be hard for human eyes to detect. However, they can introduce significant defects in precision machinery. Whether using a drawing-based documentation system, or a model-based one, it is always critical to have configuration management. Because model-based data is purely digital, the quality and configuration management checking can be 100% accurate, and never left to human interpretation.

Elysium’s CADvalidator™ can assure that models translated from other systems or from previous releases of the same system are identical. It also validates CAD data for short- and long-term storage and retrieval to ensure any derivatives do not compromise quality. CADvalidator™ assures that derivative models with long production lives remain faithful to their originals, which is critical when the originating CAD system may have gone through many releases or no longer be available. It is well-suited for companies that deploy LOTAR (Long Term Archiving and Retrieval) practices that rely on industry-standard formats such as STEP or ISO 14739, the international standard version of 3D PDF.

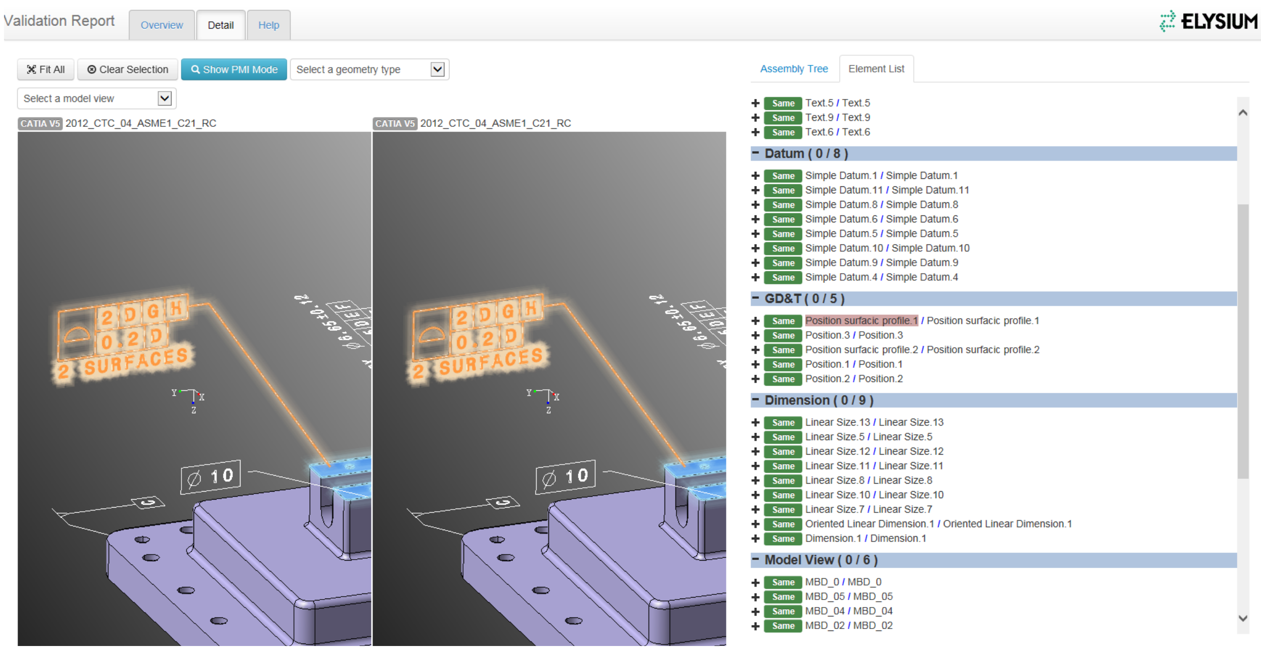


Figure 5 - Example of an Elysium HTML validation report comparing two CATIA models from different versions. The graphics area and Element List confirm that the GD&T are identical from version to version.

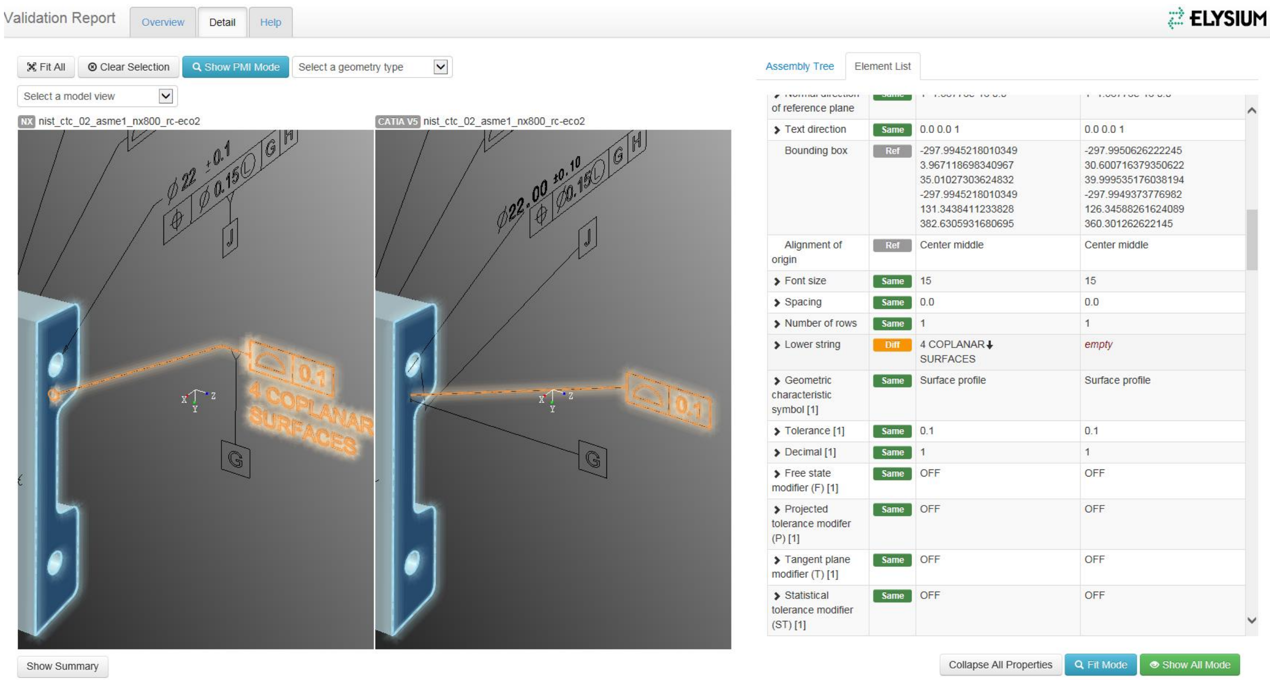


Figure 6 - Example of an Elysium HTML validation report comparing an NX model which has been translated to a CATIA. The graphics area and the Elements List clearly identifies an Elysium detected difference, in which a lower string in NX could not be converted successfully to CATIA

CADValidator compares the following element types:

- System Attributes
- Notes
- Datums
- Datum Targets
- GD&T
- Dimensions
- Model Views
- Attributes of Faces
- Attributes of Isolated Curves

CADValidator checks for the following geometry difference types:

- Face Geometry
- Isolated Curve Geometry
- Free Edge Geometry
- Isolated Points

The Elysium software detects errors in annotation values, such as “C” instead of “G” or “+0.05” instead of “+0.005.” It also detects changes in the position of both annotations (such as datum targets and tolerance blocks) and geometric entities (such as curves and faces).

Customers can set filters in the software to ignore positional errors of no significance. For instance, if the customer doesn't care if notes shift by 0.1 inches or less, the filter can exclude such errors from the list of differences.

Additional entity types will be added as customers request them. Elysium enhances software according to market demand. If a customer contributes requirements to additional capabilities, the functionality is then part of Elysium's general product offering for use by all clientele.

Conclusion

In summary, a highly robust validation software such as **CAD**validator™ enables downstream processes to leverage MBD data. While automating form fit function changes, **CAD**Validator™ also captures presentation and representation changes that are not otherwise captured with drawing-centric processes.

About Annalise Suzuki of Elysium Inc.

3000 Town Center, Suite 1330, Southfield, Michigan 48075 USA

Telephone: +1-248-799-9800; Website: https://www.elysium-global.com/

Annalise is responsible for influencing the technology direction to support MBE needs of the Americas Market. She also leads and oversees the customer engagement activity, with a depth of experience in successful foundational strategies to support model-based workflows in aerospace, high-tech, and automotive industries—ranging from CAD data quality checking, healing, validation/comparison, translation, packaging, and more.

About Jennifer Herron of Action Engineering, LLC

12081 W Alamed Pkwy #455, Lakewood, CO 80228 USA

Telephone: +1-720-242-8445; Website: www.action-engineering.com

Jennifer Herron is the CEO of Action Engineering, a registered Women-Owned Small Business that specializes in guiding organizations through their transformation into a Model-Based Enterprise (MBE) using Model-Based Definition (MBD). She serves on the Board of Directors of the Digital Metrology Standards Consortium (DMSC) which maintains the QIF and DMIS standards. Ms. Herron has extensive experience with hardware design for spaceflight and military systems, and as such, is an expert in multiple CAD packages (e.g. Creo, NX, SOLIDWORKS, Inventor