

THE SYLVIEW GRAPHICAL INTERFACE TO THE SYLVAN STAND STRUCTURE MODEL WITH EXAMPLES FROM SOUTHERN BOTTOMLAND HARDWOOD FORESTS

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Abstract—In the field of forestry, the output of forest growth models provide a wealth of detailed information that can often be difficult to analyze and perceive due to presentation either as plain text summary tables or static stand visualizations. This paper describes the design and implementation of a cross-platform computer application for dynamic and interactive forest stand visualization, titled Sylview (Scott 2006). Sylview allows users to visualize many aspects of forest stands from overall stand makeup to wood quality characteristics of individual trees. From these visualizations the user can infer the effects of different stand management practices. A primary focus in the design of the Sylview is usability. Sylview features a simple, interactive interface and intuitive visualizations focusing on legibility. As part of the development of Sylview a new data structure was designed for the efficient retrieval of required data, which will also be applied to future growth model development.

INTRODUCTION

Forest growth models and in particular the Sylvan Stand Structure model produces an estimate of individual tree growth and outputs the result as a tree list in an ASCII file format. These tree lists are very difficult for people to read and interpret the changes that occur to individual trees. In this paper we are describing a graphical user interface that displays the information in the output tree list in a form that is very easy for people to observe and comprehend.

The Sylvan Stand Structure model (Larsen 1991, 1991a, 1994) was developed in the early 1990s to allow forester to predict the development of specific stand with unique characteristics. The model is spatially explicit, uses crown size to determine tree growth in different dimensions. This model unlike other forest growth models that depend on region average data uses the data collected from specific plots, along with generalized stand dynamics principles that allow the model to be used in many regions of the world with many different species. The Sylvan Stand Structure model has been calibrated to data from the states of WA, MO, AR, MS, and TN. The model has also been calibrated to data from the countries of Finland, Austria, Italy, and Columbia. It has been used with both hardwoods and conifers arranged in both plantations and natural stands.

Because of the difficulty of understanding tree list data several visualization tools have been used over the years to help user understand the model output. The Sylvan Display program (Davison 1995) and the Stand Visualization System (SVS) (McGaughey 1997) are two visualization tools that can be used with Sylvan. However, the data stored in the Sylvan data file is much richer than the previous tools can display. Additionally, the previous software was written in the mid-1990s and program tools have improved considerably in the last 10 years. It was decided to develop a new visualization called Sylview (Scott 2006)

Sylview has benefited from the work of other in the development of forest stand visualization. Two significant

efforts include the Sylvan display program (Davison 1995), and Stand Visualization system (McGaughey 1997). Both of these models read tree list data and display the results as 2- and 3-dimensional figures as well as 2-dimensional graphs.

Mark Davison developed a visualization project, Sylvan Display program, as a M.S. thesis in 1995. This project had several goals including a 2- and 3-dimensional graphical interface to the Sylvan data and the need to compile across computer platforms, Linux, Windows and Macintosh. Mark substantially completed these tasks although the software programming tools at the time were cumbersome and difficult to use. Figure 1 is a screenshot of the Sylvan Display program interface. One nice feature of this program is that all controls are on the display window. There are not menu structures to navigate to change options of window behavior.

The second visualization tool that we also viewed in the development of our software is Stand Visualization System (SVS) (McGaughey 1997) (fig. 2). This software has many improvements on the Sylvan Display program. The ability to view tree list data and display data in 2- and 3-dimensions, and graph the data are improved. Two issues that are not part of SVS are that it is a Windows only program and many of the display control features are several levels down in a menu system.

VISUALIZATION AND USER INTERFACE DESIGN

Given the review of these programs, we came up with a list of what the Sylview program should do for the user.

- Present a plot of trees in map and profile view
- View the individual tree characteristics through time.
- Visualize the internal wood characteristics of individual trees through time.

Other considerations that we included in the design: 1) the program must run on multiple platforms (Windows, Mac, Linux/Unix), and 2) the program must rely on vector-based 2D graphics for abstracted, easy to understand views and

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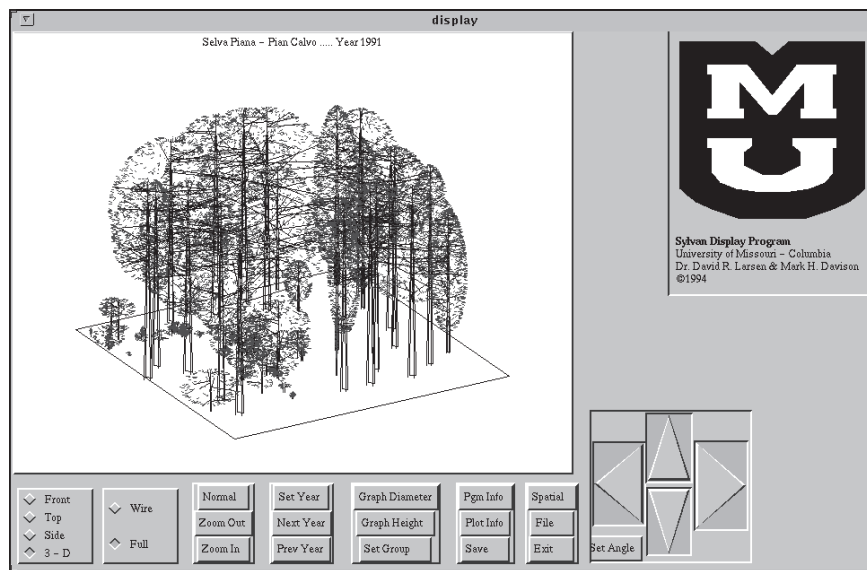


Figure 1—Screenshot of the Sylvan Display program (Davison, 1995).

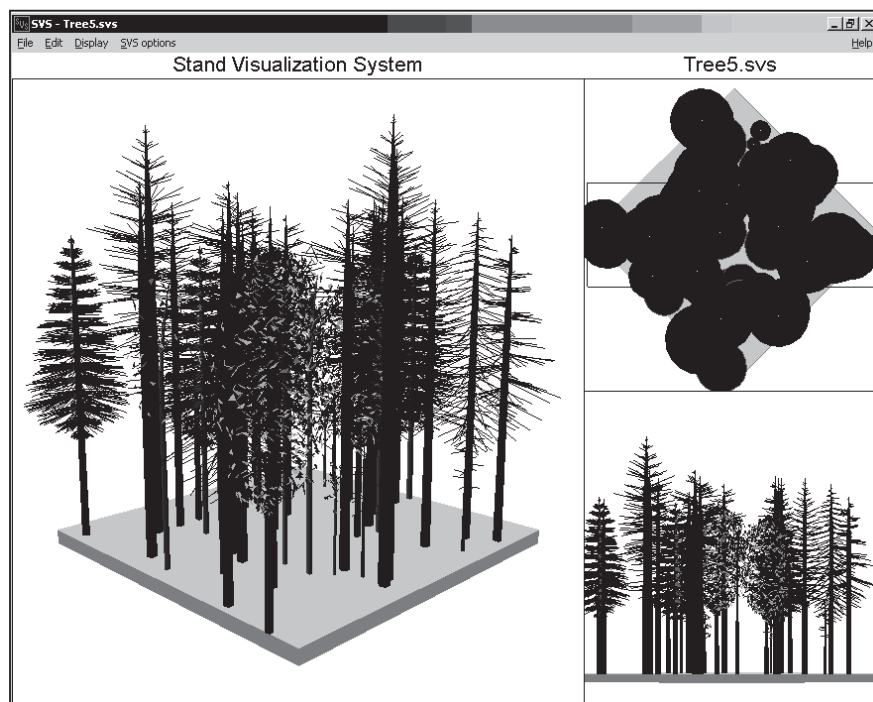


Figure 2—Screenshot of Stand Visualization System (SVS) (McGaughey, 1997).

smooth screen and print display. To accomplish this we used C++ computer language with the Qt cross-platform application framework. Additionally, we used the Sylvan C++ Library, allowing a common file input and output as well as the access to the growth model.

In designing the interface we followed two principles, 1) the principle of least surprise, the user should never be surprised at the results of his or her actions and 2) the functioning of the program should be intuitively obvious, this means objects function as the user expects. For example if a user clicks on an object (a tree) other windows about that tree or more information about the object should be presented.

The Sylvan stand structure model runs on basic tree measurements. They include diameter at breast height, total height, crown width, crown length, and crown base (fig. 3). These measurements along with the tree location are the basis of all the visualizations in Sylvan. A profile view such as figure 5 is simply two polygons the crown and the stem. The stem is drawn using taper equations; currently two are available. First is the taper equations based on Walter and Hann 1986 (fig. 4). These are natural looking, made up of two equations, one for above breast height and one for below breast height. These equations output, diameter at a specified height, and are sensitive to the crown length.

Because tree taper in the stem taper equations is influenced by tree crown and we have the crown history in the stand simulation process, we can produce a predicted tree stem profile. This stem profile graph was inspired by a graph presented in Assmann, 1970 (fig. 5). In figure 5, the diagram on the left is the original graph illustrating the branch knot

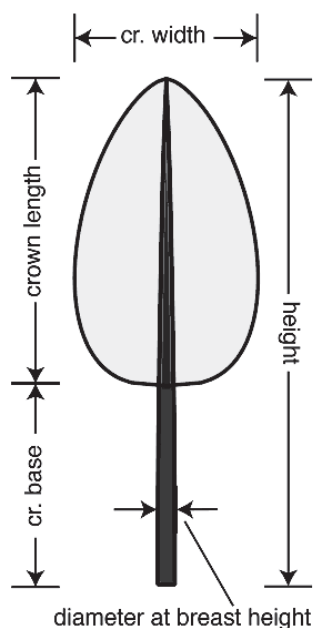


Figure 3—Diagram illustrating the two polygons used to draw a tree. The tree dimensions are labeled on the image.

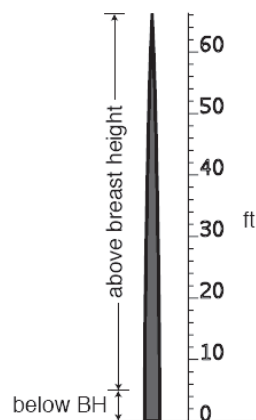


Figure 4—Diagram showing the tree stem drawn with the stem taper equations.

zones within a spruce tree. On the right is the branch zone profile produced for one tree using the stem taper and crown history as predicted by the Sylvan Stand Structure model. In this illustration the upper portion is the green knot zone, the next portion is mixed knot zone, then the black knot zone, and the bottom portion is the clear wood zone.

APPLICATIONS

There are many uses for software of this type. We would like to describe several of the potential uses. This software

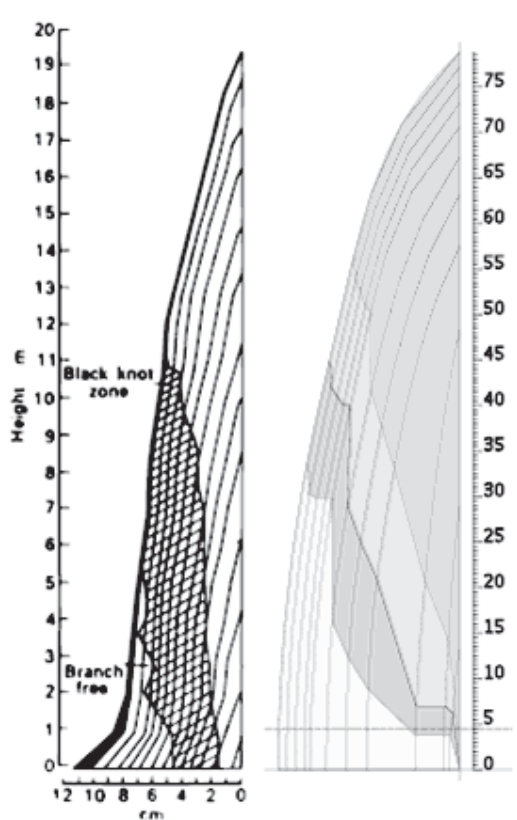


Figure 5—Diagram to illustrate the probable internal structure of the tree stem as modeled by the growth model.

is very useful for the analysis of consequences of stand management decision. The growth model is growing a single plot with the specific spatial patterns that you observe in the map and profile views (fig. 6). Given the local density around a specific tree, the model predicts the change in crown size as that tree grows and its consequences on components of wood quality. By growing high density stands, the trees will have low taper stems and small breast height diameters. Growing trees and wider spacing the trees will have higher taper rates but larger breast height diameters. Trees growing in a hole in the canopy grow at the local density, not the stand average density. These capabilities allow the user to experiment with stand management and learn how that management can change the character of the residual trees.

We have also used the software to step through repeat measurement tree data looking for measurement errors. Finding errors in repeat measurement data is quite difficult. The visualizations allow a quick and very intuitive interpretation of the data.

We have used the Sylvview visualization to detect error in the underlying growth model. Many errors are very subtle and very difficult to perceive. The use of visualization tools allows one to quickly detect problems and focus the debugging efforts on the apparent problems.

DISCUSSION

One of the nicest features of the Sylvview model is the ease of use. Once the data are loaded in to the model and the simulation runs have been made, the access to the information about the trees in the plot is excellent. There are interactive map and profiles views with tree labeling (fig. 6). Once a tree is selected an interactive stem profile, crown profile and stem cross-section are available (fig. 7). Alternatives for the selected tree and local area leaf area profile are available to help you understand the driving forces in changing crown dimensions. Also traditional stand, stock and over time tables are available as well as Gingrich and Renieke stocking diagrams (Gingrich 1967, Reineke 1937) (fig. 8).

There is a need for additional development; we plan to add a log sort table which will take the stem profile cut them into logs and tabulate them by size and quality. Additionally we have been working on providing more information on branch size and density with in the simulated logs. These factors are all related to the change in crown dimensions over time, which is a component of a stand that the forester can control.

The Sylvan program and the data viewed in Sylvview, while looking like a growth and yield model is different than the typical growth and yield models. This model uses several stand dynamics principles, and statistical relationship from the subject stand to define the tree parameters. These are designed to allow some flexibility not available in other

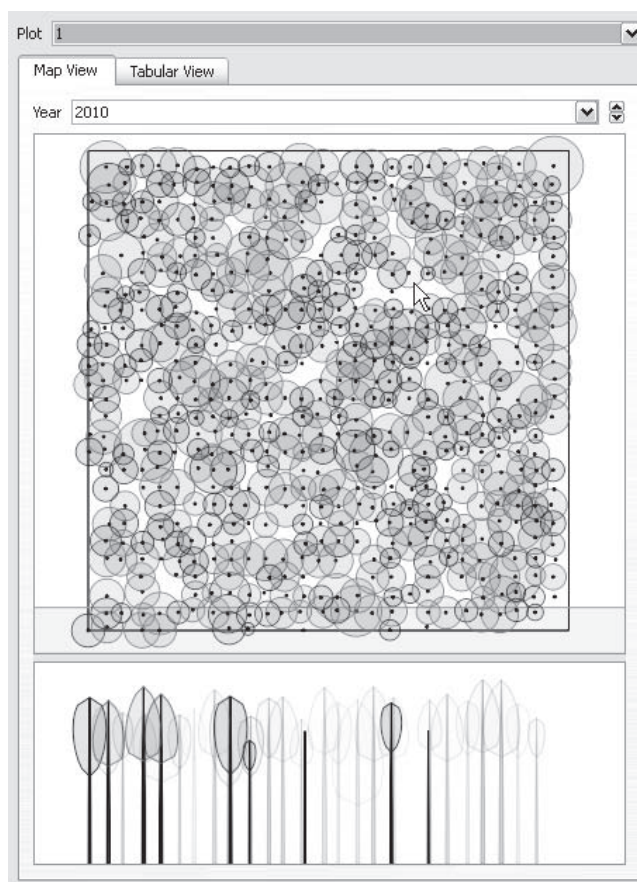


Figure 6— Map and profile views of the simulated tree data.

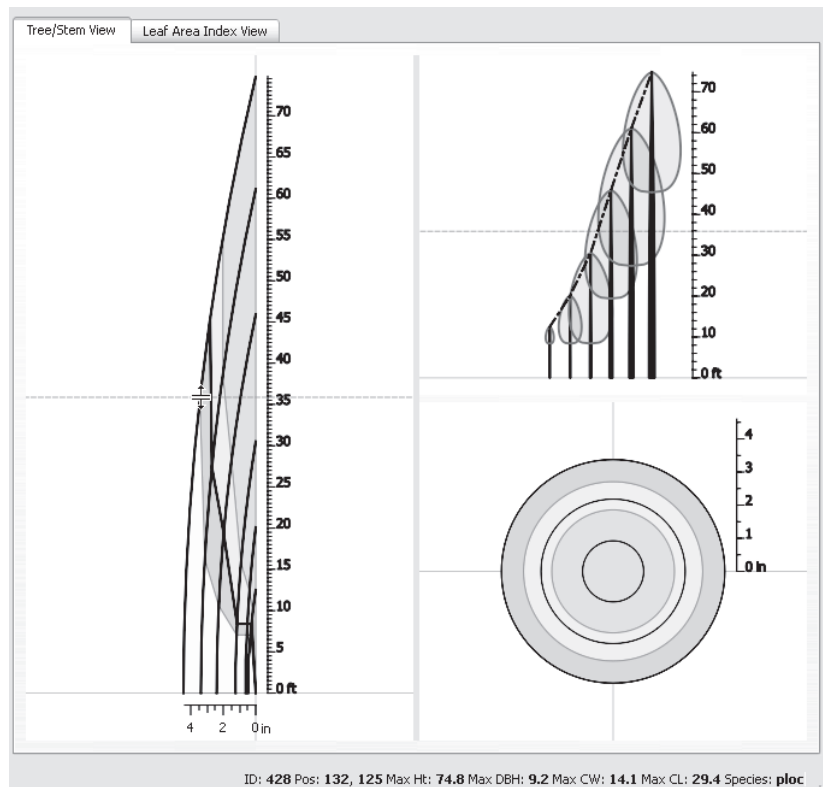


Figure 7—Individual tree information for a single selected tree. These plots include internal tree structure, crown change profile and stem cross-section (Note rings are 5-year increments).

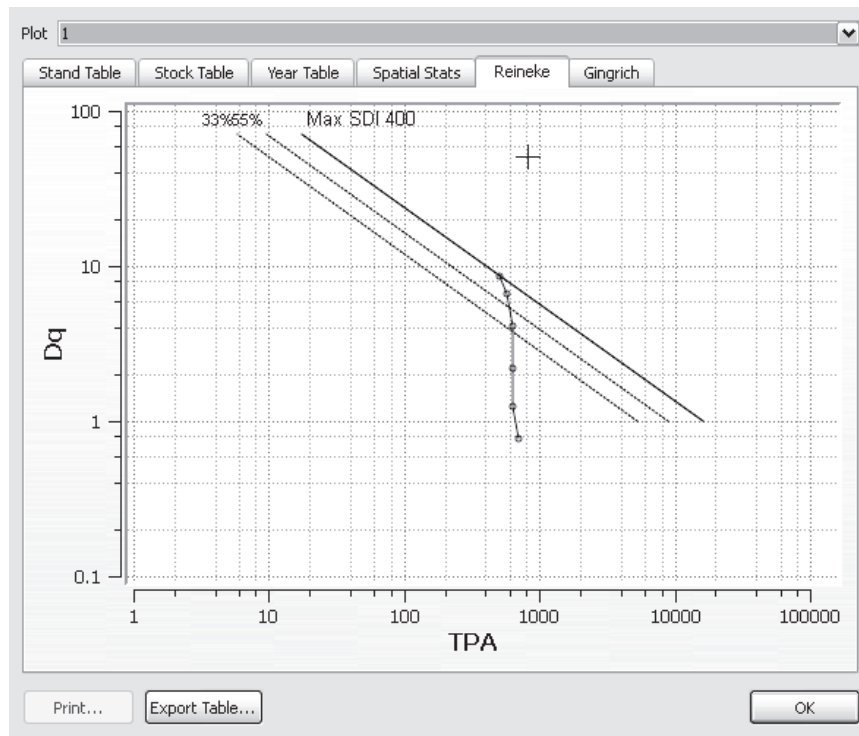


Figure 8—Reineke density management diagram with the simulated data plotted.

growth models. This also requires that the user to check the realism of the results. Research continues on methods to allow flexibility with sufficient safeguards so that the user can use the model with a high degree of confidence.

CONCLUSION

Several goals were met with this project: 1) view tree growth in graphical and text-based forms; 2) inspect the internal wood structure; 3) produce standard forestry statistical tables; and 4) export graphic for reports. This project completed the major goals of producing a user friendly graphical interface that provides easy access to that complex relationship found in the tree simulation data over time. Like all project there are areas for extension and improvement but the current work provides a big step forward in access to the modeled tree data.

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