

Power Tools for Visualization of Information

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ABSTRACT

The sheer volume of data now confronting the scientist or analyst has grown to a point where traditional tools have been rendered obsolete. To glean subtle trends that might be hidden in the mass of multivariate data demands the usage of new tools designed to handle these situations. This paper will describe the functionality of SAS/SPECTRAVIEW™ software and how it can be used for visualization of data. This paper will also discuss new possibilities in three dimensional visualization and interaction with data using VisualSpace™ software.

AN OVERVIEW OF SAS/SPECTRAVIEW SOFTWARE

SAS/SPECTRAVIEW is an interactive data visualization tool. It enables users to interactively explore relationships and trends among large volumes of data, and SAS/SPECTRAVIEW can visually analyze up to five variables simultaneously. In this paper we will use two sample data sets that are supplied with SAS/SPECTRAVIEW software, one financial and the other scientific, to demonstrate some of the capabilities of the software.

The financial data set represents mortgage payments for varying loan amounts over a range of payment years and interest rates. Loan amounts vary from \$100,000 to \$200,000. Interest rates vary from 6% to 12% per year. Finally, mortgages vary from 15 to 30 years. This data set was produced using a DATA STEP and the MORT function, and it has 16,400 payments values (observations). Several questions you might ask concerning these mortgage payments can be answered by SAS/SPECTRAVIEW.

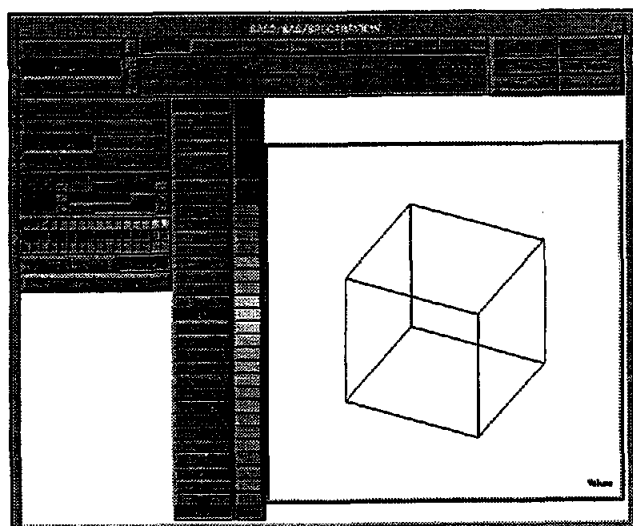


Figure 1 - SAS/SPECTRAVIEW data ramp. The ramp matches a user definable color to a given response value.

Assume you can afford mortgage payments of \$1500 per month. The first question you might ask is "How large of a house can I afford?" The answer to that question, of course depends on the interest rate and loan life. First, to help you in your analysis, you might change some of SAS/SPECTRAVIEW's parameters. For example, you can interactively change the default color palette in SAS/SPECTRAVIEW to match your analysis needs. By examining the color palette, we see that the lowest payment is just under \$600 dollars. We set the color that corresponds to this value to bright green. Next, we picked a value that is close to our \$1500 limit and set its color to yellow. Next, we set the highest payment value to bright red. Finally, we turn off all other color interpolation "stop" points. Figure 1 shows the result.

We could sort the by rate and loan length and print them, but there would be several groups and values. We could also use SAS/GRAPH to plot payments the same way, but again there would be several plots. SAS/SPECTRAVIEW provides an easier method to answer our questions. By selecting "Tools" and then selecting "Planes", you can sort through the large volume of data. You can examine a plane of values where one of the three axis variables (Interest rates, Loan Amounts and Loan Length) are held constant. To examine a plane of constant rate values, select the "Rate" plane push button. Selecting this button displays a pop-up menu with several choices. Selecting "3D Surface" from this menu turns on a cutting plane for this variable along with a three dimensional surface. The cutting plane is shown in the "Volume" view (upper left panel) and the surface is shown in the corresponding planar view (lower left in this case). The plane and surface show us payment amounts as a function of both loan period and loan amounts. The rate is constant and shown at the top of the surface view. The payment values are color coded based on the color palette we set earlier. You can change the value of the interest rate shown by moving the cutting plane in the Volume view. You simply select the "Xform" button at the top of SAS/SPECTRAVIEW and then select "Move plane" from the top right set of buttons. If you move the rate plane to 6%, the lowest value, both views update to reflect payments at this interest rate. The entire plane and surface is green, except for the \$200,000 and 15-year corner. This means you can afford a house as long as you don't pick a \$200,000 house with a 15-year mortgage.

Now lets look at the higher interest rates. Again by moving the plane, to 12%, the highest value, we see more information about the payments. Figure 2 shows, that for the highest loan amount, \$200,000, the entire edge is either red or orange, which means that at 12% interest, you cannot afford the \$200,000 house, regardless of the loan length. Because the entire edge of the lowest value is green, you can, however, afford the \$100,000 dollar home, even at 12% per year, regardless of the loan length.

and decays in size with time, which is typical behavior of ozone. It has strong diurnal (daily) behavior and generally is localized. If we were to examine another pollutant, like sulfate (SO_4^{2-}), we might see more of a drift in the cloud's location. The model, assisted by SAS/SPECTRAVIEW indicates that local controls of ozone generally would be more effective than local controls of sulfate since our sulfate pollution may have come from elsewhere.

Finally, perhaps we would like to examine the performance of the model as a whole, rather than examining specific output values. The "Volume" option in SAS/SPECTRAVIEW is a good tool for this task. This option allows us to view the entire set of data and cut into it as required. We can slice the volume of data from any direction as well as move our current slice through the volume. Figure 4 shows an example of this. It shows a volume of the model cut away to reveal the interior of the model. We can use this feature to examine the structure of modeled output without having to examine it one layer at a time. It also can assist us in spotting potential trouble areas in the model.

SAS/SPECTRAVIEW contains many more features that we have not discussed in this paper. For example, cutting planes are not limited to orthogonal planes, we can change other attributes, annotate our graphics, as well as save them for presentations or editing, as well as many other features. We have only discussed some potential uses of the software. SAS/SPECTRAVIEW has many other applications, in which large volumes of data can be evaluated in a timely and efficient manner.

AN OVERVIEW OF VISUALSPACE™ SOFTWARE

Newly released VisualSpace provides a set of tools for visualizing three dimensional data. It's three major components are VSmodel, VSlight, and VSwalk. This integrated tools set lets you create, import, light, and visualize three dimensional data.

VSmodel

VSmodel offers users an intuitive, easy-to-use, tool for building virtual worlds. The basic design philosophy of VSmodel is to

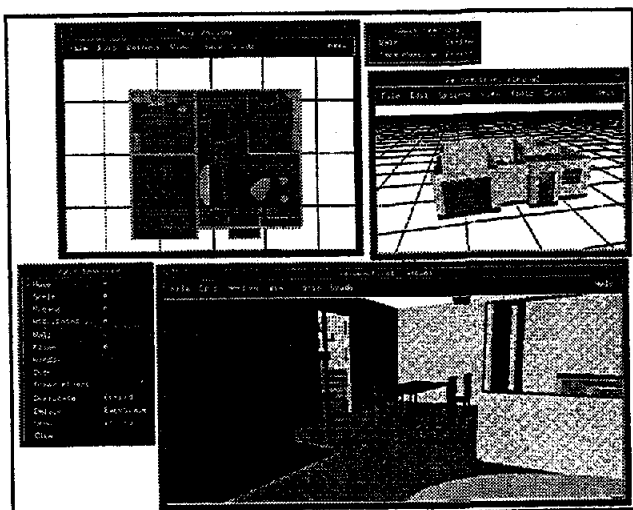


Figure 5 - VSmodel offers multiple windows, tear off menus, hierarchy and a rich set of library.

protect you from being overwhelmed by the intricate details of model building. To achieve this result, two approaches were used when designing VSmodel.

First approach lets you create models at a higher level than creating each individual polygon. It lets you create models with higher-level primitives (such as floors, walls, doors, windows, and so on) rather than requiring you to create every facet of the model. Also there is a rich library of objects from which to choose to speed up modelling. Currently there are approximately 150 objects in this library, ranging from furniture to roof systems. You can also extend this library with models that you create.

The second approach is to build other rules into these primitives to enable the software to resolve some of the relationships. For example, if a wall contains a window, repositioning the window within the wall will recreate the polygons that make up the wall. These rules will not allow the window to spill outside the geometry of the wall.

Creating and editing the models are done with the use of several resizable windows. These windows can be thought of as portholes to the virtual environment. You are not restricted to any number of windows or projections, and you can create as many isometric and perspective windows as you desire. Immediate graphical feedback is always provided for all windows when objects are added or manipulated.

Edit racks enable you to edit the objects. These racks are placed around objects when they are selected, and the handles on the racks are used to perform the manipulations. You can edit a single object, related objects, or multiple objects that are selected together. You can sort through the selected objects to find the ones out of a group that consist of objects that are close or on top of each other.

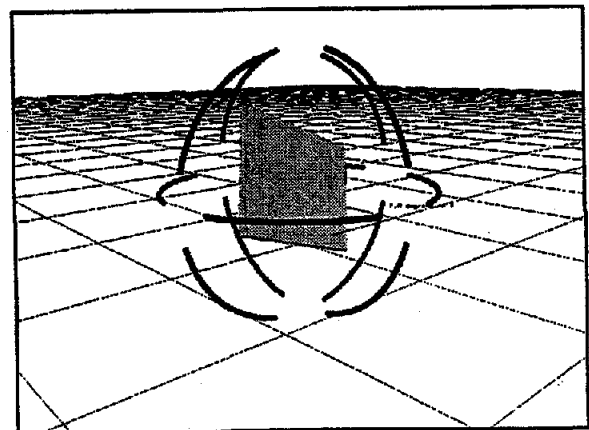


Figure 6 - The use of edit racks ease the transformation of objects even in perspective views.

The user interface uses pulldown menus, which can be "torn off" the menu bar and placed at a convenient location for frequent use. Keyboard accelerators enable more experienced users to speed up the modeling process.

VSlight

VSlight uses models generated by VSmodel and applies global illumination techniques to add realistic lighting effects to the models. The rendering techniques of VSlight differ from traditional rendering techniques that produce a pixel-mapped image of a single view and that a substantial amount of time to calculate. Radiosity, the global illumination technique used in VSlight, produces a view-independent solution, soft shadows, and color bleeding to give depth and realism to the model. VSlight does not produce a visible image. Instead, it creates a file, with the lighted model, that contains all the data from the input file from VSmodel plus shading information for each surface. With the lighted model, VSwalk can interactively view the shaded model from any vantage point.

The Radiosity technique applies the radiative-heat transfer equation to solve the lighting problem. Lights that are defined in VSmodel send light energy to surfaces in the model, and those surfaces in turn bounce light back to other surfaces. As the energy is accounted for, the light solution becomes more accurate. The user is allowed to "preview" the lighting solution at anytime to decide whether or not a solution is acceptable or if further refinement is needed. This preview or intermediate result is an approximation of the final result. Initial solutions are very coarse and may not have all the light-emitting objects processed but, the whole of the model can be visualized. With this progressive refinement, a user can start the calculations, see results immediately, and receive updates that show new lights emit light or a shadow that becomes refined over time. This lets feature enables you to adjust and decide on the quality of the outcome.

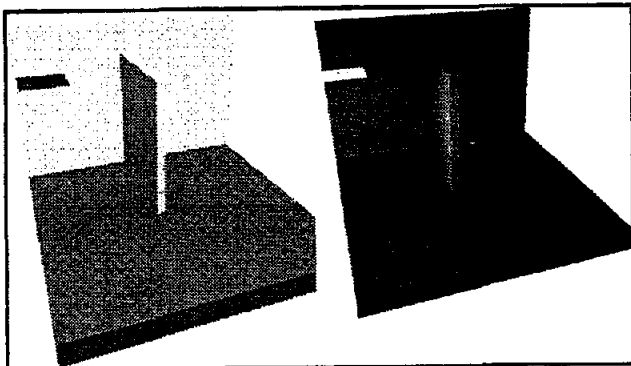


Figure 7 - The model on the right is rendered with VSlight and the one on the left has flat shading with phong lighting.

VSlight creates its lighting effects by sampling light energy at different points along a surface. The more sample points you have the better and longer the solution will take. Quicker, and less accurate solutions can be generated by limiting the number of sample points. If there are instances where the color or intensity of adjacent sample points differs greatly, VSlight realizes that the solution requires more precision and subdivides these polygons until these differences are not as great. This procedure is called adaptive subdivision. Other effects such as color bleeding and the intensity of shadows are controlled in VSmodel by assigning color and reflectivity to the surfaces and the power and color of lights, to give the user control of how the scene will look.

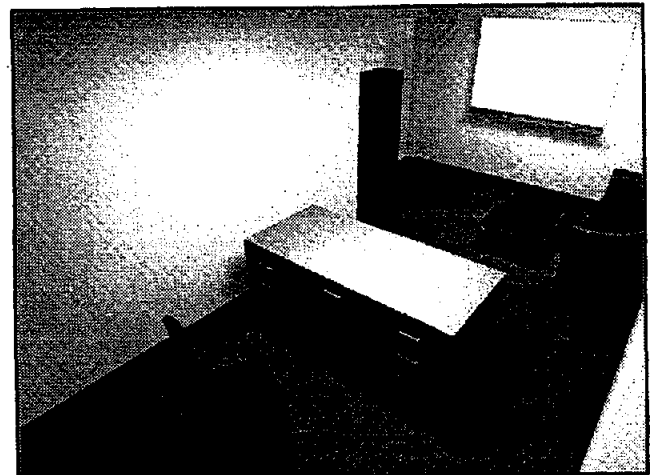


Figure 8 - A scene from VSwalk with a rendered scene by VSlight.

VSwalk

Vswalk is an interactive high-performance navigation tool that enables you to move around the virtual environment in real time. The virtual environment can be the model created by VSmodel, the lighting solution by VSlight, or imported models from .dxf (drawing exchange format) files.

The three dimensional model created by VSmodel is illuminated using VSlight's global-illumination technique to generate a lighted model that is view independent and that looks realistic. VSwalk takes the file created by VSlight and builds a virtual model in which the user can navigate.

Designed for speed and movement, VSwalk enables users to move about freely in the model by using the mouse as an input device and a set of intuitive navigational controls. Quicker refresh rates and higher speeds of movement are achieved by putting together the polygons in a flat structure to create the three dimensional model, instead of storing them in a hierarchy of primitives like the modeler does. VSwalk also takes advantage of the fact that the model it is fully lit with shadow effects and shading that are already taken into account by VSlight. Therefore, VSwalk does not waste precious cycles trying to light the model in real time.

The navigational controls mimic the way human beings maneuver in the real world. In VSwalk, mouse movements govern the position of the focal point of the view-camera within the virtual world. The movement is accomplished by giving a certain speed to the eye point, and moving the focal and the eye points in the direction of the established view vector. When they press the first mouse button, users are able to move into the virtual model in the viewing direction, while the second mouse button reverses the direction of movement. The position of the cursor, with respect to the center of the view window, determines the viewing direction as well as the speed at which users moves about the eye point.

Interactive Updates from VSlight

In accordance with the strong inter-relationship that the three components of VisualSpace product exhibit, the VSlight and VSwalk components, also are able to communicate to each other for the purposes of interactive lighting updates. In other words, once the VSwalk component opens a file that is currently being generated by VSlight, users can press a CTRL-u in the VSwalk window to see the updated model as the lighting calculations progress. As the effect of each light in the model resolves, VSlight updates its out, put file which is reflected in the model that is loaded in VSwalk. This is a very convenient way to observe the progressive refinement of the lighting solution.

Multiple Path Recording and Playback Feature

VSwalk enables users to create and record predetermined paths through the model and store those paths in files. These paths can be used immediately or read from a file at a later time and played back in two different methods. The first method is called fixed playback. It enables users to playback the pre-recorded path based entirely on the recorded information. Both the eye and the focal point locations are derived from the pre-determined path. Whereas, in the free playback method, enables users to change the focal point (or the viewing direction) while the eye point follows that was recorded earlier.

Height Lock and Other Features

Height Lock

Height Lock enables you to lock the height of the eye point, and the eye point movement is restricted to a single plane. The focal point is still free to move in any direction.

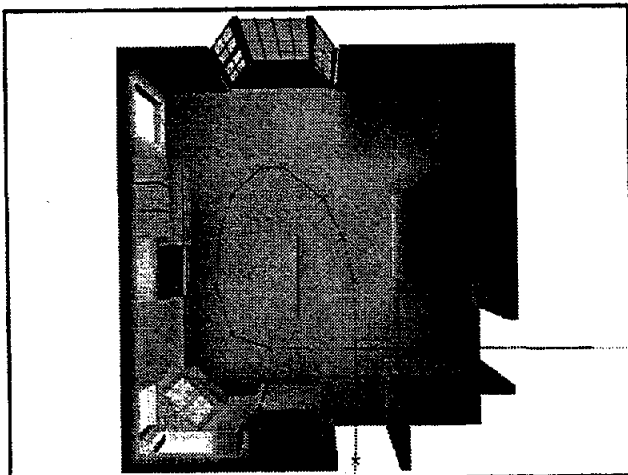


Figure 9 - The recorded path is shown on the top view. Notice the depth provided by the perspective projection, and the effect of the cutting plane through the model.

Isometric Controls

These controls are only applied to the isometric views. The Depth On feature lets you toggle between a parallel projection and a perspective projection. Switching to perspective projection adds depth to the isometric view. The Set Cutting Plane option will enable you to pass a cutting plane through the model parallel to the isometric view that you choose. By doing so, you can observe objects that were hidden behind other surfaces.

Perspective Controls

These controls are applicable to the perspective view only. On this panel, you will find Field of View and Speed that enable you to change the viewing angle of the perspective camera and the speed at which you navigate through the model respectively. The Up, Down, Left and Right arrow buttons enable you to move parallel to the plane in which the perspective camera is located.

CONCLUSION

Recent advances in affordable high speed computers has ushered in the information age. As a result, analysts are now faced with an avalanche of information and data analysis requirements. Traditional data analysis techniques are rapidly becoming obsolete in regards with dealing with such large volumes of data. It is no longer possible in many cases to explicitly examine all data values. More sophisticated and efficient methods are needed.

The appropriate use of computer graphics technology can empower today's analyst with greater capabilities, while providing for more efficient use of available time. As a result, the analyst can tackle tasks that were not practical just a few years ago. SAS/SPECTRAVIEW and VisualSpace are two such tools aimed at today's more complex data analysis and visualization needs.

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