LONG TERM RETENTION OF DIGITAL MODELS

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This article is based on the work of the LOTAR project, which, through the European Body for the development of global Aerospace standards (ASD-STAN), aims to develop a standard for long term retention of digital aircraft data. Project members include BAE SYSTEMS, Airbus, EADS, Dassault Aviation, SNECMA and MTU, and is supported by the ProSTEP association. The European industry is working closely with its US counterpart, the AIA to promote a global consensus, and with the PDES Inc. Long Term Data Retention project.

The aim of this article is to sketch digital model retention:

- What is the problem?
- Why think about models now?
- What do we need to do?
- What else do we need to do?

WHAT IS THE PROBLEM?

Computers are now expected to last only three years, and the operating systems change more frequently. Historically, new versions of CAD systems are released at least every six months, and are replaced or completely rewritten every few years. However, many of major products designed using them last much longer - cars 10-20 years, ships about 40 years, aircraft designs up to 70 years, and nuclear reactors over a hundred years. Consequently, the computers and their software can be expected to be replaced many times over the life of a product.

The problem is, when systems change, they do not always read in old data correctly. This is particularly true with complex data structures such as geometry. Software manufacturers rarely support software versions older than the last but one, let alone the last but one generation. The problem is, if we update our software, or even change the software completely, will we be able to reliably read our old data?

The picture (figure 1) illustrates the sort of change that could happen when copying a model from one generation of system to the next. The part in the new version would not fit where the old one did, and the risk of this sort of error would require us to perform detailed checks on a part design every time we updated the CAD system.

This is not merely a technical question, but a real business problem. A complex product may take up to five years to get into production, and may be in production for many years. However, the design data does not cease to be used when production finishes. It continues to be used in servicing the product, in manufacturing spares, and in modifying the product - not just upgrading it, but responding to changes in regulations or finding new suppliers.

The problem is that the CAD system will become obsolete quite early in the life of a major product. Not only will it be obsolete, but even if a version is available, the number of people who know how to use it will also get fewer and fewer. Consequently, one will have to replace the CAD system at several points in the product lifecycle. And even if we are able to drop the product after 20 years (and risk losing customers), we would still be legally liable while it continues in service, and usually for several years longer, and would need to provide design data in case of accident.

WHY THINK ABOUT MODELS NOW?

Early CAD systems were viewed as an electronic pencil. Their main advantage was that if you changed one line, then all the others could be redrawn automati-

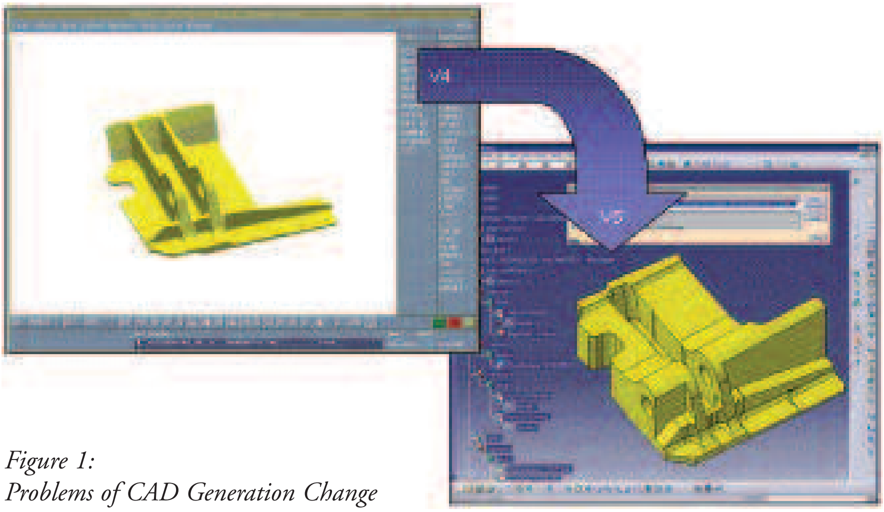

Figure 1:
Problems of CAD Generation Change

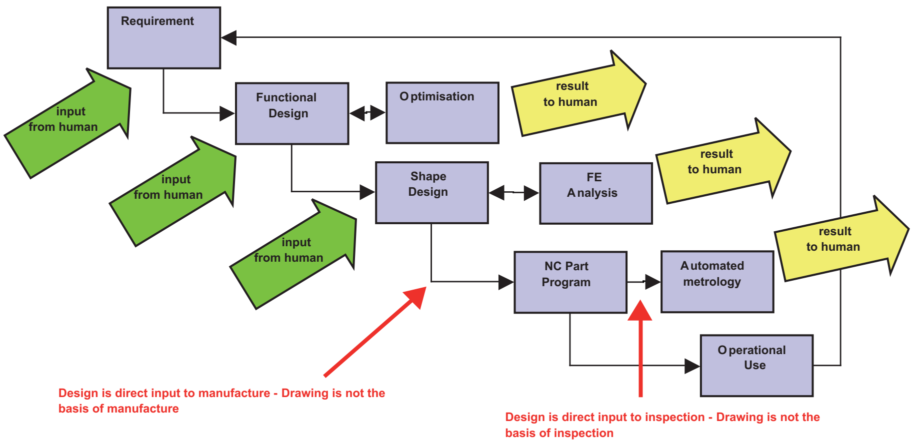

Figure 2: Use of Models in Design and Manufacture

cally. The next stage was to build in aids to the draftsman - an «electronic version of the draftsman's spline« was first suggested in the 1960's. (A spline is a long, flexible strip of wood or plastic, which was used to guide a pencil along a curved line. The shape was set by holding the spline down on the drawing board by heavy weights). While there has been much development in CAD, most has been about improved tools for creating and checking shapes. However, in the last few years, more complex functionality has been added, in which the tool itself generates extra information, such as geometric tolerances.

Another way of putting this is to say that a drawing records what the draftsman intended, but a model defines what he wants. In a drawing, a dimension is 200mm because that is what the annotation says. In a model is the size and shape it is, and if one wants to find out how big something is, then one has to measure it.

It's not simply that the model defines the shape, but that shape is used directly - without human intervention - to analyse properties of that shape. Finite element analysis is done directly on the shape defined by the model, not on a reinput of model details. This is increasingly true all along the design chain, where the output of one model is the input to another, and humans are there to check the final output, not mediate the intervening operations. That is, the model is the master, not the drawing.

WHAT DO WE NEED TO DO?

Consequently, if we use the model as the master source of the product design, we need to keep it. However, since the model is always interpreted through software, we need to show that software correctly interprets the model. That is, if we take a model, and put it into an archive, then, when we take it out again, we must show that what went in is what comes out again.

Note, the archive model shown here is based on the OAIS model of an archive, in which data is ingested from the producer, stored and then accessed by the consumer. The OAIS standard defines the concepts and terminology, so that archiving schemes can be compared.

The question is, what do we mean when we say that what goes in must match what comes out? The discriminating concept here is the «key characteristic« - a thing we care about. For a document, we care about preserving the text, we do not care if the paper yellows over time. In a CAD model, we don't care of the font of annotation is Arial or Times, or the surface comes out the wrong colour. What we care about is the shape of the thing - does it have the same volume and surface area. There have been called verification properties, and have been added to STEP AP 203. In this context, data exchange between different CAD tools is seen as essentially the same problem as exchanging data across time.

	Preserve	Don't Care
Document	Text	Colour of paper
CAD Model	Shape Edges Surfaces	Annotation Font

Cloud of points is a technique of putting points over the surface of a model, and using these as the verification mechanism. That is, we can use the cloud of points to automatically check that what went into the archive is the same as what comes out. Further, rather than putting points at random over the surface, points can be put at critical points, either to show that the surface is accurately reproduced, or that edges have not moved significantly.

The Cloud of Points picture were provided by ITI and SNECMA and illustrate ITI's CADIQ product, which was used to develop the test criteria.

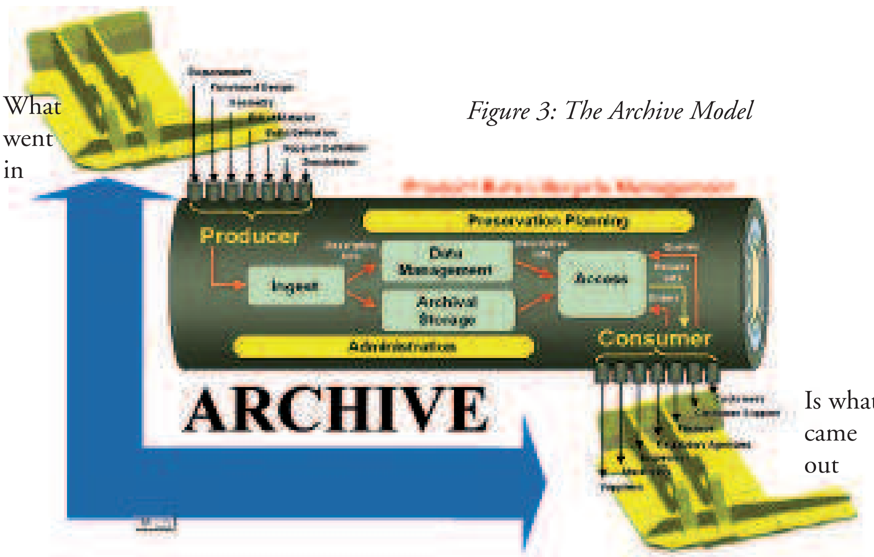

Figure 3: The Archive Model

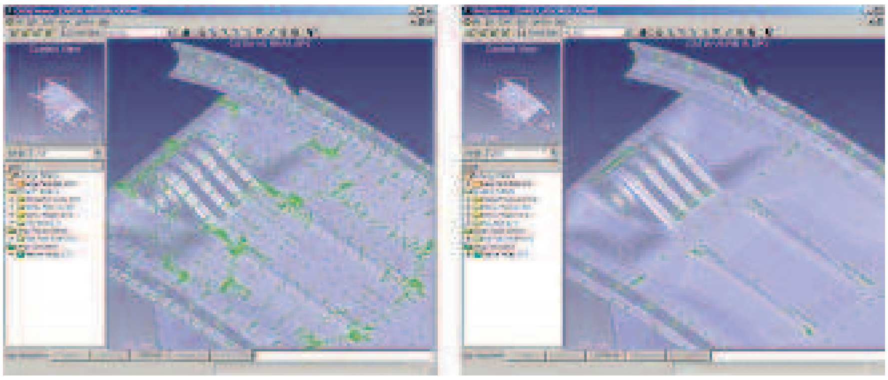

Figure 4: Verification by Cloud of Points

WHAT ELSE DO WE NEED TO DO?

There is not simply «The retention problem", but rather, there is a whole series of them. At the simplest level, one could keep the computer and the operating system and the software. There has been work on this for document retention, but is out of scope for the LOTAR project, since the sorts of modelling tools used in Aerospace not only require complex software, but also skilled users.

At a higher level, there is a problem of retaining data, for which the OAIS standard provides not only a reference model, but a template. The next level is to retain the model, that is, to ensure the information remains well structured and accurate when read into a new modelling tool. This is the focus of the LOTAR project. However, the model does not tell the whole story, and needs to be supplemented by the knowledge of how to interpret the model - an area where much work has started in recent years.

CONCLUSION

The most important conclusion is that Long Term Data Retention is a business issue, since it affects future revenue. It is also important to stress that model retention is a different problem to retention of drawings or images, and needs a different approach. In particular we need to define the key characteristics of the model, and try and define verification properties that will help check if these properties have been retained. It is also important to stress that model retention is not the whole problem. It needs to be supported by a well defined archive, and there is further need to capture the knowledge that sits behind the model.

The development of standards in this area is still at an early stage, but in setting out the principles, LOTAR has already made important advances by defining the basic principles and processes. Implementation projects - such as the MIMER project, supported by EPM Technology - are already using the standard, and the German Automotive industry association VDA has adopted its early results.

BREAKOUT - OAIS - ISO 14721.2003

NASA's Open Archival Information System is a reference model describing an archive environment, to enable archive architectures and services to be compared.

An OAIS-type archive is expected to meet certain minimum responsibilities:

- negotiate and accept appropriate information from information producers;
- obtain sufficient control of the information to ensure long term preservation;
- determine the scope of the Designated Community (the people who will use the information in the future);
- ensure the information is understandable by the Designated Community without the assistance of the information producers;
- follow documented policies and procedures to ensure the information is preserved against reasonable contingencies, and to enable the information to be disseminated as authenticated copies of the original or as traceable to the original;
- make the information available to the Designated Community.

The OAIS reference model details a conceptual design for an archive, including its primary components and their associated functions and relationships, to support these requirements.

LOTAR: LOng Term Archiving and Retrieval of digital technical product documentation, such as 3D-CAD and PDM data (http://www.prostep.org/en/projektgruppen/lotar/)

ASD-STAN: Aerospace and Defense Industries Association of Europe – Standardization (http://www.asd-stan.org)

AIA: Aerospace Industries Association - US Trade association representing the nation's leading aerospace manufacturers (http://www.aia-aerospace.org/)

ProSTEP: A association of industry members is to provide support to companies in their endeavor to meet the challenges posed by today's networked collaboration. (http://www.prostep.org)

BAE SYSTEMS: The premier global defence and aerospace company (http://www.baesystems.com/)

Airbus: A leading aircraft manufacturer with the most modern and comprehensive product line. (http://www.airbus.com/en/)

EADS (European Aeronautic Defence and Space Company): A global leader in aerospace, defence and related services (http://www.eads.net/1024/en/Trailer_EADS.html)

Dassault Aviation: A major manufacturer in civil and military aviation (http://www.dassaultaviation.com/en/aviation.html?L=1)

SNECMA: Designs, develops and produces engines for civil and military aircraft, launch vehicles and satellites (http://www.snecma.com/index2.php3?&lang=en)

MTU: A strong player in the development, manufacture and repair of commercial and military engines (http://www.mtu.de/en/index.html)