INTRODUCTION

In the summer of 1988, SAS Institute, Inc. acquired a three-dimensional modeling, rendering and animation software company called NeoVisuals, Inc. Based in Toronto, the company and its software propelled the Institute into an arena of programming that is one of the growth areas of our industry. Recent organizational changes combined with the constant evolution of graphics workstations and terminals have made the question, "What is the future direction of NeoVisuals?" very timely. This paper will address that question as thoroughly as possible. We are working at this time to add this excellent software package to the other fine products of the SAS system. Within the next year, there will be two new SAS products derived from the current stand-alone software. As work continues into the future, additional products and enhancements will follow, which will benefit the NeoVisuals product as well as the entire SAS system.

There is a possibility that some of you are still uncertain about what NeoVisuals is or does. NeoVisuals is a multifaceted product. It is a three-dimensional modeling system which allows you to create, or import from CAD/CAM systems, representations of real world or imaginary objects within the computer. You can manipulate their surface characteristics, control what lights illuminate them and set the desired viewing angle as part of the modeling process. NeoVisuals is also a photo-realistic rendering system. Once the model, lights, and camera angle have been established, the system determines what the eye would see and, using a variety of shading techniques, can produce a picture that is difficult to distinguish from a photograph. Additionally, it is a video-animation system. You can animate the models, lights, and camera over time to produce animations such as those you have seen in the last three SIGI opening sessions.

But a greater uncertainty may be, "What will NeoVisuals be within the SAS system?" NeoVisuals will become a SAS product which will be a three-dimensional modeling system, a photo-realistic rendering system, and a video animation system. Additionally, the functionality of NeoVisuals will be used for other new products as well as providing new graphics capability for the entire SAS system.

The objective of this paper is to highlight the first manifestations of this union and provide glimpses into the longer range plans. In doing so, we will discuss the history of NeoVisuals, the efforts of the past year, the immediate directions of the coming year, and the goals for the years following. Due to the fact that names for the upcoming products have not been chosen and/or registered, names have been selected to label them and will be written in lower case to indicate their unofficial status. NeoVisuals will still refer to the current stand alone product. Sas/vista will be used for NeoVisuals migrated into the SAS system and sas/graph+plus for a hybrid SAS/GRAPH and NeoVisuals product.

HISTORY

Neovisuals, Inc. (NVI) was founded by Steve White in Toronto, Ontario in the early 1980's. The first development platform was the VAX/VMS environment. The software was written in Fortran. When SAS Institute was first introduced to the product in 1987, the primary platform was Silicon Graphics, Inc.'s graphics workstations running their version of Unix called Irix. Ports were underway to Hewlett Packard and Sun graphics workstations as well. The Institute's video department was seeking an animation system for its productions and chose NeoVisuals Inc.'s product, VISHAD. In August of 1988, SAS Institute, Inc. acquired the company and changed the product name from VISHAD to NeoVisuals. Sales and marketing for the product was moved to Austin, Texas, while the research and development staff of Neovisuals, Inc. in Toronto continued to work on the product in that city. A group was formed in Cary, a year ago, to investigate the incorporation of the three-dimensional graphics technology into the SAS system and to convert the software to the C language. Recently, a reorganization of the sales, marketing, and R&D depart-
ments has occurred. Active marketing of the product has been suspended until the product is reintroduced within the SAS system. Sales calls and product shipment are being handled by the main headquarters in Cary. Karen Lee is the contact person for licensing the NeoVisuals software. Additionally, technical support is now handled from Cary. Call the Technical Support switchboard for any problems or questions regarding your licensed NeoVisuals product.

As the C conversion progressed, the size of the Cary NeoVisuals R&D staff grew and, concurrent with the other organizational changes, the research and development for NeoVisuals has been consolidated in Cary. This move will allow more efficient use of the personnel and equipment involved in the effort of improving NeoVisuals as it becomes sas/vista.

1989 HIGHLIGHTS

Much of the current NeoVisuals product is the result of work accomplished since its inception until the acquisition by the Institute. Similarly, much of what still lies in the future for the sas/vista product has been developed in the recent past. Therefore, the description of future directions of NeoVisuals starts with highlights from last year's work. Primarily, enhancements to the user-interface will be discussed. However, a great deal of work has also gone into converting the code to C and improving rendering performance.

NeoVisual's excellent interactive, graphical interface has been improved over the past year. Final touches to some of the changes will result in a menu-driven interface that is even more user friendly than the current design while still containing the same basic layout. The main differences will include:

- global access to the most frequently used utility functions
- a checking system to prevent a user from failing to save his/her work
- two new design interfaces which help a user learn how to create models
- increased functionality and feedback in the attributes menu

While creating an object, you frequently need to adjust features of the menu interface to create the desired model. These utility functions fall into two main categories: changing the view of the model and controlling the cursor and therefore drawing movement. Unfortunately, you must exit the modeling menu to access the functions of the utility menu. In the interface for sas/vista, these functions are constantly available on the right-hand side of the screen. Fewer button pushes, and menu changes combined with instantaneous control of modeling related features will allow you to work quicker and more confidently.

Another menu function that will be improved in sas/vista is the placement and use of the SAVE button. In NeoVisuals, you are not required to save changes made in some menus, while you are in others. Inconsistent placement of this button in menus requiring a save has increased the new user's learning curve. While this feature was designed to allow an advanced user to accomplish his/her work faster, it has also led to the loss of work by new and, occasionally, experienced users who did not see or forgot to use the SAVE button. The new menu design features a consistently and visibly placed SAVE/IGNORE button combination. If you make any modifications in a menu below the SAVE/IGNORE buttons and then attempt to leave that menu without choosing either to save or ignore those changes, you will be prompted to select either button before any other work can be done. Efforts are underway to allow you to turn off this check as you become more confident with the software.

A third major change involves the addition of new modes for model creation. Two new creation modes, called Jigsaw and Lathe, have been developed by designing new interfaces for existing functionality. The inspiration for these new modes came from observing artists attempting to create three-dimensional models using a two-dimensional input device, the mouse, on a two-dimensional screen. Since most graphics artists have already been working with two-dimensional media, the conflict is obvious. Most models in NeoVisuals start as a two-dimensional outline which is then extruded to produce a three-dimensional object. Extrusion is a process which involves copying a polygon, moving that polygon through space and connecting the resulting polygons. Jigsaw and Lathe model construction perform the extrusion automatically. As the outline polygon is designed in a planar drawing window, the extruded object can be
viewed in a three-dimensional viewing window. The names for these construction modes arose from their real world analogs. The Jigsaw method is similar to cutting a piece of wood with a jigsaw. The extrusion is linear in a direction parallel to the outline face. The depth of the extrusion as well as the number of copies can be controlled. The Lathe method is similar to turning a piece of wood. The extruded copy is rotated about the outline’s vertical axis. The degree of rotation along with the number of copies extruded are the control variables for this method.

The final major design change planned for sas/vista’s menu interface is the attribute setting menu. You use this menu to control a model’s appearance, by setting surface characteristics and rendering instructions. You can define dull or shiny, transparent or opaque surfaces in combination with a wide variety of colors. Other features include:

- shadow casting
- texture mapping
- which lights will affect a model
- gouraud or phong shading

While the current design has proven to be very useful, there are three areas of improvement. First, you are currently unable to select a model from the application menu. Second, you are unable to observe the result of attribute changes without leaving the attributes menu. Finally, approximately 25% of the space is occupied by little used features. Fortunately the third problem helped provide solutions to the first two. Some of the little used space was used to allow selection of models. In sas/vista you will be able to set different characteristics for several models without leaving the attributes menu. The remaining space is used to feedback for the model’s new attributes. A quick rendering of either the selected model or the entire scene will be available at the touch of a button. Again, fewer button pushes and menu changes will accelerate the work output. Additionally, some of the frequently set model characteristics will be available in the model creation menu.

DIRECTIONS FOR 1999

The major directions for the NeoVisuals software for 1990 are:

- inclusion of NeoVisuals in SAS as sas/vista
- develop new sas/graph+plus and SAS/ASSIST slide presentation system products
- provide a complete model library
- add support for several new platforms and devices

sas/vista

The first development direction is to add NeoVisuals to the SAS system. NeoVisuals as a SAS product will have the same look and feel as the current product with the exception of the enhancements mentioned earlier. It will also require the same level of hardware support, i.e., 3-D graphics workstations or terminals. Sas/vista will differ from NeoVisuals in its underlying host code and the support of additional 3-D platforms.

NeoVisuals, as sas/vista, will benefit from the portable nature of the SAS systems host support code. With much less effort required to support low-level host functions, the developers will have more time to add new functionality and create new applications. Rewriting the code in C will remove software memory constraints that are presently imposed. With SAS task management facility, only the currently executing module of sas/vista will need to be in memory. The complexity of models you can create in sas/vista will be limited only by the hardware’s capacity.

There will be many benefits for the SAS system as well. The design for including a three-dimensional graphics window in the display manager will be completed this year and implemented in Version 6.10. Sas/vista will be able to read SAS/GRAPH output directly in order to eliminate the use of a CGM file as an intermediary. As SAS/GRAPH increases its color capacity, sas/vista may be enhanced to write SAS/GRAPH catalogs as well. Additionally, the three-dimensional and animating functionality will be moved into the SAS system for use by other products in the future.

The first portions of the SAS supervisor which will be used by sas/vista are:

- memory management
- I/O management
- task management
- string utilities
These are areas which will no longer demand time from sas/vista development. On the other hand, sas/vista will retain NeoVisual's interface. The first release of sas/vista will use NeoVisual's command parser in line mode and batch operation. In menu mode, the menus and their management will be the same as NeoVisuals and the screen display will be controlled by sas/vista to maintain the necessary interactive speed.

As of this printing, and as demoed at SUGI 15, sas/vista is running as one SAS proc. During the next year, the main functions, such as modeling, rendering, attributes, and animation will be divided into separate tasks. These tasks may be called from the main sas/vista proc or as individual procs. Work must also be completed on accessing the SAS supervisor functions, finalizing the menu changes, and two new modeling functions.

Beveling and solid modeling are two new functions which will be added to sas/vista. Beveling is an operation used to add an extra 3-D effect to many objects, especially letters. While a beveled edge appears to be a simple move and scale extrusion, this only works for concave polygons. The bevel function will automatically divide a convex polygon into a corresponding set of concave polygons which can then be properly scaled. Solid modeling, also known as boolean operations, allow models to be combined to form new objects. The combination method can be additive or subtractive. An additive operation merges the two models into one new object. While a subtractive operation is used to cut holes or sections from a model, both of these functions represent one of the future directions of sas/vista -- adding more complex operations while keeping the user's input simple.

sas/graph+plus

The second major direction for NeoVisuals development is combining its 3-D functionality with the existing products of the SAS family. Ssas/graph+plus is the label for the first product representing this effort and will combine features of SAS/GRAPH and sas/vista. The new product will be a three-dimensional, interactive business and scientific graphics package. Ssas/graph+plus will represent SAS data as a 3-D model within the sas/vista environment.

While the benefits of three-dimensional visualization are obvious for a SAS/GRAPH proc like G3D, other traditionally two-dimensional charts will also benefit from the unique look that a three-dimensional system can offer.

The first set of SAS/GRAPH procs scheduled for inclusion in sas/graph+plus are G3D, GLOT, GCHART, and GSLIDE. The first release will require a three-dimensional graphics workstation or terminal.

As a hybrid of SAS/GRAPH and sas/vista, sas/graph+plus will use functionality from both systems. SAS/GRAPH's data access and analysis, including its grammar will be used to connect the product with SAS data sets and existing SAS/GRAPH jobs. Sas/vista's modeling, rendering, and screen display modules will be used to construct and display the model generated by the analysis. There will be two basic modes of operation. In the interactive mode, the model is constructed from the submitted proc statements and then presented in a reduced version of the sas/vista full-screen menu. At this time, you can perform many editing features such as adding or deleting text, changing the models surface attributes, changing the viewing angle, or moving the lighting location. Alternately, the entire job may be run in batch mode using new options in the proc statement. Changes made in the menu which differ from the default values of the new options will be logged for use in the future batch jobs. Jobs originally written for corresponding SAS/GRAPH procs will be given the default options so they can be run by merely changing the proc name.

As stated before, many of the new options will benefit traditionally two-dimensional charts as well as the three-dimensional charts. Here are some examples. The viewing angle and light position can be set to give unique and eye-catching perspective. Bars and lines can be 'three-dimensionalized' by transforming bars into 'ingots' or cylinders and lines into tubes or ribbons for heightened visual effect. Choosing from an almost infinite number of colors and changing other surface attributes can give additional emphasis to the graph. Three-dimensional 'clip-art' models and various background treatments will be available to add interest and information to the graph.
PRESENTATION SLIDE SYSTEM

Providing the power of NeoVisuals without requiring the high-end graphics workstation or terminal is another goal of NeoVisuals integration. The first step in this direction will be a SAS/ASSIST driven presentation slide system. A prototype of this application was used to produce slides for many of the Institute's speakers at this year's conference. This system is intended for production of high quality text slides, but will not require knowledge of sas/vista. SAS/ASSIST will provide an interactive menu driven interface to lead you through the selection of a background, text input, slide preview and batch job submission. The presentation slide system will access the sas/graph+plus version of GSLIDE from the SAS/ASSIST menu. Therefore, sas/graph+plus will be required. Slide preview will be possible on low-resolution terminals to eliminate the necessity for the high-end platform sas/graph+plus will normally require. Once the job is submitted, the slide will be rendered in batch mode and available for imaging to a high-resolution camera. If your installation does not have a camera, you may select an output format which can be sent to one of the slide imaging services which are now available for this purpose.

To prevent redundancy, a wide variety of interesting backgrounds and bullet styles will be provided with the system. Backgrounds will vary by title, highlighting features, patterns, colors and border treatments. Bullet styles will include globes, boxes, pyramids, cylinders and many others. Once a background has been chosen, pre-selected color choices for the text and bullets will be available. Color combinations for each background and corresponding text will be chosen by the Institute's staff artists to ensure readability and color compatibility. In addition, the SAS system's spelling checker will be used to help prevent errors on the slides. Sas/vista can be used to add custom designed backgrounds to the system.

MODEL LIBRARY

A fourth development direction is to make NeoVisuals easier to use and learn. A library of pre-constructed models starts that process. Three-dimensional 'clip-art' models have been mentioned previously in this paper. This section will describe what they are. The models are three-dimensional representations of common objects which have been constructed using NeoVisuals, or sas/vista, as examples of what sas/vista is capable of and to enhance sas/graph+plus charts. They will be available as a library of models and have been, and continue to be, built by the Institute's video department staff and sas/vista testing staff. You can bring these models into sas/vista for immediate use or modify them to suit your needs. The first release will contain between 100 and 200 models and will be updated with each subsequent release. Your own contributions and suggestions for additional models are welcomed.

Current categories of models include:

- buildings
- office equipment
- foods
- time pieces
- tools
- furniture

As 'clip-art' objects, they have several advantages over two-dimensional systems which use pre-drawn objects to enhance graphics. The primary difference between these two sets of objects is that the 2-D objects are drawn prior to use while the 3-D objects are modeled prior to use and not drawn, or rendered, until the entire graph is drawn. For 2-D objects, this means that the perspective view, shading and color must be chosen prior to drawing and using the object. The object will appear redundant if used several times in one presentation. Also, care must be taken to insure that any shadows or highlights used to create a graph are consistent with the 'clip-art' object and that these pre-drawn objects were drawn with the same shading when they are used together. On the other hand, three-dimensional models are not shaded by the artist at the time of their creation. Sas/vista determines the highlights, shading and shadows for the model at the time of rendering according to the same viewing angle and light positions that apply to the rest of the scene. Redundancy can be avoided with three-dimensional models by rotating them to different views and changing surface characteristics. Color mismatches will not be a problem because the model's colors can easily be changed for each unique graph.

NEW PLATFORMS AND DEVICES

An additional direction for NeoVisuals is expansion to new platforms. Currently NeoVisuals supports Silicon
Graphics Inc. workstations, SUN 3/260 workstations, Hewlett Packard 300 SX workstations and Digital Equipment Corporation's Vax mini computers. During the coming year, several new platforms and devices will be added to the current list supported by NeoVisuals. In addition to the current operating systems, UNIX and VMS, sas/vista will be ported to IBM's MVS, CMS, and AIX platforms. Data General's AVION workstation, SUN's Sparcstation and Tektronix's 423X workstations are also being considered for the first release depending on time and resources.

Additional high-end graphics terminals which will be supported include: Tektronix's 423X terminals, Megatek's Sigma series and IBM's 6000 terminals. Configurations with either 8, 12, or 24 bit planes will be supported.

LONG RANGE DIRECTIONS

The long range plans for NeoVisuals will be an extension of the major directions outlined for the next year. The new products, sas/vista and sas/graph+plus, will be enhanced and enlarged. Continued integration of NeoVisuals will see benefits for the display manager and other SAS proc. As more of the developers at SAS are able to tap into the technology, new applications and proc will result.

Following the inclusion of NeoVisuals into SAS, attention will turn to incorporating advances in computer graphics technology. Sas/vista will remain a competitive product in the marketplace. Initial priority will focus on the rendering and animation enlarged. Continued integration of a paint system to complement the product. Advances in hardware will be a driving force for additional research and development. The software must be adapted to let the platform it is running on do as much of the work as possible. Displaying smooth shaded objects in real time is possible now. Soon features such as texture mapping, haze, and motion blur will be available in real time.

Sas/graph+plus will move forward by adding additional procs to the first set described previously. Additional options will be added such as planar contour projection and surface slicing. For example, data contours within a moveable plane could be viewed in one window as the plane is passed through the surface in another window. Work will also continue to provide interfaces for terminals, workstations, and personal computers with less graphics hardware support. Additionally, integration of the animation capabilities will be an area of effort. One use of animation will be to automatically spin a 3D type plot in space with user controllable axes of rotation and speed. Another use will be to show changes over time in data which is represented by bar charts and/or line plots. Finally, animation scripts will be provided for presentations using video tape or CD-ROM. As an example, the camera may move along the horizontal axis as the bars grow in succession. As the camera moves back to reveal the entire graph, titles and legends tumble into place. Advancements in video technology, primarily in hardware interfaces, are required for this process to be a reality. When these advances arrive, you will be able to supply the script number option to a sas/graph+plus proc to produce your video presentation.

All of the above goals for sas/graph+plus will also apply to the rest of the SAS system. As a separate product from sas/vista, functionality available to sas/graph+plus will also be available to other SAS products. Further integration of the technology is planned with enhancements to the display manager and the X system of the supervisor which handles full-screen user interfaces. At that time, the display manager will have a three-dimensional graphics window on appropriate devices in addition to the two-dimensional window now available in Version 6.06. The display manager's buttons, sliders, and other widgets will also be three-dimensional.

Current and future SAS procs will be able to access the three-dimensional graphics window as well. As the underlying graphics libraries in sas/vista are further refined and modularized, proc writers will have a rich set of portable 3-D graphics routines at their disposal. Modules which will be available include all of the functions discussed for sas/vista and sas/graph+plus. Procs which analyze data or events over time could use the animation module to replay the changes which occurred in real time. By utilizing advanced rendering algorithms which create transparent, reflective, or refractive effects, new methods to visualize data will be available.

The future directions of NeoVisuals within the SAS system are boundless. New applications of the technology will arise from all areas of the Institute. While the video department has been the most prolific Institute
user of the system, corporate communications and marketing are increasingly utilizing the software. These internal users and the external marketplace will help guide these directions, but you as a NeoVisual user, SAS user, or potential sas/vista user have an excellent opportunity for input. Let us know your thoughts, desires and needs during this formative time. The iron is hot.

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