

HTML- and VRML-Based Results Reporting for MSC/DYTRAN and MSC/SuperForge

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ABSTRACT

MSC/DYTRAN is a general-purpose, 3D, transient, non-linear, explicit finite-element and finite-volume analysis program. Post-processing MSC/DYTRAN models is difficult because of the large variety of problems and the fact that models may include large deformations, failed elements, fluids, fluid-structure interaction, and fluid free-surfaces. The amount of data generated by an MSC/DYTRAN calculation can be over whelming, especially for the novice user.

Traditional results inspection methods use ASCII-based output files for summaries and error messages, and the most common visualization method is to use powerful post-processing software tools such as MSC/PATRAN to view the MSC/DYTRAN results stored in binary results files.

A new method of results inspection will be introduced. MSC/DYTRAN will automatically generate an HTML and VRML based report, which provides access to the results in a structured, fast and easy way. The results are web-based, and can thus be shared directly with others.

INTRODUCTION

MSC/DYTRAN is a general-purpose, 3D, transient, non-linear, explicit finite-element and finite-volume analysis program. MSC/DYTRAN is used to simulate problems such as bird strike on aircraft, aircraft crashworthiness, water impact of aircraft and spacecraft, automobile crashworthiness, occupant safety, airbag inflation and occupant interaction, explosion containment, weapons effects, and hypervelocity impact.

Results inspection for MSC/DYTRAN models is difficult because of the large variety of problems it is used to simulate and the fact that these models may include complex features such as large deformations, failed elements, fluids, fluid-structure interaction, and fluid free-surfaces.

The amount of data generated by an MSC/DYTRAN calculation can be overwhelming and cumbersome, especially for the novice user. Traditional MSC/DYTRAN results inspection methods use ASCII-based output files for summaries and error messages, and the most common visualization method is to use powerful post-processing software programs such as MSC/PATRAN to view the MSC/DYTRAN results stored in binary results files. MSC/DYTRAN users must learn how the results are organized by file and how to use these post-processing software programs in order to evaluate their MSC/DYTRAN simulation.

A new method of results inspection will be introduced. Now MSC/DYTRAN will automatically generate an HTML and VRML based report, which provides access to the results in a structured, fast and easy way. The results are web-based, and can thus be shared directly with others. Eventually this system will be enhanced so that these results can be generated automatically at the end of an analysis and an email could be sent to the user with a hyperlink to the results report. Or a report could be created and updated during a simulation so the user and other interested people could monitor the analysis to make sure it is working correctly.

PROBLEM DEFINITION

Presenting MSC/DYTRAN analysis results is a difficult task. MSC/DYTRAN is used to model highly nonlinear, transient events so results must be presented in deformed shapes and must include 3 space dimensions and animate over time. In addition MSC/DYTRAN includes both finite element and finite volume technology. So results must be presented using tools typical for structural meshes such as fringe plots, deformed shapes, etc. as well as using tools familiar to the Computational Fluid Dynamics (CFD) community such as isosurfaces, isovolumes, vector plots, cutting planes, streamlines, stream surfaces, etc.

Adding further complication MSC/DYTRAN problems frequently deal with impact, explosions, and severe deformation. Material failure is included in MSC/DYTRAN so the results visualization must allow for the failure and removal of elements over time.

Interactive Post-processing Programs

Interactive post-processing programs such as MSC/PATRAN are currently the most common method of visualizing MSC/DYTRAN results. These tools are general purpose, they are designed to visualize a variety of structural and/or CFD analysis results

such as MSC/NASTRAN. Typically some customization is required of these tools so that they can be used to postprocess MSC/DYTRAN results. Such customization should include file readers to import the archive files, support for failed elements, enhanced animation capabilities, and strong support for fluids visualization. Since a considerable amount of data must be processed for an accurate understanding of the problem postprocessing performance is critical. However these basic requirements: interactivity, performance, general-purpose, and custom features are fundamentally opposed. Compromises are inevitable.

The most common problems with interactive post-processing tools for MSC/DYTRAN are slow performance, inadequate fluid visualization, and lack of support for failed elements. Additional problems include the cost of these tools, their complexity, and the required time to master all their capabilities.

Sharing Results and Animations

Then there is the problem of sharing the results with customers, management, and collaborators. These people may not have access to or the skills to use these interactive programs. Typical methods of sharing the results of a MSC/DYTRAN simulation include written summaries culled from the various text output, printed graphs of x-y data, and visualizations of the results in snapshots of time. Sometimes small snapshots are printed in sequence so the recipient must glance quickly from frame to frame to gain insight into the results.

A more effective method of conveying an understanding of the simulation results requires the creation of animations. These animations are typically created and saved in the proprietary format of the interactive post-processing tool. This places a burden on the analyst to “show” the animations to managers, customers, and coworkers via the interactive tool or a burden on these people to install and learn the interactive tool in order to view the animations. A solution to this problem is the adoption of standard animation formats which can be played back as simply as playing a video tape. The animations can be transferred by email or file transfer.

However, there are problems with attempting to share animations of simulation results. One problem is that some interactive tools do not yet support writing animations to standard formats such as MPEG, AVI, QuickTime. Another problem is that these formats are not standard across all computer platforms, QuickTime is prevalent on Macintosh computers and available for Windows PC, but is not available for UNIX computers. AVI is common on Windows PCs but much less so on Macintoshes and is not available on UNIX computers. MPEG is the format most universally supported among the three formats, but is not always or universally supported by the major computer platforms as standard. Additionally these formats have sub variations in compression, file format, etc. that sometimes make playing back an animation unsuccessful. These animations have a common limitation, they are strictly 2D. The analyst must prepare the animation in the way he considers to be most suitable for the recipient to understand the results, or multiple animations have to be created showing different zoom levels, perspectives, and result sets. This process is always a compromise between the analyst’s time, number of files to be sent, number of required views, number of result sets to be included, and the needs of the recipient. A final shortcoming is that the animations are stored in a raster format from which the original data cannot be easily

extracted. Animation files are thus inefficiently large, holding much data which is completely irrelevant to the results. For example an animation will include data representing the background. File compression is frequently employed to overcome this shortcoming but results in throwing away resolution and relevant data. And the animation does not store the results but rather just a picture of the visualized results.

Job Monitoring

Currently MSC/DYTRAN does not provide much “quick look” capability so that the user can determine the simulation status while it is running. Typical use includes asking for cycle and material summary data in a text output file, checking back from time to time. Although it is possible to read the archive files up to the point that they were last updated using the interactive postprocessing tools, there is no functionality to just grab an update and view it. Nor is there the capability to “watch” the simulation as it is unfolding. For these reasons MSC/DYTRAN is typically used in a “run and wait” mode rather than “run and watch” mode. Monitoring an MSC/DYTRAN job is unnecessarily cumbersome and intensive.

The goal of introducing VRML- and HTML- based results reporting was to address these shortcomings in the currently available tools of the MSC/DYTRAN user.

DESCRIPTION

In March 1999, MSC/DYTRAN V4.6 for the Windows NT , the capability to create VRML files from MSC/DYTRAN results was provided for the first time. The capability is quite limited offering no variable results, no animation, no custom navigation aids, no ability to hide parts, and no capability to combine the results into a single assembly. However the importance of that capability was that it laid the foundation on which we can easily improve and distribute to the MSC/DYTRAN user.

Creating a VRML file

The MSC/DYTRAN for Windows NT application introduced in V4.6 is shown in Figure 1.

Using the capabilities as provided by MSC/DYTRAN V4.6 requires that the user double click on an archive file (.ARC). This assumes that the preference “allow creation of VRML files after clicking archives” has been selected. The preferences available for VRML are shown in Figure 2.

Figures 3 and 4, respectively, show the output files listing before and after clicking on an archive file. The VRML files (.wrl for “world”) are generated in batch mode so that the user can quickly view the results of the simulation. The VRML files can then be viewed in the default browser, equipped with a VRML plug-in. Hand over to the browser is automatic if this option is set in the preferences.

Creating a VRML- and HTML-based Report

To generate more advanced VRML files and supporting HTML files that make up a results report the arc2vrml translator was modified. To use the new translator it is now necessary that a small file named “arc2vrml_case.txt” be created and present in the directory which contains the results files. Here is the arc2vrml_case.txt file used in the examples of Figures 1-4:

```
PROGRAM DYTRAN
ModelName demo1
DEMO1_AIRBAG_0.ARC
DEMO1_ELLIPS_0.ARC
```

The contents are simply the name of the program that created the results (DYTRAN, SuperForge, or DropTest), the name of the model, and the archive files to be translated. This file must currently be manually created or copied and modified but a graphical user interface is being developed to automate and simplify this process.

Translation still requires only that the user double-click on an archive file, this starts the translator which reads the arc2vrml_case.txt file for instructions and writes out the VRML files. Figure 5 shows a series of screenshots taken of the resulting VRML file by stepping through the VRML file. As shown in the screen shots navigation and display tools are provided by the standard CosmoPlayer viewer and we have added to those animation control buttons to step through or play the results. We have also provided for hiding parts of the results which is particularly useful for large, multi-part assemblies.

Updates

New capabilities, as described in this paper, add to the existing framework without any modification to the MSC/DYTRAN V4.6 user interface. As new capabilities become ready for release they can be made available via the Internet and separately installable over the current capability.

DISCUSSIONS OF FUTURE DIRECTIONS

Currently we have developed only the basic framework of functionality. Results are limited to deformed shapes, including failed elements. Fringe plots and other results methods are not functional as of this writing. Additional navigation aids are needed. Automation features such as email notification and job monitoring have not been implemented. Parts are assigned colors according to the archive file that they came from in a preset way. These are all examples of enhancements that are needed. However as new features are added it is critical that the conversion process remain simple and easy.

Currently there is little control offered to the user on the conversion to VRML and HTML reports. The archive files to be converted to VRML is nearly the only data used by the report generator. Additional options like those above will be devised and added. Currently the conversion process is controlled by a simple text file. A utility with a graphical user interface is being created which will offer the options for the batch conversion. This utility will eliminate mistakes caused by hand editing the controlling text file and further automate the conversion process.

Additional ease of use can be provided to the user by including conversion instructions embedded in the MSC/DYTRAN input deck. It is currently proposed to make these instructions inside the comment lines of an input deck making them completely invisible to MSC/DYTRAN or a utility unless it is specifically looking for these instructions. The advantage is that once it is determined how an analysis should be visualized, the instructions can be saved with the model and reused. They can also be used as a company or group standard.

After embedding instructions in the input deck the logical next step is to create the VRML report automatically at the end of the simulation. It is also anticipated that viewing the simulation results during execution is desired and would have significant improvements in productivity, a simulation which is off track will be noticed much quicker and corrections can be made and the simulation restarted.

To ensure that collaborators are able to view some MSC/DYTRAN results it may be a useful option that the results are stored with the necessary viewer in a single executable file. The resulting file will be more portable and convenient than requiring the recipient install a VRML plug-in for what may be a one-time event. The executable itself may permit the results to be separated from the player.

Since VRML is relatively new technology being developed by a large number of people with very diverse goals in mind there will undoubtedly be additional developments now we are not even beginning to consider. Multi-user support is one obvious area which we have no concrete plans but which would obviously be useful in supporting presentations and collaborative post-processing and data interpretation.

CONCLUSIONS

VRML- and HTML-based results reporting offers several advantages to the MSC/DYTRAN user over current interactive post-processing tools. Key advantages include a 4D format, support for changing connectivity such as failed elements, low cost, low complexity, low training, portability across hardware platforms, and compatibility with the Internet. Yet, VRML- and HTML-based reports in no way prevent advanced users who still want to use interactive tools from doing so.

Advantages of using an industry standard such as HTML and VRML make definition, development, and distribution of a viewer unnecessary, users already have a HTML viewer on their computer and there are several free VRML viewers, such as CosmoPlayer, available as plug-ins to standard web browsers. Training on how to use the viewer is also eliminated since the user is probably already experienced in HTML through other activities and the use of VRML is growing more common. For the advanced user the VRML file can be viewed and edited using a simple text editor. So MSC/DYTRAN customers can benefit from the advances made over time by the entire VRML community. They are not locked into the limitations of a proprietary solution.

The introduction of our VRML and HTML-based reports will improve the sharing of results, results interpretation, and analysis collaboration. VRML has advantages over other industry standards for animations in that it is a format for 4D (3D + time) data whereas animations are strictly 2D + time. So it is not necessary for the analyst to predefine the best viewpoints and results sets, they can all be included and the recipient can explore the data with limited but easy to use navigation and other choices readily available. VRML is a vector format and 3D so the resulting file is larger than a single animation file but smaller than multiple animation files of the same simulation, and there is no resolution penalty for zooming in on areas of interest. VRML-based reporting means more people can review results and offer insight and interpretation.

Finally VRML and HTML-based reports will enable easier more natural job monitoring. This will greatly decrease the model debugging process as mistakes will be caught more quickly.

Overall it is expected that using MSC/DYTRAN will be much more satisfying, efficient, and more collaborative with this new capability.

ACKNOWLEDGEMENTS

ABBREVIATIONS AND TRADEMARKS

HTML – Hypertext Markup Language

VRML – Virtual Reality Modeling Language

MPEG – Moving Picture Experts Group

QuickTime – Apple Computer

AVI – Audio Visual Interface, Microsoft

REFERENCES

FIGURES

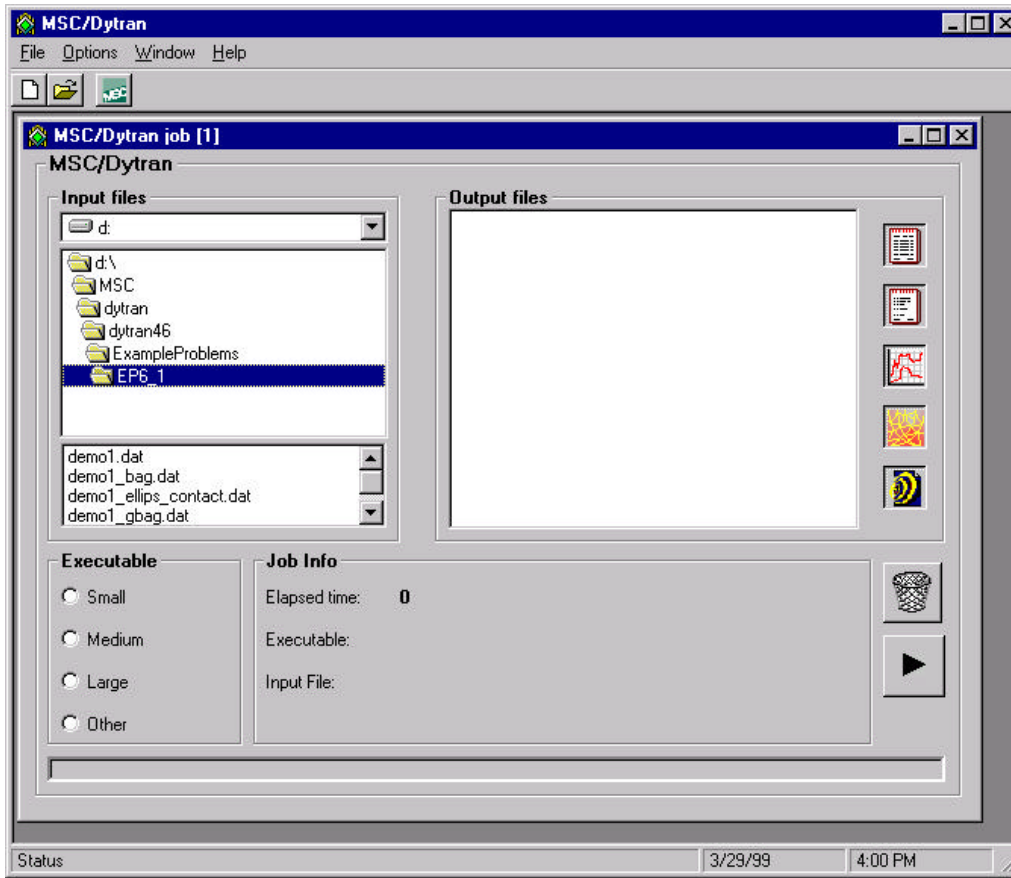


Figure 1. The MSC/DYTRAN V4.6 for Windows NT user interface.

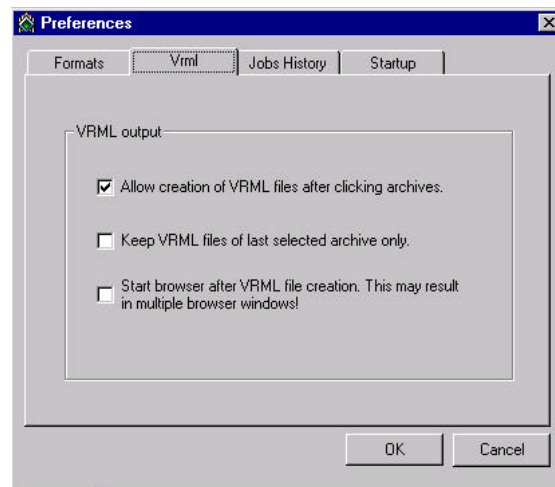


Figure 2. VRML creation preferences available in the MSC/DYTRAN user interface.

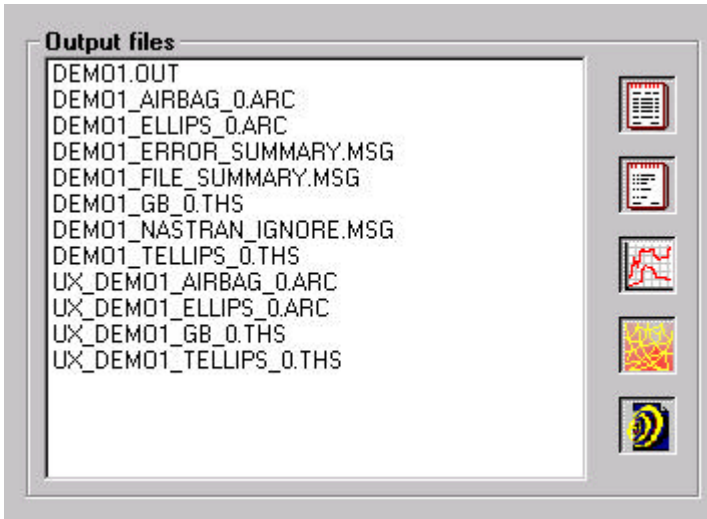


Figure 3. MSC/DYTRAN output files listing before VRML conversion.

Note: Double-click on an archive file to convert to VRML. Arc2vrml_case.txt file must be present for translation control. Result is shown in Figure 4.

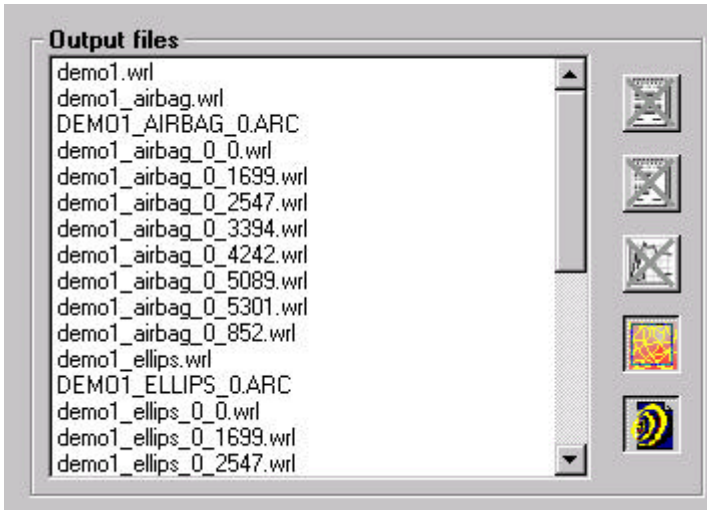


Figure 4. MSC/DYTRAN output files listing after VRML conversion.

Note: Message files (.MSG), Output files (.OUT), and Time-History files (.THS) are filtered out by the buttons on the right of the listing. Only Archive files (.ARC) and VRML files (.WRL) are shown.

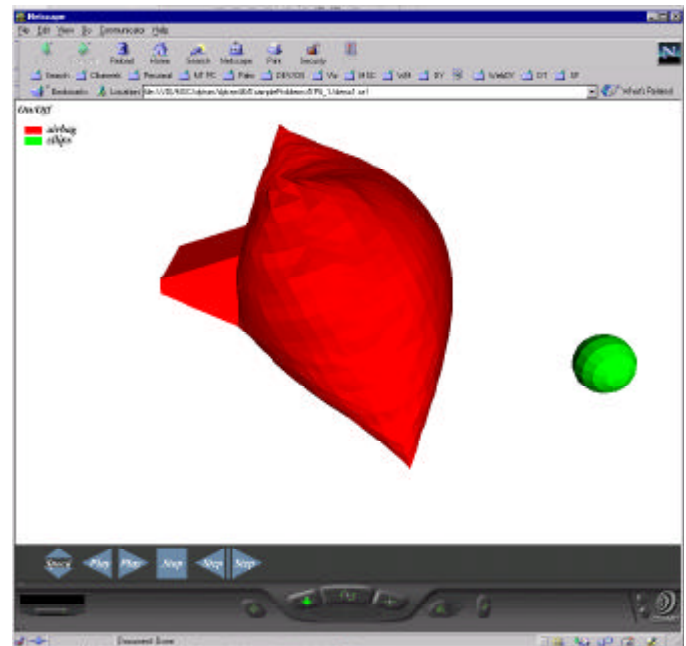
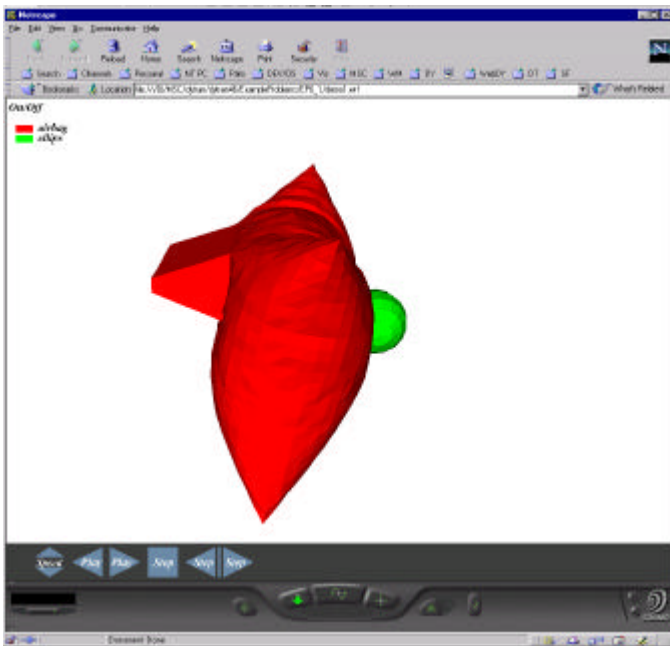
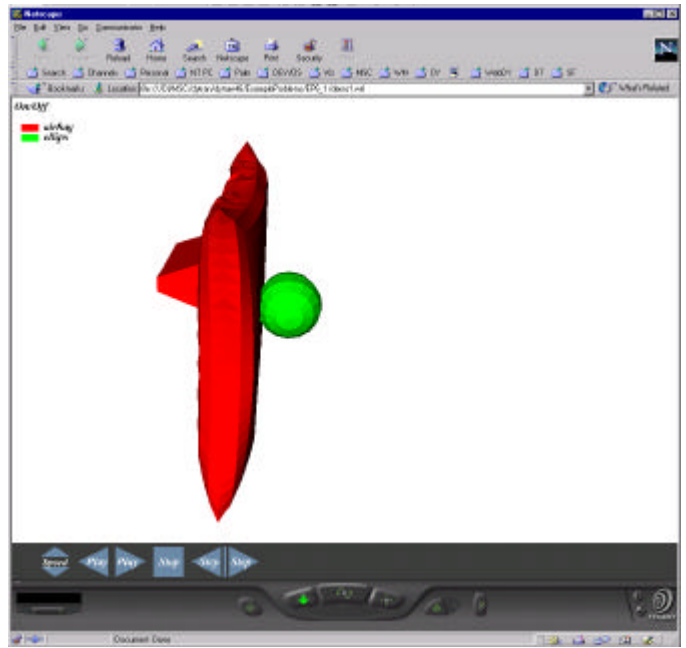
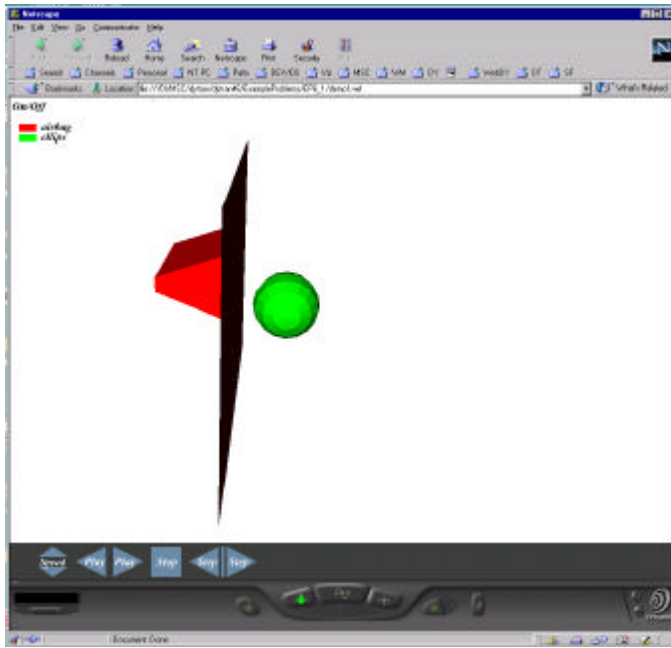


Figure 5. MSC/DYTRAN VRML Results.