

SOLIDWORKS® MBD: MIL-STD-31000 Appendix B Compliance

Abstract:

This is a discussion on [SOLIDWORKS MBD](#) software's abilities with regards to being compliant to the United States Department of Defense Standard MIL-STD-31000 Appendix B (MODEL BASED DEFINITION (MBD) – MODEL ORGANIZATIONAL SCHEMA). MIL-STD-31000 is freely available at the web site “WWW.Assistdocs.com” . This web site is operated by the US Government for the distribution of standards and other documents that are approved for “Public” release.

Prior to SOLIDWORKS 2015, I believe that SOLIDWORKS was compliant to the standard and appendix B; however in order to achieve a documented MBD Schema, the definition of special processes and strict adherence to those processes is required. With the release of SOLIDWORKS 2015, this is no longer the case. The SOLIDWORKS add-on "SOLIDWORKS MBD" makes this process much easier. In fact SOLIDWORKS MBD add-on is as good as or better than other CAD system's methods for MBD schema control.

About the author:

My name is Rich Eckenrode and I am the president of RECON Services Inc. My experience with multiple CAD/CAM systems spans more than twenty five years working in the defense industry segment. Since starting RECON Services, I have served under various contracts to investigate and advise the United States government on the configuration of 3D TDPs (Technical Data Packages) using 3D PMI (Product Manufacturing Information) annotations. I have also been working with MBE (Model Based Engineering) and MBD technology and process research for over ten years, working with multiple CAD modeling systems. I was privileged to participate on two projects that are relevant to this paper.

The first project was the committee that defined MIL-STD-31000, in fact I served as the co-chair for the manufacturing sub-committee.

The second project was as the CAD modeler who generated the first set of CAD models in SOLIDWORKS of Dassault Systemes, CATIA of Dassault Systemes, NX of Siemens and Creo of PTC for NIST (National Institute of Standards and Technology) that demonstrate 3D PMI within 3D CAD models. These models were intended to be used as examples of semantic PMI elements within CAD models (when semantic methods exist within a given CAD system). These models are available for download from the NIST web site:

<http://www.nist.gov/el/msid/infotest/mbe-pmi-validation.cfm> .

Explanation of MIL-STD-31000

MIL-STD-31000 is the standard used by United States government procurement officers when they need to add product technical data in some form to the contract list of deliverables. This technical data might be in the form of 2D drawings or 3D models or some combination of both as defined by the contracting officer.

The main body of the standard guides procurement officers in what items can be selected for procurement.

Appendix A provides details and suggestions about TDP elements to be acquired.

Appendix B is the 3D MBD schema description. This paper is primarily focused on this part of the document and the application of its requirements.

Appendix C is titled 3D TDP Validation Guide and the initial intent was to provide rules for software translation companies to insure that derivative models could be trusted to represent native CAD models when these derivative models were included in the TDP requirements. This guide goes into greater model quality definition and should be handled in a different discussion. The only required derivative suggested to the standards committee was a STEP file. (The combination of STEP and the native CAD will satisfy data requirements for some time to come. STEP translation technology is very mature without many data quality issues but still subject to validation requirements.) Lightweight viewable files like PDF could be requested and subject to data quality validation.

MBD schema requirements:

The MBD schema that currently resides within MIL-STD-31000 as appendix B will eventually move to ASME-Y-14.41.1. This would be a more appropriate place for the MBD Schema to reside since the ASME standard is more about 3D data visual format and the military standard is more about data requirements.

The requirement for an MBD Schema in MIL-STD-31000 that describes "Presentation States" does not require that appendix B be used exclusively. Instead the requirement is for the contractor to have a schema and publish it to the end user. Therefore the appendix is mostly an example of what could be done. The example includes modeling best practices that most engineering departments already employ. The main point of any schema is how the data is organized and how the end user is going to access it. Primarily "Presentation States" are required to be defined.

Presentation states are not much different than looking at a 2D drawing, "You look at sheet 1 and from that point on you are guided using other orthogonal views, detail views, sectional views and auxiliary views until you understand all model requirements."

It is all about views that the designer can use to tell the consumer of the data what the design intent and requirements are. The suggestion for views to be alpha numerical ordered is only needed when the designer wants to share some information in a certain order or prior to other information like legal statements which need to be viewed first.

Some of the “Best Practice” items in Appendix B are suggestions that will improve efficiency while publishing models to a schema and not really schema requirements themselves.

Limitations prior to SOLIDWORKS MBD 2015:

While working on the SOLIDWORKS model set for NIST, I realized that while SOLIDWORKS software was very good at the creation of 3D PMI using DimXpert™, the application of the MBD schema was hard to accomplish.

Through the use of named views and similarly named annotation views you can accomplish a procedure reliant MBD schema that would have to be accepted by TDP procurement folks. The procedure went like this:

- (1) A named view was created that captured location, zoom factor and orientation of the named view. The view should be named with a name convention that will match annotation views. Example "MBD-1". Increment the number for subsequent view requirements.
- (2) An annotation view or multiple annotation views are created for display of various annotations. Multiple annotation views can be made visible while at a given named view setting. The annotation views should be named similar to view orientations that they will be related to. Example "MBD-1-a" and "MBD-1-b" for two annotation views that will be related to the MBD-1 view.

This combination of the named view and all annotation views that apply to that model named view is known as one of the presentation states. Multiple presentation states can and most likely should exist within each MBD CAD model.

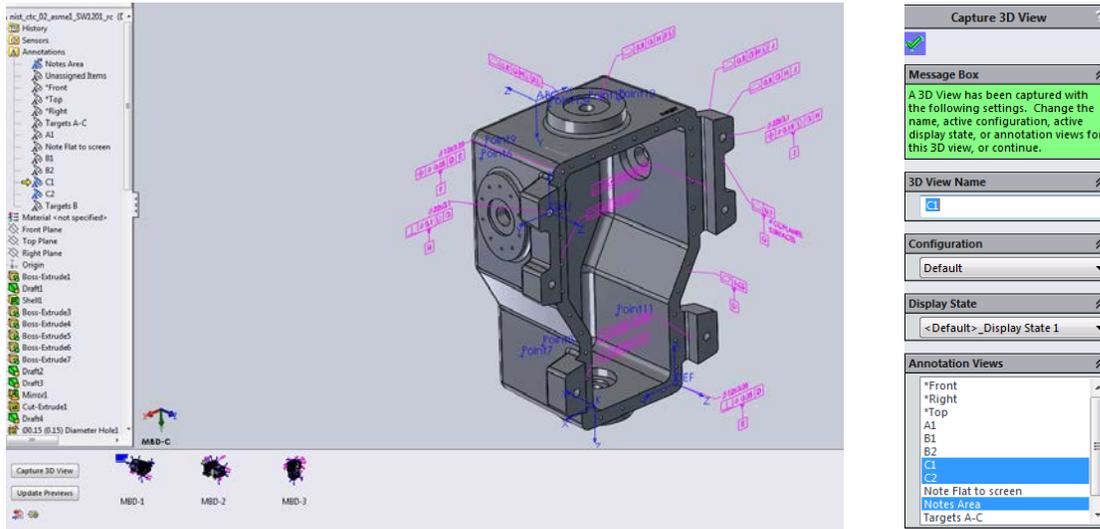
Viewing these Presentation states would be the result of selecting the named view and manually showing or hiding the appropriate annotation views.

SOLIDWORKS MBD 2015:

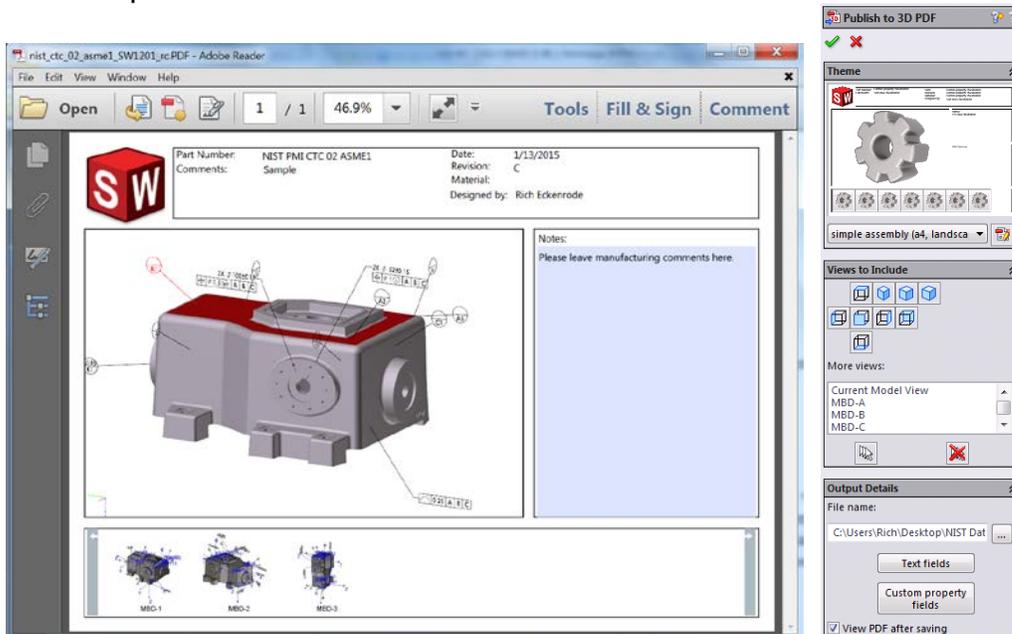
The ability to create multiple presentation states quickly and very easily came to fruition with SOLIDWORKS 2015 add-in software, “SOLIDWORKS MBD”. With this new tool all you have to do is click on an existing 3D View (Presentation State) thumbnail and that view and related annotation views will be displayed.

Using SOLIDWORKS MBD “out of the box”, there is a tab at the bottom of the window labeled “3D Views”. The menu under this tab currently has four functions; Capture 3D View, Update Previews, 3D PDF Publish and eDrawings Publish.

The “Capture” button allows a 3D view to be saved including design configurations display states, annotation views, display styles, location, orientation, and zoom factor. A thumbnail of that view will be added to the list of available 3D views.



The PDF Publish button will generate a 3D PDF file based on a template file selection and view selection. This provides an excellent method to publish light weight derivative PDF file. Templates are customizable.



The eDrawings Publish button provides the ability to publish the 3D model to eDrawings format which is the SOLIDWORKS viewing tool. This format is very good for external consumers who have access to use eDrawings as well as internal consumers who might be part of an internal design review or similar activity.

The Capture 3D View button captures what is displayed so you can either stage your views based on the procedures described earlier or manually organize the view and create a capture.

Critique of SOLIDWORKS internal investigation to compliance with MIL-STD-31000:

SOLIDWORKS management completed a self-evaluation under my supervision (they completed test cases while I evaluated the results.) They were perhaps over critical of themselves with regard to testing against appendix C. That appendix does not fit their primary business case for software development.

Of the MIL-STD-31000 tests that were not appendix C requirements they judged themselves non-compliant on two of seventy tests (3%).

(1). Cross-hatching cannot be added in SOLIDWORKS models

I'm not sure if this is really important in SOLIDWORKS since the display of the cross section model is understandable enough. Some other CAD system might display cross section models as open shells which under some circumstances might be hard to understand.

(2). Variables and parameters are not supported in special block symbols. This might be an issue depending on the definition of "block" in SOLIDWORKS relative to custom symbol creation. Symbol (block) creation is not really a targeted data requirement of the military standard.

Both issues are likely not real issues in SOLIDWORKS being fully compliant to MIL-STD-31000 since the real test to that compliance is the ability to have Presentation States.

In Conclusion:

The “MBD Schema” limitations found in SOLIDWORKS prior to the introduction of [SOLIDWORKS MBD](#) in the 2015 release of the software are completely eliminated. The ability to achieve a highly compliant MBD Model viewing Schema is as good as or better than other CAD systems.

Based on review of the SOLIDWORKS internal investigation of MIL-STD-31000 Appendix B compliance; the score would be 97% compliant. In my opinion both issues marked as non-compliant might not be legitimate measures to the standard since the standard tries to set up requirements for data organization that will ease viewing consumption.

I believe that SOLIDWORKS compliance to MIL-STD 31000 Appendix B is closer to 100% if not at 100%.

SOLIDWORKS MBD is a real improvement for the MBD methods being used in both commercial and government systems design. The ability to quickly create Presentation States will help all industry SOLIDWORKS users to improve their abilities to utilize MBD in their everyday processes.