

# **Control and Management of Model-Based Product Definition for DP Tooling Designs**

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## **Abstract**

New methods are being developed and piloted to enable model-based engineering and manufacturing. Tooling designs are developed and defined with CAD models and drawings. Using advanced parametric CAD/CAM modeling systems, solid feature-based models having all the geometric characteristics of the product are created with an associated drawing. If the product is an assembly, an assembly is modeled with associativity to its constituent part models. An effective configuration management and control system has to be in place before either the models or drawings can be used to support downstream manufacturing applications. The system has to be able to manage and control all of the files while preserving the associativity provided by the CAD/CAM package. This paper details the work done to demonstrate the use of a particular CAD system product data management system to manage and place under configuration control parametrically defined and fully associated CAD product definition models and drawings.

## **Introduction**

The Nuclear Weapons Complex (NWC) is transitioning from the use of paper-based methods to model-based methods for product realization. Future product designs will be developed using model-based product definition to ensure manufacturability at high quality levels. Model based design and manufacturing implementations link analytical and solid based models to define a highly manufacturable product that meets the NWC's needs, intent and specifications. NWC laboratories and the Oak Ridge Y-12 Plant are working together to develop the capability to define models that characterize the product throughout the life cycle of a product.

Product definition consists of the set of CAE/CAM models, drawings, specifications, and other information that, as a minimum, describes a product, specifies product performance requirements, and defines product identification elements. Product definition may also specify additional design and production requirements to assure design intent is met. Accordingly, product definition may include requirements for product geometry, materials, equipment, tooling, records, manufacturing, testing, inspection, acceptance, handling, shipping, storage, and the related procedures. NWC production sites intend to use CAD/CAM models with associated design drawings to drive downstream manufacturing applications.

Model based engineering and manufacturing practices result in multiple representations of product definition. The NWC uses CAD/CAM systems to create associated 3D product models and drawings. If the product is an assembly, the CAD system associativity extends to the product models of its component parts and sub assemblies. This paper details a project that demonstrated a system to manage and control the use of solid models and associated drawing for product definition of tooling.

## **Management and Control of Product Information**

Tooling is itself a product and has to be designed and produced. Tooling is being defined and built from electronic product definition models. At Y-12, a model consists of multiple representations. One representation is a solid model with a fully associated drawing. If the solid model represents an assembly, there are CAM/CAM associations with its component parts model. These associations are maintained and internal to the CAD/CAM system. At Y-12, the design of record is a representation in the form of a drawing plot file.

There are multiple product-defining representations of a given product. The representations may be interrelated and provide specific views that help define the product and how it is to be made. The design process for tooling is migrating from a 2D

drawing based system to a 3D model based system. An electronic drawing is also created through associations to a 3D solid model.

Figure 1 shows a component part consolidated model that consists of a 3D model, an associated drawing file and a 2D drawing plot file. The CAD/CAM system maintains associativities between the drawing file and the 3D model. The 2D drawing plot file is essentially a picture of the drawing file. The consolidated model is managed and controlled as one entity. Release and versioning is done at the consolidated model level. This requires validation and verification to ensure that there are no inconsistencies between the model and the drawing and that the drawing doesn't contain information that doesn't show up on the 2D drawing plot file. If there is a change to any of these files a new version of the consolidated model is issued.

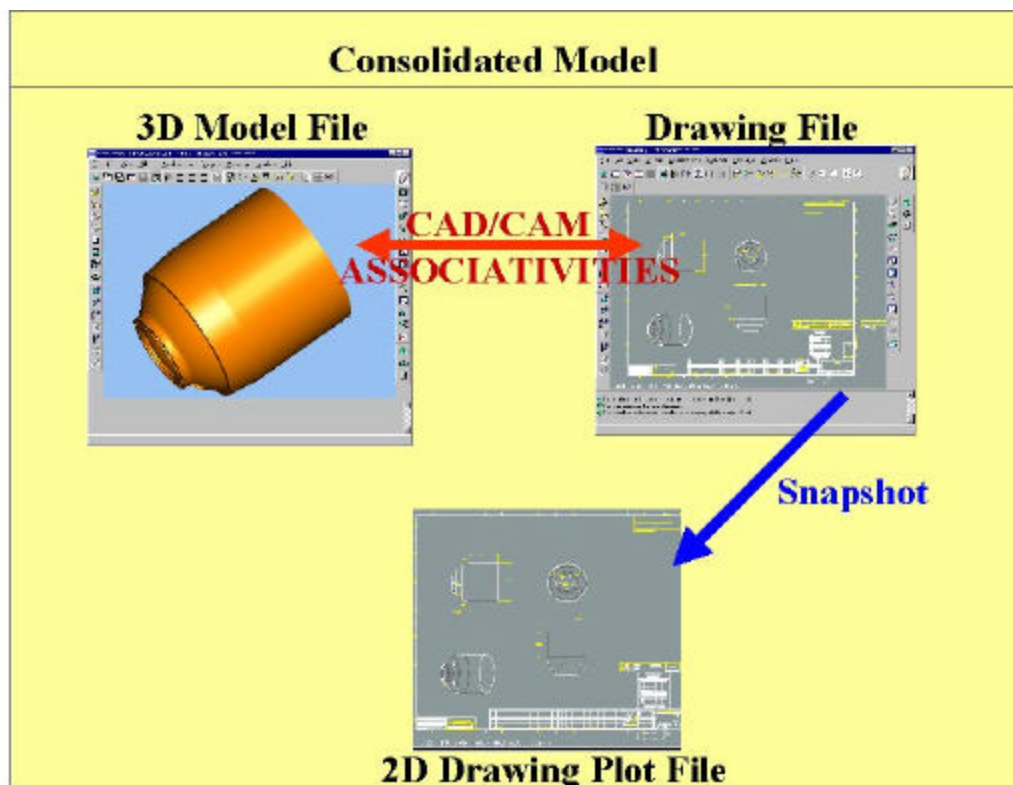


Figure 1: Components of a Consolidated Product Definition Part model

In a consolidated model of an assembly, there are CAD/CAM associativities between the 3D model and the 3D models of its component parts. Figure 2 shows the consolidated assembly model and its associations to a specified version of the component parts consolidated model. The consolidated model of the assembly is released and revised independently. The CAD/CAM associativities are preserved with the 3D model at the specified version of each consolidated component part model. If a component

consolidated model is revised, the consolidated model of the assembly will not be altered and will reference the version of the component consolidated model it used. An assembly consolidated model is revised only if the change in the versioned component consolidated model is significant in the assembly model.

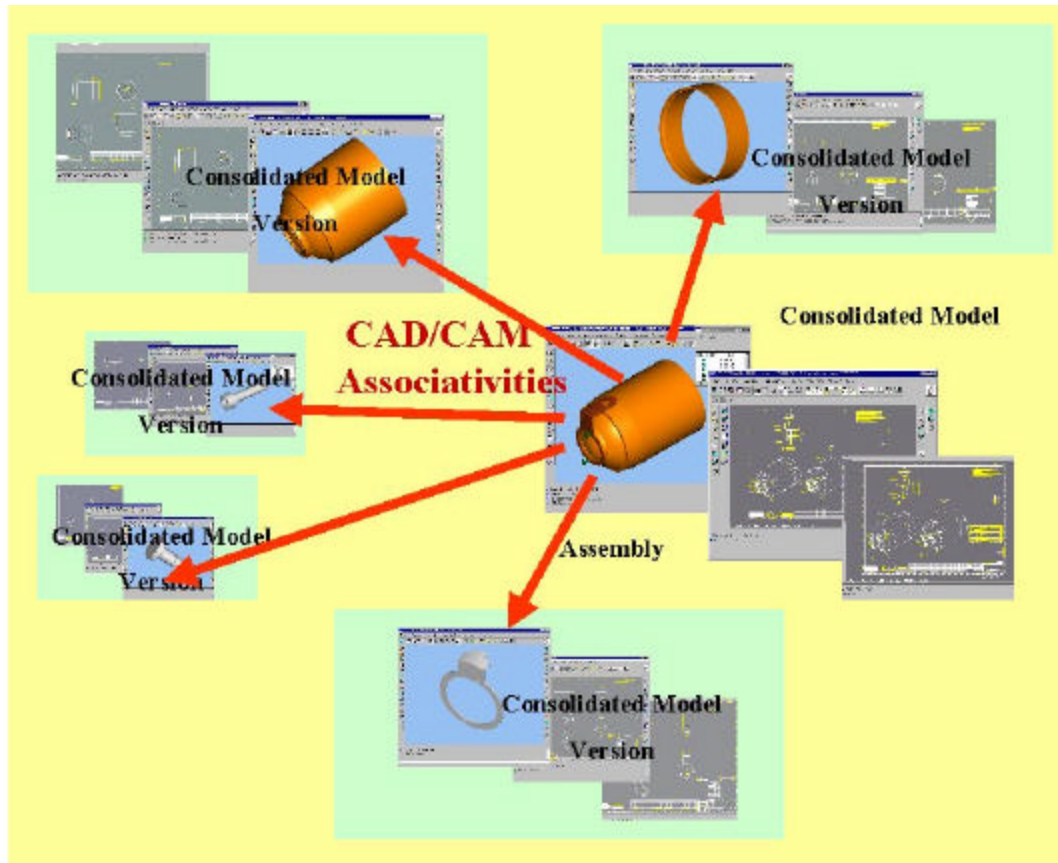


Figure 2: Assembly Consolidated Product Definition Model

## Demonstration System to Release and Version Tooling CAD/CAM Product Models

Tooling is currently using Pro/INTRALINK, a CAD/CAM product data management system, to manage and control its Pro Engineer models and files. Pro/INTRALINK is utilized to maintain the associativity of the component objects of the consolidated model, control access to the data, preserve the content of the data once it has been processed through Y-12's release cycle, and provide the mechanisms required to retrieve desired objects for future modification or revision. Pro/INTRALINK primarily use is to manage

and control Pro Engineer files since it understands and can manage the CAD\CAM file dependencies.

The following process was implemented to demonstrate how a versioned consolidated model is released and put under management control:

- Step 1: A partial consolidated model is created. This consists of the 3D model and CAD generated drawing. The files are validated and verified.
- Step 2: Within these files, parameters are established that defined version/issue and a list of needed approvals. All the files associated with this model are promoted in Pro/Intralink to a hold for release level.
- Step 3: A comment, approval and release workflow cycle is automatically initiated in Metaphase, a product data management system for Y-12. A 2-D drawing plot is generated from the CAD drawing file. The approvers are notified and the task is added to their approval pending work file. Each of the approvers then independently reviews, comments and approves or rejects consolidated model package. If it is not approved, the necessary changes are make to the consolidated model files and the Step 1 is started again.
- Step 4: If all approve, then the approvals with dates are added to the consolidated models. A 2D drawing plot file is generated and the consolidated model is automatically promoted in Pro/Intralink to the release level. The 2D drawing plot file is send to the appropriate business data bases as the official record copy.
- Step 5: The versioned consolidate model is managed and control from this level through the Y-12 Metaphase product data management system.

## **Summary**

It was demonstrated that managing and controlling product representation at the consolidated model level supports the basic concepts of model based engineering and manufacturing. It also preserves the CAD/CAM model associativities and allows them to be used in down stream applications. Using these methods, the correct controls are established so that the business side is assured that product definition is under version control while users can use the representation of that version best fitted for their application.

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