### HP and MSC Collaboration on MSC/SuperModel

Harvey Ivory harvey.ivory@macsch.com

The MacNeal-Schwendler Corporation Costa Mesa, California Andrew Page page@cv.hp.com

Hewlett-Packard Corvallis, Oregon

# ABSTRACT

Recently graphics visualization problems have become too complex for current graphics hardware and software to handle. Hewlett-Packard has developed a software solution to this problem called HP DirectModel. DirectModel is a toolkit that application developers, like The MacNeal-Schwendler Corporation, can use to allow their applications to visualize with very large CAD and CAE datasets. MSC is working with HP to apply DirectModel technology in MSC/SuperModel, an application that is designed to work with large models. By working together HP and MSC are bringing you software and hardware that will help you do your job easier, faster, and better.

### Introduction

We at Hewlett-Packard and The MacNeal-Schwendler Corporation have been working very hard to bring you the best hardware and software to help you solve your engineering problems. Recently though graphics visualization problems that design engineers are being tasked to solve are becoming too large for both the systems and software to handle. As an example, in talking with a large automotive manufacturer, HP was told that currently a design engineer can visualize only a car door, not the whole car.[1] This means that the designer would have a very hard time determining if that door will fit correctly into the frame of the car. This problem not only affects car manufacturers; we have heard the same type of problems from all of our customers. The fact of the matter is simple, as hard as we work to make our hardware faster and more powerful the size of the problem you need to solve is just growing faster.

So in following with our tradition of designing systems to help you solve your problems, we at HP have set out to provide a solution, HP DirectModel. DirectModel is a toolkit that software developers like the MacNeal-Schwendler Corporation can use to make their applications interact with these large 3D CAD or CAE datasets. A DirectModel powered application will have the ability to visualize datasets that would bring most applications to a standstill today. DirectModel powered applications, like MSC/SuperModel, will help you solve a new series of problems, hindered only by your imagination.

#### **HP DirectModel**

As we said before, CAD and CAE models are growing in size and complexity more rapidly than the hardware can efficiently handle. At HP we see that there is a need for more than just a hardware solution to solve this problem, so we have developed HP DirectModel. DirectModel draws on the best that graphics research has had to offer over the past few years. This is the first time many of these cutting edge algorithms have been brought together in one place, and when they work together the results are amazing. DirectModel takes a large model and applies the tools it has at its disposal to let you interact with it. This is in contrast to most applications today that just try to draw every polygon and let the graphics hardware do extra work.

In the past, the problem of large models has just been solved with faster and faster hardware. Models have surpassed a level of complexity that will be solved by hardware alone though. It is no longer feasible for hardware to just render faster, the application must now render smarter in order to visualize these large datasets. Rendering smart is not an easy task though, so we are developing DirectModel to provide a frame-work that application developers can use to bring this "smart rendering" to their application. When an application uses DirectModel, DirectModel will handle all drawing of the 3D graphics. This allows DirectModel to do performance-enhancing operations like removing all the unnecessary polygons from the scene. As you can see in the image on the top of the next page, often when you are looking at a model there are large sections that are unseen.

When using DirectModel, these polygons will not be drawn, thus increasing the performance. This algorithm is called view-frustum culling, or removing polygons that are outside your view. Polygons that are outside the view are not the only ones that DirectModel can remove though, it can also remove polygons that are hidden behind objects in your scene.

Imagine that we are looking at a CAD model for a racing car as in the pictures below. This car has many parts that are hidden from view under the body. In the picture below and to the right, you can see that there are many detailed parts in this car, but if we are only interested in the view on the left we do not need to

draw them. The engine and parts are occluded from our view and with some help from the new HP-VISUALIZE-fx line of graphics cards, DirectModel



**View-Frustum Culling:** When a person is looking at a model, much of that model is out of view. DirectModel will not draw that geometry.

can find these parts that are occluded and remove them. This simple operation can increase application performance by a factor of two or three in models with many of these hidden polygons. There comes a time though that the graphics system is still overwhelmed even after DirectModel has removed as many polygons as it can. When this situation occurs, DirectModel provides a mechanism to simplify the model itself.



**Occlusion Culling:** If we are trying to interact with the car at the left, there are many parts that can not be seen. As you can see in the car on the right, there are parts that would be removed when using HP-VISUALIZE-fx graphics cards and HP DirectModel.

Model simplification is a very powerful tool that allows DirectModel applications to achieve the goal of interacting with very large models. When the model is too big for the graphics system to handle interactively there is only one way to bring the interactivity back, make the model smaller as far as the graphics system is concerned. This means we



**Simplification of a model:** The model on the top is the original while the model on the bottom has been simplified. As you can see, the parts are much rougher but still hold their general shape.

need to reduce the number of polygons that make up the model. As you can see in the images on the left it is very nice to see a model with nice smooth corners and rounded parts, like the top image, but if that comes at the cost of not being able to interact with the model they can seem less important. When moving a model to find a particular piece or view, a simplified view like the bottom image certainly gives you enough visual clues to identify your part. When you are done moving and interactivity is no longer required, DirectModel will return to the nice smooth original view. Once these simplifications have been created. DirectModel chooses the appropriate simplifications for a given set of criteria. If the person using the software wanted to navigate through the model at a constant frame rate of say ten frames per second, DirectModel would choose the appropriate simplifications until it ran out of time. If the person using the software wanted to just choose a constant simplification level, DirectModel can do that too. As you can see

simplification is one of the powerful tools that DirectModel has at its disposal, and its flexibility and controllability make it one of the most powerful.

Along with tools to reduce the amount of information that DirectModel sends to the graphics card, DirectModel also makes sure to use the graphics card to the best of its abilities. This is true if application is running on a new HP-VISUALIZE-fx graphics system or one with no graphics accelerator. DirectModel will run on almost any graphics card, and almost any computer from a Windows NT/95 PC to a HP-UX workstation. It will also run on computers other than ours including Sun, SGI, IBM and Digital machines. DirectModel is truly multi-platform and will tailor itself to make the best use of the system that it is running on. You will not see the same image of the same part when you are navigating on a laptop PC that you would on a high performance workstation, but you can still interact with the model. This difference in image comes as a result of the simplification that we mentioned in the last paragraph. On a workstation DirectModel can choose better versions of the model since there is a lot of graphics performance on the machine. When there is not a lot of graphics performance, like on a laptop PC with no graphics acceleration, DirectModel must choose lower quality versions of the parts to keep the interactivity. The fact that you could look at a million polygon model on a laptop is quite amazing though.

Amazing is a word that many people have used to describe DirectModel. DirectModel contains many ground-breaking technological enhancements. The technology in DirectModel will allow designer's like yourselves to reach a whole new level of interactivity with your designs. No longer will you be relegated to looking at just a small part of the model, now you can look at the whole model. DirectModel powered applications will help you do your job even as problems become large and much more complex. We at HP are driven to provide you the best possible solutions to your engineering problems, and we think that DirectModel is one of these solutions. There are also many application developers who share this idea too, MacNeal-Schwendler is one of them, so they have decided to bring DirectModel to you.

### MSC/SuperModel and HP DirectModel

When the developers at MacNeal-Schwendler first heard about DirectModel, they thought of one application that needed its technology before all the others: MSC/SuperModel. Since MSC/SuperModel is "an analysis process management and advanced aerospace modeling solution that dramatically reduces the time required for design simulation" [2], performance is critical. There are a few particular operations that really require graphics performance, and that is where we are going to first integrate DirectModel.

With the advent of DirectModel technology, one of the features that MSC/SuperModel will be able to provide the designers and engineers is the ability to preview an assembly of component models prior to analysis. By taking advantage of DirectModel's ability to quickly load the submodels, a person using the software can be presented with a graphical view of the model within seconds. This reduced time to load is achieved by only loading the finite elements (as polygons) and none of the engineering data (element properties, material properties, or others) or relations. This fits exactly what MSC/SuperModel needed to achieve for its desired model preview functionality.

The current vision of how DirectModel and MSC/SuperModel will work together is, users will be given the option to preview an assembly of selected components. When the preview option is selected, a DirectModel application will open each MSC/PATRAN database, read the FEM data from it, and translate the FEM data into the DirectModel format. In the translation process, simplifications for the parts are also created. This allows DirectModel the ability to choose the correct level of detail for the given viewing parameters. The person using the software can easily navigate through their data, and determine if all their submodels line up as expected. Since the spatial alignment of submodels can be determined before submitting the job for analysis, the entire process of generating a valid SuperModel analysis can be accelerated. Although the file translation process from an MSC/PATRAN database to a DirectModel database is very quick, it is also possible to generate DirectModel data before hand and store it as part of a SuperModel File Manager logical file. If the DirectModel files are already present, load times for previewing an assembly of components will drop to just seconds. The view will start with the simplified version of the model, and then as time progresses the normal simplification will be read in. No longer are you stuck waiting at a blank screen for your submodels to load in, you see something very quickly. Since reducing the number of invalid analysis runs will directly reduce overall modeling time, this DirectModel solution was a very logical choice for integrating with MSC/SuperModel.

## Conclusions

Hewlett-Packard and MacNeal-Schwendler are both committed to bringing you the best tools to help you solve your problems. MSC/SuperModel is a great example of this in the Aerospace business. MSC/SuperModel has been designed to save you time in your model analysis and using DirectModel will help to achieve this goal. By providing a high performance 3D graphics frame-work for MSC to use in developing their applications, HP has once again shown that we are here to help solve the problems you deal with every day. MSC/SuperModel may be the first of MSC's suite to adopt DirectModel, but should not be the last. In the future all of the MSC application suite may be based on DirectModel. The future also holds a lot for DirectModel. There are going to be new versions with new features and technology to help you do your job better, easier, and faster.

# References

[1] DirectModel White Paper, Hewlett-Packard, 1997. http://www.hp.com/go/DirectModel

[2] MSC/SuperModel Solutions for CAE Process Management and Advanced Aerospace Modeling, MacNeal-Schwendler Corp. 1997. http://www.macsch.com/aerospace/SuperModel/smindex.html