

Algorithmic Plant Growth

By

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Abstract

The basic idea of the simulator is to imitate the growth of three different plants based upon four different environmental factors that include soil type, sunlight, water, and temperature. By adjusting these factors, the user will be able to “grow” a plant on the screen which should resemble a real plant that is exposed to the same environmental conditions. This report discusses the results of a project to develop a plant growth simulator and summarizes work to validate requirements, and develop instructional material. In addition, it discusses issues and lessons learned from difficulties that were encountered during production of the simulator.

Algorithmic Plant Growth Simulator

1. Statement of Problem

Plants are all around us, but not many of us have time to enjoy them. People want to grow plants, but fail because they lack the appropriate amount of water or sunlight, or are in the wrong temperate zone. Children try growing plants in a small cup for a school project, but the plant fails to grow because it lacks water or sunlight, or is over watered. These plants can take several weeks to grow, and results can be far from what is expected. Why should these individuals have to wait that long to see the error of their efforts? Since I have a Bachelor's degree in Biology, I wanted to combine what I learned in those four years with the knowledge I gained in the Information Technology at the College of Applied Science to create a plant growth simulator. The program allows the user to simulate the growth of a plant on a computer screen without the restraints of time.

2. Description of the Solution

This program models the growth of a plant based upon differing environmental variables using a multimedia environment that was created in Flash MX 2004 Professional. The user interface allows the user to select one of three plants, and also allows the user to adjust four environmental variables to see how the plant grows when subjected to these variables.

This program was designed to demonstrate how a plant grows when subjected to varying environmental factors. Once the user runs the simulator, he/she should be able to subject an actual plant to the same types of variables, and have the plant grow in a manner represented by the simulation.

When the application is launched, the title screen appears. From this screen, the user is able to start the simulator, or enter the Help pages. The Help pages give the user a description of how to use the program, background on what environmental factors the plants need to grow, and some references for further research.

2.1 User Profile

This application was designed for a younger school aged audience, so they are the primary users of this application. Parents and teachers can use this application too, but they use the same interface as the children. The application was designed this way so that parents and teachers can see exactly what the child sees and can help guide the child if he/she has difficulty using the program.

2.2 Design Protocols

This project combines two computing areas within the Information Engineering Technology program. The primary focus of this project is multimedia production, with a secondary focus on programming.

1. The multimedia portion of this project was created in Flash MX 2004 Professional, and Photoshop CS. Photoshop was used to create the backgrounds of the different pages of the project, and Flash was used to create the buttons, slider bars, the branches for the plants, and the text that appears on the screen.
2. The programming portion of this application was written using ActionScript 2.0, which is an object oriented programming language. This was used not only to grow the plants on the screen, but also to alter the plant growth based upon the user selected environmental variables.

For this project, the design elements are simple. This was done for two reasons. First, the primary users of this application are children. Because of this, the navigation scheme was designed to be easy to follow. Second, because this is a multimedia project,

too much design, or too many background colors would have taken away from the actual plant growth.

3.0 Deliverables

For this project, a number of deliverables were developed for the final design.

For this project the following deliverables were specified:

1. The program opens to a Welcome screen from which the user can either enter the simulation, or go immediately to the Help Pages to see how to run the simulation.
2. There are three different plants that the user can select from:
 - Burning Bush
 - The American Hornbeam
 - Dogwood
3. There are four environmental variables that the user can adjust:
 - Sunlight
 - Water
 - Temperature
 - Soil Type

The first three variables are controlled by slider bars, and the soil type is altered by using radio buttons.
4. A Help page that the user can click anytime during the simulation, if they are not sure how to get the plant to grow. This screen is accessible from the Welcome screen as well as from all the Plant Growth screens.

4.0 Design and Development

4.1 Budget

Flash MX 2004 Professional and Photoshop CS were the only purchases that were needed for this project. Flash is available for \$249 at the University of Cincinnati bookstore. If I was not a student, this version of Flash would have cost \$699 from the Macromedia Web site. (1) Photoshop CS retails for \$649 at most retail establishments (2), but is available to UC students for \$199.

This project was developed on an HP Pavilion laptop, model dv4000. It has an Intel Centrino processor, 512 MB of RAM, and a 100 GB hard drive. It was purchased for \$1100 at Microcenter.

4.2 Timeline

This project involved several challenges, learning mistakes, and accomplishments over the course of its development.

4.2.1 Senior Design I Accomplishments

During Senior Design I, I accomplished the following:

- Analyzed other plant simulators
- Developed my proposal and oral presentation

During my research, I only found one site that had a plant growth simulator, but it was not user friendly. After seeing this example, I knew that it was possible to create a program that was more exciting and more user friendly.

4.2.2 Senior Design II Accomplishments

During Senior Design II, I accomplished the following:

- Started development of environment and factors
- Prepared proof of concept
- Prepared Design Freeze documentation and oral presentation

4.2.3 Senior Design III Accomplishments

During Senior Design III, I accomplished the following:

- Completed MDI (Multiple Document Interface)
- Tested design and functionality
- Completed Documentation
- Presented final project

Finding images and modifying them to work in my project took more time than anticipated, but did not involve testing. The detailed timeline can be found in Figure 1.

| ID | Task Name | Duration | Start | 1st Quarter | | | 2nd Quarter | | | 3rd Quarter | | | 4th Quarter | | | 1st Quarter | | |
|----|------------------------------|-----------|--------------|-------------|------------|-----|-------------|-----|-----|-------------|------------|------------|-------------|-----|-----|-------------|-----|-----|
| | | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
| 1 | Senior Design I | 50 days? | Mon 1/3/05 | [Red bar] | | | | | | | | | | | | | | |
| 2 | Co-op term | 55 days? | Mon 3/28/05 | | | | [Red bar] | | | | | | | | | | | |
| 3 | Senior Design II | 50 days? | Mon 6/20/05 | | | | | | | [Red bar] | | | | | | | | |
| 4 | Co-op term | 73 days? | Wed 9/21/05 | | | | | | | | | [Red bar] | | | | | | |
| 5 | Senior Design III | 50 days? | Mon 1/2/06 | | | | | | | | | | | | | [Red bar] | | |
| 6 | Research Topic | 50 days? | Mon 1/3/05 | [Blue bar] | | | | | | | | | | | | | | |
| 7 | Senior Dsgn I Presentation | 10 days? | Mon 2/28/05 | | | | | | | | | | | | | | | |
| 8 | Learn Flash | 125 days | Mon 2/28/05 | | [Blue bar] | | | | | | | | | | | | | |
| 9 | Learn ActionScript 2.0 | 155 days? | Mon 2/28/05 | | [Blue bar] | | | | | | | | | | | | | |
| 10 | Develop Environment | 135 days? | Mon 7/25/05 | | | | | | | | [Blue bar] | | | | | | | |
| 11 | Develop Plants | 150 days? | Mon 8/1/05 | | | | | | | | | [Blue bar] | | | | | | |
| 12 | Senior Dsgn II Presentation | 10 days? | Mon 8/15/05 | | | | | | | | | | | | | | | |
| 13 | Develop Variables | 108 days? | Mon 9/12/05 | | | | | | | | | | [Blue bar] | | | | | |
| 14 | Test | 130 days? | Mon 9/5/05 | | | | | | | | | | [Blue bar] | | | | | |
| 15 | Final Documentation | 55 days? | Mon 12/19/05 | | | | | | | | | | | | | [Blue bar] | | |
| 16 | Senior Dsgn III Presentation | 5 days? | Mon 3/6/06 | | | | | | | | | | | | | | | |

Figure 1. Timeline

4.3 Software

This project uses Flash MX 2004 Professional. This program was chosen because it has a built-in Multiple Document Interface (MDI) template. This program was also chosen for its animation capabilities and advanced graphics that can be distributed over Windows and Macintosh platforms.

Controlling the animations was completed using ActionScript 2.0. This language was selected for two reasons. First, it is an Object Oriented language, and since I have a background in C#, I thought it would be an easier language to learn. Second, ActionScript 1.0 is not supported in later versions of Flash. Therefore, I would have created a program that would be obsolete in a year.

4.4 Hardware

The Windows hardware requirements for Flash MX 2004 are listed below (9).

Processor: 600 MHz Intel Pentium III processor or equivalent

Operating System: Windows 98 SE (4.10.2222 A), Windows 2000, or Windows XP

RAM: 128 MB RAM (256 MB recommended)

On any new PC, these hardware requirements are not an issue, but if a user has an older machine, they may not be able to run the software.

5.0 Proof of Design

When the user starts the simulation, he/she is taken to the Welcome screen. This screen has a plant that grows as soon as the program is launched, as well as two buttons, (see Figure 2.) The Start button takes the user to the Plant Selection screen, while the Help button takes the user to the Help pages, where he/she may see how to use the program, and also receive some background information about the different environmental factors.



Figure 2. Welcome screen

After the user clicks on the “Start” button on the Welcome screen, they are taken to the Plant selection screen, (see Figure 3.) On this screen, the user selects one of the plants from the listbox, and then clicks on the “Enter” button. This directs the user to the Growth screen for the selected plant.



Figure 3. Plant selection screen

Figure 4. Shows how the program allows the user to simulate the growth of a Burning Bush. This plant will reach 8-10 feet at maturity (17). It likes partial to full sun, is widely adaptable to most water amounts, and can grow well in either soil or sand.

Once the user has finished simulating the growth of this plant, he/she will be able to click the “Back” button to return him/her to the Plant Selection screen.

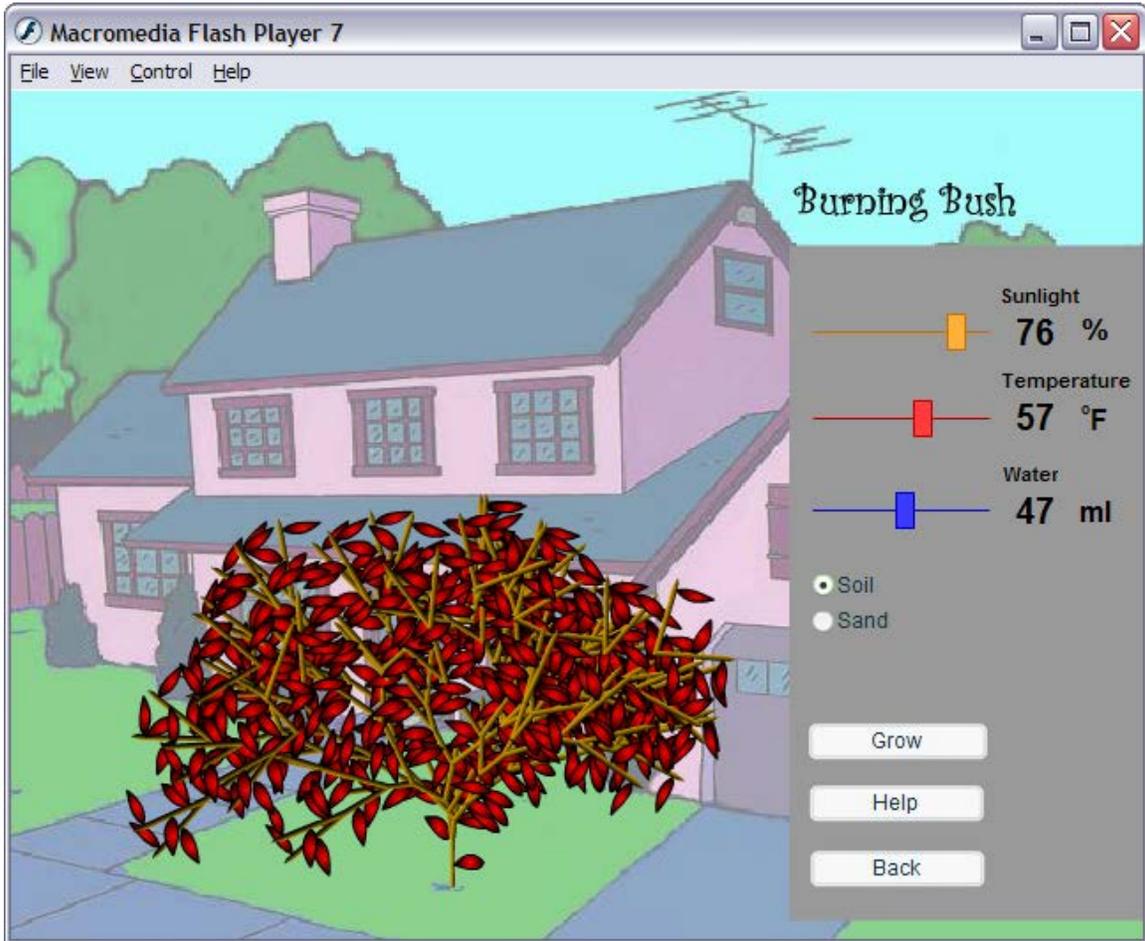


Figure 4. Burning Bush

Figure 5. Shows how the program allows the user to simulate the growth of the American Hornbeam. This plant will grow 20-30 feet at maturity (17). It grows well in sunlight conditions ranging from full sun to full shade, it likes moist to wet soil, and prefers well drained soil rather than sand. This page also contains a "Back" button that will allow the user to return to the Plant Selection screen.

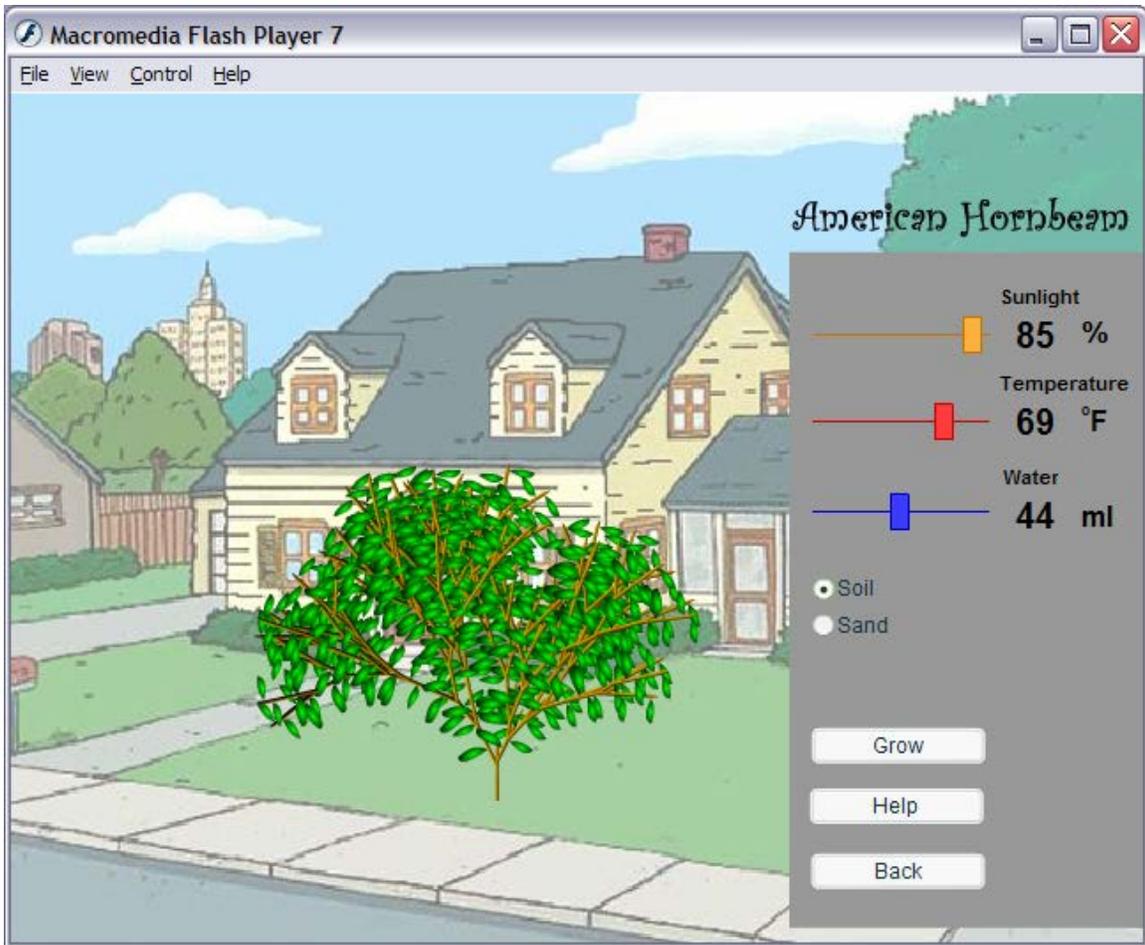


Figure 5. American Hornbeam

Figure 6. Shows how the program allows the user to simulate the growth of a Dogwood. The Dogwood is a tree that at maturity will grow 15-20 feet high (17). It likes full to partial sun, is adaptable to most water amounts, and is adaptable to both soil, and sand. This page also contains a "Back" button that will allow the user to return to the Plant Selection screen.

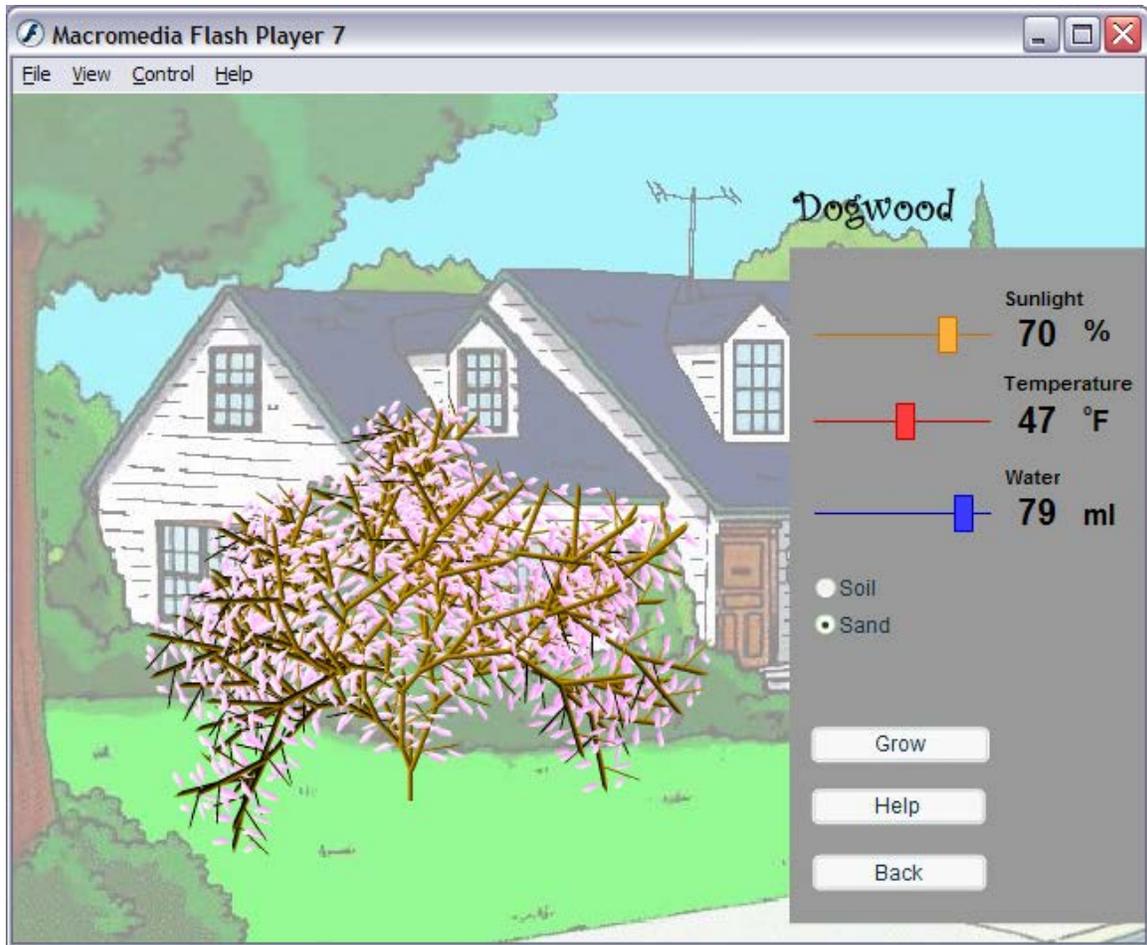


Figure 6. Dogwood

The Help screen, Figure 7. gives the user directions on how to use the simulation. On this screen, the user is instructed to select a plant from the list box, and then click on the “Enter” button. The second step shows the user that they need to adjust the variables by using the slider bars, and then click “Grow”. From this screen the user also has the option to click the “Plant Info” button to view plant information.

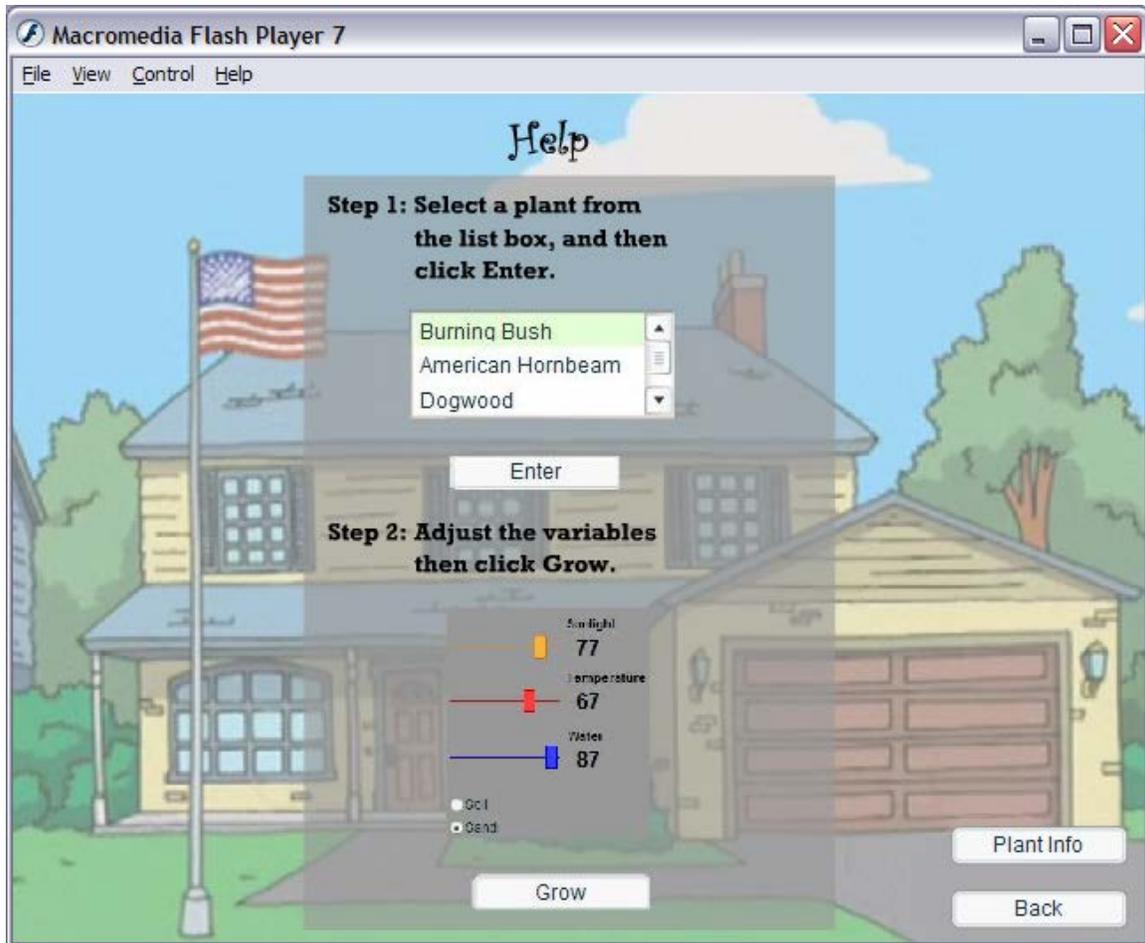


Figure 7. Help screen

The Plant Information screen, Figure 8. gives the user some basic information about what growth parameters will make the plant grow the best. This screen has a “References” button, as well as a “Back” button. The Back button will allow the user to return to the Plant Selection screen so he/she can proceed to the simulation, and the “References” button directs the user to References page, Figure 9. which gives the user some Web sites for additional information.

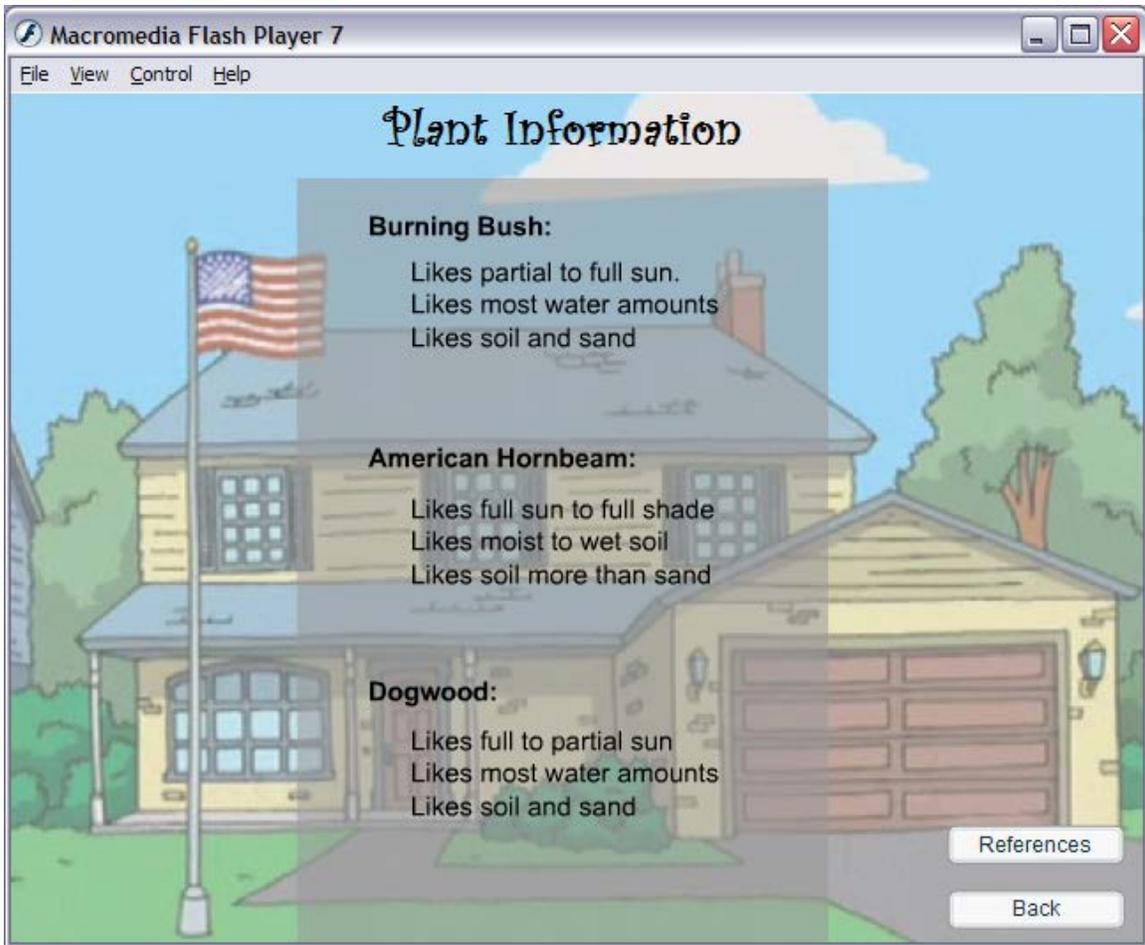


Figure 8. Plant information



Figure 9. References

6.0 Testing Procedures

Due to the complexity of the code, testing for this project was integral to the design and functionality of the final design. Every time a change was made to a line of code, the project was recompiled and tested to ensure functionality and usability. By testing so often troubleshooting was kept to a minimum.

Once the project was in final testing, it was given to family and friends to test. Any issues that were encountered were corrected and tested to see if the error occurred again.

7.0 Conclusions and Recommendations

7.1 Conclusions

This project was completed in an effort to combine my education in Biological sciences, and my education in Information Technology at the College of Applied Science. I created a visually appealing application that is aimed at a younger school-aged audience, but can still be used by teachers and adults. Production of this project required the use of Flash MX 2004 Professional. This project was completed over the three quarter Senior Design sequence. The budget of this project would have exceeded \$1000 minus labor, if it were to be completed in the real-world. The project achieved all design freeze deliverables. Testing this project was an ongoing process that occurred after every major change to the code

7.2 Recommendations

A good understanding of Flash is recommended before starting such a project. It is also recommended that a user has a good understanding of an Object Oriented programming language, so that they can understand how ActionScript 2.0 functions. Learning both Flash and ActionScript 2.0 proficiently takes a period of about three to four weeks for each program.

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