



## **The World of 3D Product Manufacturing Information**

### **CAD to CAM - where did it start and where is it going?**

An outline of the evolution of CAD helps us see how things started, understand where we are now, and to consider where they are going. Lets start at the very beginning.

In the beginning was the drawing, and either alone, or with companion drawings, it was both a definition of a product and instruction as to how it could be made. Perhaps in the very beginning, it may have been that drawings came about solely for the purpose of enabling something to be manufactured. The current status of the drawing as the kernel of product definition and often the legal entity reflects the way our design and manufacturing industries have developed.

Even now, in many places the drawing is still a goal. It is a milestone. It reflects achievement and a point of completion. Now, not so often produced with pencil and paper it is still a work of art, and something to be read by skilled men who will gather over it and pronounce wise interpretation. Why is it still with us? Now, more that twenty-five years into Computer Aided Design, why is the drawing still so important?

The drawing has withstood the onslaught of technology because it does something that CAD technology didn't effectively do. It presents information that has not, until recently been included within the CAD model.

In the early days of CAD the objective was the creation of a drawing. People spoke of drawing productivity and CAD came to the world of design engineering almost like the word processor came to the typing pool. It was going to save man-hours and increase the throughput of the drawing office.

Though crude by modern standards early CAD systems often did speed the production of drawings, especially where modifications to an existing electronic design were required. However, the goal was the production of hard copy on paper - a drawing.

It wasn't a comfortable evolution. Skilled draftsmen could often match the speed of electronic drawing production and were frequently able to do things that couldn't be done on the electronic system. A battle arose in which the vendors of CAD systems began to search for unique benefits and to find productive gains that would compel engineers in all disciplines to accept this new and exciting technology.

Meanwhile, in the manufacturing departments new breeds of manufacturing tools were also taking hold. Machine tools with computer controllers and the ability to "remember" programs and to repeat a job with unfailing accuracy without manual intervention. It didn't take long before these two newly computerised environments began to look at each other to see what they could provide to enable productive gains.

If 2D profiles could be effectively exported from computerised design systems in such a way that the computerised manufacturing system could "read" them, then the milling and drilling and profiling systems with computer controllers could save hours of manual programming and would soon build up a library of frequently manufactured parts, the two features combining to make massive savings in time.

This is exactly what happened. The design systems began gradually to be able to output programs for the machine tools. At first, the method might have been with punched paper tape which might be simply walked from department to department, but then came electronic links via RS232, and it seemed that design and manufacturing would soon become one.

However, even though it became possible to produce programs and export them from a design system to a machine tool, something was missing. The manufacturing men were still waiting for receipt of drawings and the queue at the plotter became more and more the critical factor on the design to manufacturing timeframe.

CAD systems evolved and became more and more sophisticated. Working in 3D became common place, the ability to take machine tool paths from 3D models became common place and very reliable, machine tools became more sophisticated able now to programmatically change tools and to work in many axes. The Machining Centre arrived, enabling a whole variety of manufacturing tasks to take place at one point. But, the manufacturing men still needed access to drawings to establish the exact manufacturing criteria for the component.

Design departments offered and provided full 3D models, as well as tool paths. The generation of tool paths became a function of the manufacturing departments and the arrival of internet local area network technology brought design and manufacturing together in a way that had simply never before been possible.

But, the manufacturing engineer still required drawings.

Why? Why does manufacturing still require the production of drawings before being able to manufacture? The answer lies in the 3D CAD model, or more correctly, the answer doesn't lie in the 3D CAD model. From the very beginning, the drawing contained information that has not been until recently, incorporated within 3D models. For example material specifications and machining tolerance information together with surface finish characteristics – none of this information was available without access to the conventional drawing. Problematically, when it was included in the 3D model, there was no formal standard saying how it should be held, or how it should be displayed or interrogated. The 3D model was actually making things worse.

However, there are now signs of a solution. ASME Y14.41-2003 Product Data Definition standard covers 3D annotation and dimensions and other elements of manufacturing information. These have not traditionally been part of a 3D model, having been normally communicated by 2D drawing. This standard provides a means whereby the 3D model can at last provide the information required, and the term which seems to be coming most popular to describe this capability is the inclusion of 3D PMI. (3D Product Manufacturing Information) This term covers the range of manufacturing information including standard text and dimensions together with material specification and surface finish information, geometric tolerance details – the complete set of Product Manufacturing Information.

However, even so, things are not necessarily straightforward. It is still possible for there to be different systems deployed within the design and manufacturing departments. Therefore it is now becoming necessary to enable the translation of CAD models between these systems, including the 3D PMI data.

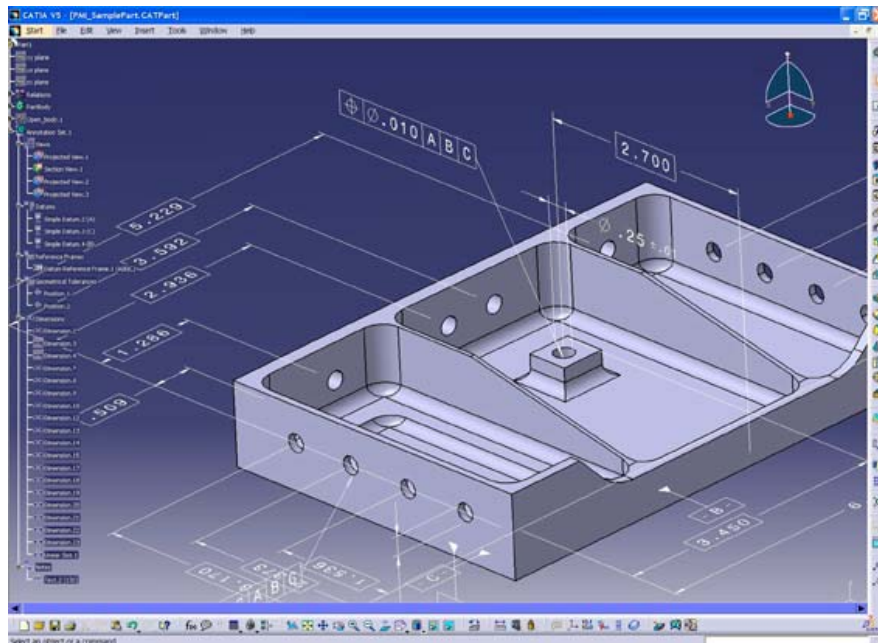
Theorem has been working on the support of translating this information for some time and has already sold and installed some ASME Y14.41-2003 compliant translators. The first of these was a CAD to CAD installation, delivering a number of translators that operate between I-DEAS and CATIA V5. This configuration has been deployed at Ford and is currently in productive use supporting the translations between various vehicle programmes.

The desire to make information available on an enterprise wide basis has also led to the need for the wider information set of 3D PMI, now defined in ASME Y14.41-2003 Product Data Definition standard, to be also made available for visualisation applications. As an example of this use of the extended data set Theorem has created a customized version of the standard CATIA V5 to UGS JT translator. This special version processes CATIA V5 Assembly & Geometry data together with 3D PMI data generated using the CATIA V5 Functional Tolerancing & Annotation application and translates the data into the UGS JT visualization format. This customization project has been implemented at major USA Aerospace Defence Company.

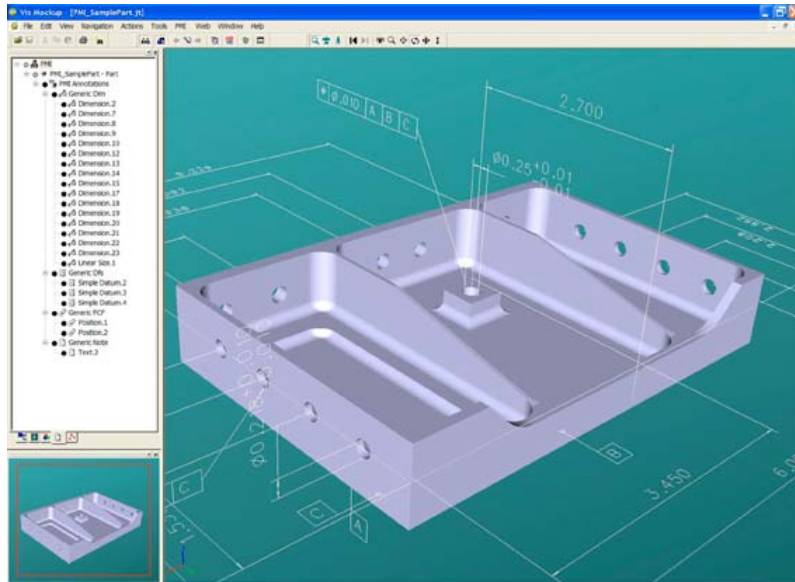
Standards are evolving rapidly, and as the various CAD vendors extend their support for the creation and migration of 3D PMI data Theorem will also extend the existing translators to support the translation of the data.

So, we have seen how we started, where we have been, and we now seem to be able to see where we are going. What was a major gap in the information flow between design and manufacturing is now being filled through the appliance of ASME Y14.41 and best in class translation products.

### Illustrations



Above: A CATIA V5 part showing 3D product manufacturing information (3D PMI)



Above: The CATIA V5 part, including PMI having been translated by CADverter into UG JT for enterprise wide visualisation in Viz Mockup.

**- END -**

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