Fundamentals of Computer-Aided Design

(ME 6104)

Resubmit HW#5-6 : Non-manifold model

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< 6> Non-manifold model

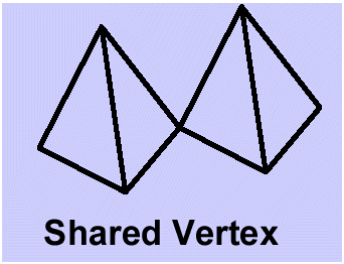


Fig. 6-1 Non-manifold Solid Model

Manufacturing Point of View

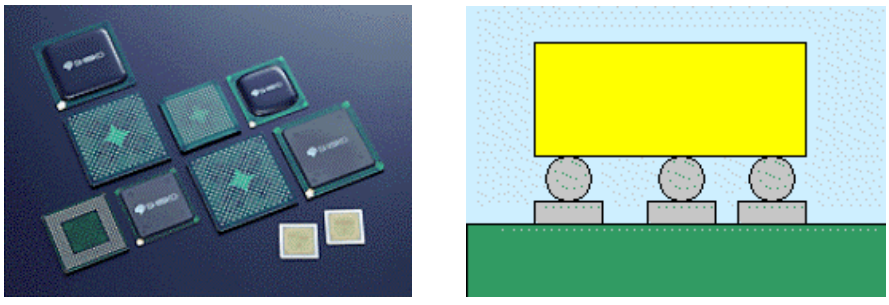
First, I want to talk about the shape of a pair of pyramids joined at a single vertex. Is it realistic? No. It is a kind of idealized shape and it is not manufacturable. So, manufacturing point of view it is not necessary to represent non-manifold solid model. And non-manifold model disobey the Euler characteristics. So, you can not use algorisms or data structures (Winged edge) based on Euler characteristics for representing non-manifold solid model. That is the reason why most mechanical part modelers did not support non-manifold model.

Analysis Point of View

But as you know, usually in analysis process idealization of shape takes place very often. And in analysis point of view it doesn't matter the shape is manufacturable or not. Only the matter in analysis is element, node, boundary condition and fast solving.

Let me give three examples of non-manifold model for analysis.

Example 1 : Point Contacts Assembly



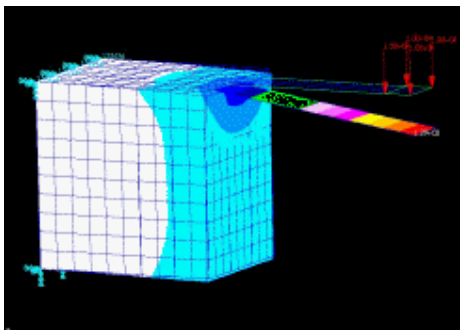
(a) Ball Gray Chip Package (b) Idealization for Thermo Analysis

* Sai Zeng, Eislab -Georgia Tech

Fig. 6-2 Non-manifold Model for Analysis

Fig. 6-2 shows Ball Gray Chip Package. And idealized non-manifold model comes out for thermo analysis. So, solid modelers supporting non-manifold model is very convenient to engineers in CAE area.

Example 2 : Thin material attached to a block



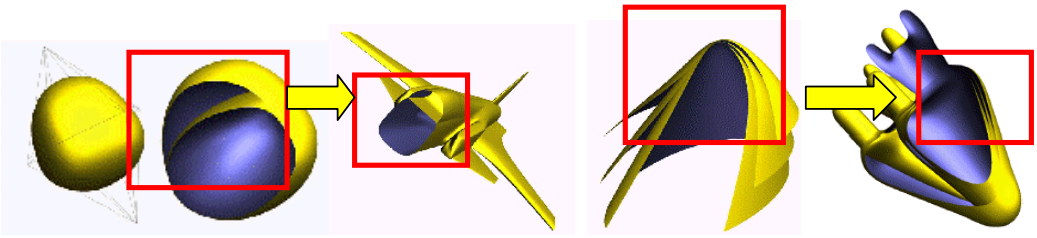
* Sai Zeng, Eislab -Georgia Tech

Fig. 6-3 Diving Board (Non-manifold Model for Analysis)

At the analysis point of view, the calculation time is very important. So usually thin material is idealized to surface for fast calculation. Fig. 6-3 shows the typical case.

Example 3 : Non-manifold surface.

(a) Three Flowers sharing one point (b) three petals sharing one edge



(c)a ball with interior patch (d)cockpit of air plane (e)several surfaces sharing one point (f)human heart

* Lexing Ying, Denis Zorin,: “Non-manifold subdivision”, New York University

Fig. 6-4 Non-manifold Surface Model for Analysis

Exampe3 is the surface case not the solid but it is a good example for non-manifold problems. Usually in case of thin thickness material product, surface analysis model is efficient and powerful rather than solid analysis model. But the problems happen when thin thickness solid models converted to surface models because the converted surface models are non-manifold like the cockpit and human heart in Fig6-4.

Therefore, in analysis point of view, representing non-manifold model is very useful.

Some Algorithms for solving the problem of non-manifold model

I just want to see the problems of non-manifold models.

(1) Non-manifold subdivision

By Lexing Ying, Denis Zorin(New York University)

Short description : The topic of this research is the development of subdivision algorithm for non-manifold model because most subdivision algorithms to get smooth surface are based on manifold model.

(2) Efficient Compression of Non-Manifold Polygonal Meshes

By Andre Gueziec, Frank Bossen, Gaubriel Taubin, Claudio Silva (IBM)

www.research.att.com/~csilva/papers/vis99a.pdf

Short description : The most of the methods currently available for geometry compression require a manifold connectivity. But many real world polygon meshes are non-manifold that is, contain singularities. That is the motivation for this research, the development of compression algorithm for non-manifold model for fast analysis.

Summary

As I mentioned before, representation of non-manifold model is very useful to FEA . But it is difficult to use non-manifold model because most algorithms related to graphics and FEA are based on manifold model. But many researchers now are trying to solve the problems of non-manifold model.

I guess non-manifold model will be also useful to making animation because like the case of analysis the idealization of shapes takes place often in animation.