Comments on composite design and manufacturing

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This document presents some aspects of composite part modelling, exchange and manufacture based on the presentation by Richard Murrish on 12th August 2011.

# Modelling

Boundary Representation modelling, the currently prevalent modelling technique, has implicit assumptions that the part material is homogeneous and that the part is rigid. For the problem of composite parts it is necessary, therefore, to make a compromise and use a compound object. This is something which lies a little outside normal modelling, but it would seem to be better to optimise the modelling needs before deciding on the exchange method. For data exchange it is probably possible to exchange everything as an assembly with additional information as to how to interpret it, but it would be better to research an optimal modelling method as well. Models of composite objects, as presented, could be considered as compound or structured models with relations between the model elements. In any case, if the theoretical model is correct then the software developers should be able to find a way of exchanging composite models.

It was surprising to see wireframe models being used. It would seem more natural to use shell, or sheet objects, which are degenerate models of thin plates. There was extensive work done on a special design system for thin plate constructions in Norway (SINTEF) during the late 1970s and early 1980s and they were incorporated into the first hybrid modeller (volumes, sheets and wireframe models) developed in Sweden (KTH – Kjellberg) during the same period. Essentially these sheet objects are degenerate representations of thin objects, like plies, and have an implicit thickness. If this thickness is not uniform for composite sheets, then some adaptation may need to be done but this should be possible.

It might be that the object can be derived implicitly by giving a basic shape and then the plies are derived as offsets from this. If this is possible then you have two modelling methods, an explicit one and an implicit one, which would need to be distinguished.

The different ply characteristics, woven, straight and so on, need to be identified and categorised, as do material characteristics. These could be added as ‘notes’ (information elements) to plies.

# Design

How is composite part design done? Is the part outer shape designed first and then the composite design made or is the part designed as a set of layers from the outset? Reverse engineering was mentioned in the presentation. Is one method of design to make a shape in, say, clay, to measure this and then design the composite part from this?

In order to capture the design intent then you should have a natural design method, something which Professor Torsten Kjellberg of KTH was talking about at the end of the 1970s. This lesson hasn’t been learned by software developers so it would be necessary to look at how designers really want to design and then to determine tools to make this possible. The more it is necessary for designers to adapt their thought processes to the tools then the further away you get from having a clear design intent. This calls for a dialogue between the users and the developers to get this.

It is necessary to make a distinction between what has to be done manually and what can be done algorithmically. If there are tasks which are boring, mechanical tasks which can be transferred to algorithms then this is preferable to having manual tools. In general, it is preferable to develop high-level tools, where possible, to free designers from routine tasks. This, too, needs a dialogue between developers and users.

# Manufacture

Defining a facetted form as the only shape form for manufacturing is a mistake. While it is understandable that the tolerances are lower, it would be better to communicate the ideal shape, if possible, and let the manufacturer do the faceting, if needed, based on the process tolerances. If the facetted model derives from the designer then it would mean that the designer has to decide on the faceting tolerances expected for the manufacture. This, in turn, would mean that the designer would have to know about the manufacturing process and would limit future part production. Rapid prototyping went down this road and the legacy of STL, with all its drawbacks, is still around, even though there are better technical solutions available now. If the part is derived from reverse engineering, then you might want to communicate the STL form of the data, but this shouldn’t be the only method. Exact shape is better if you can get it.

The big expert on data exchange for layered, or additive, manufacturing is Professor Hascoët (IRCCYN) from ECN, Nantes, France. Additive manufacturing is not the same as composite manufacturing, but it would be interesting to compare the two to see if there are common elements.