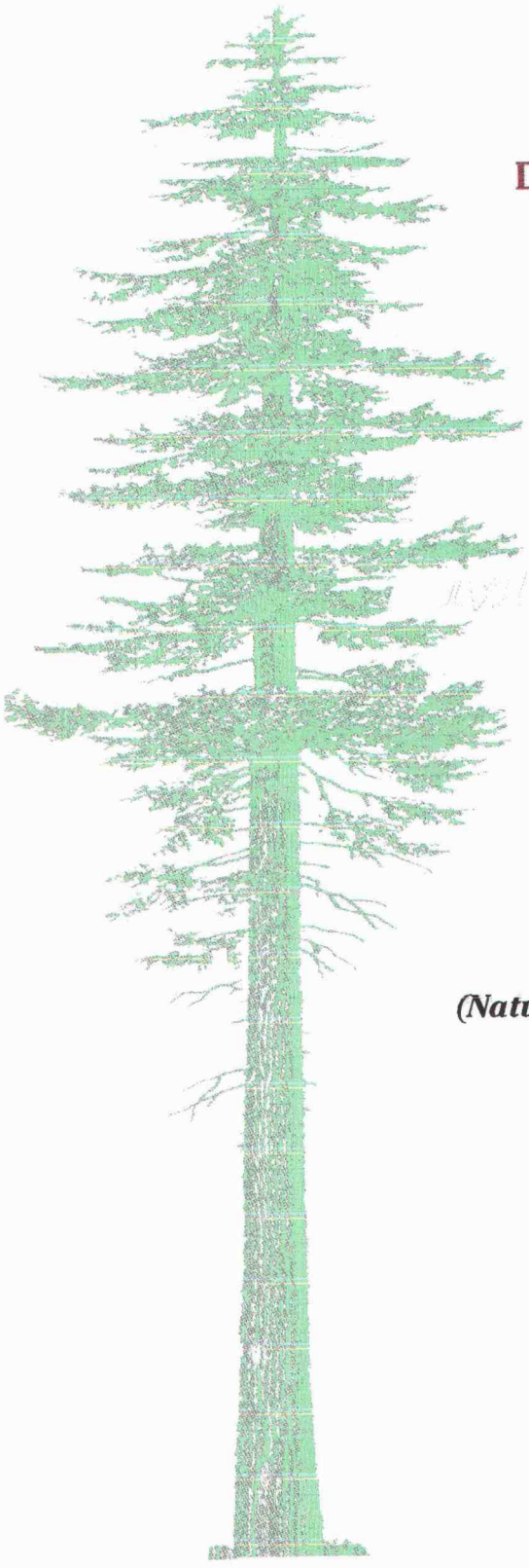

DEVELOPING A MULTIMEDIA TREE IDENTIFICATION CD-ROM

by

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Introduction

Providing students with the skills necessary to identify trees is an ongoing challenge at Oregon State University. Several colleges within the university offer courses that teach tree identification. In the College of Forestry alone, two courses are offered that emphasize identification of native and introduced trees. The content and format of these courses are dynamic, and change depending on variables such as the availability of live samples on or near campus, the seasonal attributes of trees, and frequently in Oregon, the willingness of both teacher and student to tolerate inclement weather in order to identify samples in their natural setting.

There is currently significant interest in using state-of-the-art technology to provide educational programs within the tree identification curriculum. The College of Forestry, for example, has developed several slide-tape and video programs dealing with tree identification and related information. Slide-tapes and videotapes are considered low-cost to produce and are easily accessed by both faculty and students through the Forestry Media Center (FMC). These programs are, however, linear in format and therefore require repositioning of slides and rewinding of tapes based on the particular needs of specific audiences.

In 1994 the FMC began working with a master's degree candidate emphasizing natural resource education who was interested in the application of multimedia technology to tree identification. The program to be developed, *Conifers of the Pacific Northwest*, was intended to be a CD-ROM prototype, designed to be used in conjunction with the College of Forestry's tree identification courses. The goals of this project were to improve instruction in tree identification for the College of Forestry at OSU, and, to allow a natural resources graduate student the opportunity to apply various teaching and learning principles in the design and development of technologically advanced teaching applications. It was the first attempt by this student, a professional forester by education, to examine the process of designing and developing educational programs to support forestry education.

The resulting program, *Conifers of the Pacific Northwest*, includes information on 12 genera and 29 species of conifers native to the Pacific Northwest, and three common ornamental conifers. Information about these trees is accessible either through indices of tree names or through an identification key. Also included in the program is a glossary of dendrological terms, an interactive map describing the geologic history of Oregon, and a key with practice samples that can be used to learn the skills necessary for the process of tree identification. Accompanying the program is a written user's guide that describes the main components of the program, described above, and the buttons used to navigate through these components.

This paper contains two important themes. One of these themes is the pedagogical framework of the multimedia program development process, and how the process benefited me as an educator in-training. The other theme is that of the program itself, *Conifers of the Pacific Northwest*, and its design, development, evaluation, and implementation.

Multimedia

Before the invention of fast, powerful computers, the term multimedia simply defined the use of several media, such as films, video, music, and text, simultaneously. Multimedia, then, did not imply any more interactivity with the audience than that of a wall-hanging. Today, however, the term multimedia implies several other things. Most importantly, the term multimedia is most often used to describe interactive computer software. Within this interactivity, multimedia is a class of computer-driven programs that create, store, transmit, and retrieve textual, graphic, and auditory networks of information (Gayeski 1992). A subset of multimedia is hypermedia[1], a class of software consisting of *networks* of related text, graphics, audio files, and video clips through which users navigate using icons or search strategies (Gayeski). Multimedia can be accessed on CD-ROM (read-only compact disks), run off of a computer's hard-drive, or accessed through networks such as the World Wide

[1] For the purpose of this paper, the term multimedia is used to imply both hypermedia and multimedia programs.

Web. Today the term multimedia today implies vastly different things from 30 years ago, the differences found mainly in the basic functions of input, output, processing, and control (Park 1994).

Multimedia is fast becoming a standard protocol for information exchange, with its presence on university campuses in faculty development labs, student labs, and staff offices. Multimedia offers storage of large volumes of information in connected locations, as well as the ability to combine video, audio, text, and images into a single project. Multimedia also can be used in a variety of ways, depending on how it is designed. It can teach a particular skill or task, or provide general content knowledge on a subject. It can be designed as an individual lesson, or it can encompass an entire course. It can simply be a media manager, providing access to graphics, videos, texts, and sounds via lists. It can be designed as an electronic book that has information organized as you might find in a textbook. It can also be designed as a simulation, allowing users to complete tasks and hone skills within a controlled environment.

Interest in multimedia is not due solely to these benefits. Research has shown that using multimedia has many benefits to both teaching and learning processes. It is often found in literature regarding the use of multimedia in educational settings that educators believe emerging technologies will alter the student/teacher roles. Teachers will assume the role of "facilitator," while students will become increasingly independent from the teachers (Park and Hannafin 1994). As a result, using multimedia in the curriculum may increase classroom productivity through a reduction of instructor dependency, and provide students with more opportunity to interact with information in a consistent format. Furthermore, students who use multimedia may develop better analytical skills (Karraker 1992), and may have improved retention of learned materials since "ease-in-learning increases with the use of multiple mediums" (Simpson 1994). Multimedia also has the ability to reach a broader range of student learning styles than any single medium (Dede 1992).

While the virtues of multimedia are many, there are several drawbacks to multimedia and its related technology, that are worth mentioning. One fundamental complaint is that the technology required to create and use multimedia is costly and accessible to few potential users. To create multimedia one must have access to scanners, digitizers, audio-visual computers, expensive authoring software, and large databases. To provide a single multimedia station, then, can be quite expensive. To provide a multimedia station for every potential user would be virtually impossible. Thus, the university environment, with computer labs for students, development labs for faculty, and networks that link remote servers with workstations, has become the perfect place-- one of the select places-- for the development and use of multimedia. Another complaint of multimedia is that there are too many different platforms and techniques for multimedia development to allow either affordable equipment or affordable development efforts (Solomon 1994). Essentially, a developer can create multimedia for either Macintosh and DOS-Windows platforms, or for "World Wide Web" servers. It is typically quite difficult to create "hybrid" programs, or programs that can be accessed on two or more computer platforms. Unless one plans very carefully, to create one program that meets the needs of all potential users and their hardware is tedious. The university environment once again provides a perfect forum to overcome this obstacle, because the target user can be defined by the equipment and software available to students.

My decision to experiment with this technology was made only after having taken all the virtues and drawbacks discussed in the literature into consideration. Moreover, it was due to the significant increase in multimedia development in natural resource fields worldwide. For instance, *Legume ID* was developed as a multimedia instructional tool for a horticulture course at Oregon State University (Hannaway 1992). *Plant It!* CD is multimedia used by homeowners to identify and gather information on a myriad of horticultural trees, shrubs, and herbs (Mason 1992). *Linnaeus*, a multimedia database distributed by the Expert Center for Taxonomic Identification, assists in the study of protists found in Scandinavian coastal waters. There are many other published examples of multimedia software designed for use in

natural resources, and many more that are unpublished and used in specific locales. Estep, Sluys and Syvertsen (1993), in describing the *Linnaeus* CD, submit that "computers offer a possibility to make systematic expertise on biodiversity quickly and effectively available to the scientific community and to non-specialist users." Furthermore, Hannaway (1992) found that multimedia instructional materials are consistent with the spirit and character of scientific inquiry, allowing students to "explore, exercise critical thought, understand context... and use modern instruments to extend their intellectual capabilities." These authors offer two key concepts for the creation of the CD-ROM *Conifers of the Pacific Northwest*..

The Authoring Program, Macromedia Director

One of the difficult steps in multimedia software development is selecting an authoring tool. While many possibilities of the medium should be explored, novice multimedia developers often don't know what characteristics to look for in an authoring tool. They are also limited by the hardware and other software available to them and the availability of technical assistance.

The authoring tool Macromedia Director[2] was used to create this project for several reasons. First, of the three development tools available at the FMC, Macromedia Director is currently one of the leading authoring tools for multimedia production. Learning the basics of Director, then, provides skills needed for improved future productions. Second, Director is used by three media production centers at Oregon State University, which would ideally provide technical expertise should it be needed. Finally, Macromedia and Netscape, a popular World Wide Web service provider, recently devised a method to allow Macromedia products to be remote-accessed through Netscape using a plug-in or helper application called Shockwave. A Director program can extend beyond the local range of a CD-ROM; once created it can be placed on a server and accessed by using the Netscape browser.

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[2] Macromedia, Macromedia Director are registered trademarks of Macromedia, Inc. All other trademarks, including Shockwave, Netscape, Microsoft Word, Sun Microsystems, and Adobe Photoshop, are the property of their respective owners.

Director movies, if the developer plans ahead, can be created to run on a less powerful computer without any problems and can also be created to run on both Macintosh and IBM and IBM-compatible computers (Appendix 1). *Conifers of the Pacific Northwest* was designed and developed using the Macintosh platform.

When working on multimedia programs additional development software is often needed. It may be necessary to have a graphics program at your disposal. If audio clips are used, then a computer-based audio editor may also be needed. Director provides basic graphics and audio editing, but for increased editing capabilities additional specialized software is desirable. Similarly, when incorporating digital video into Director, video can be created using the Director software or by importing Quicktime or video for Windows (for Macintosh and Windows computers, and for Windows computers only, respectively). Additional software used for this project is described later in this section.

Program Design

Conifers of the Pacific Northwest was designed to provide a database of information that describes conifers native to the Pacific Northwest and to provide a program useful to the identification of these trees. Ultimately the information available to the user, and the skills learned in using the program, should assist with the identification of real samples.

The most tedious portion of the design and development process was to design the basic layout of the screen then format the program content accordingly. In general, each screen was divided into 5 fields (Figure 1): a screen title, a graphics window, a standardized control panel of buttons, a text field, and, a field containing the tree name. Screen designs reflected an interest in keeping the available functions simple, providing clear procedures for

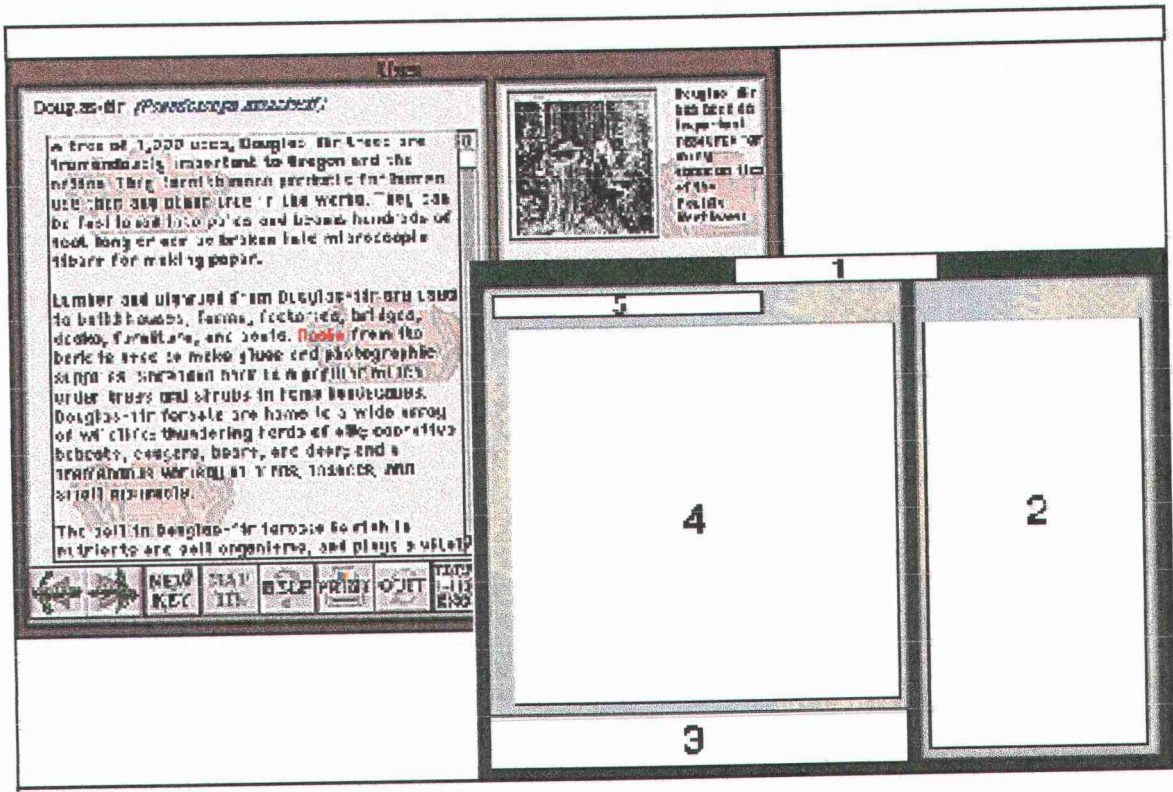

Figure 1: Screen Design for the information on conifers native to the Pacific Northwest. No matter how arbitrary, a standardized screen design only needs to be learned once. For the tree information screen, design includes:1) a screen title; 2) a graphics box; 3) a standardized control panel of buttons; 4) a text box; and 5) the tree name.

navigating within the system, and allowing users to focus on the content of the information rather than on the tasks of navigation and control.

Text was created for the program using two procedures. Much of the text on tree species comes from the popular Oregon State University extension circular, *Trees to Know in Oregon* (Jensen and Ross 1994). Original computer files containing the text were imported into the Microsoft Word word processing program, then text was cut and pasted, as needed, into text fields within the Director program. Other text was created using the word processing functions available in Director.

Graphics were incorporated into Director in three ways. First, slides used in tree descriptions were chosen from the dendrological collection available at the College of

Forestry. Slides were digitized using a slide scanner, improved using the Adobe Photoshop graphics software, then imported into Director. This procedure proved to be quite time consuming. Consequently, the remainder of the slides required as graphics for the program were professionally scanned onto a photo-CD, then manipulated in Photoshop and imported into Director. Other graphics were created in Photoshop or in the Director paint window. Graphics were saved as PICT files (in .PCT file format) at screen-level resolution (72 dpi), then linked into Director using the import-link command.

Conifers of the Pacific Northwest contains several different, independently accessible resources (often called nodes in multimedia development literature), and several different pathways that a user can access this information (called links). These resources are described later in this section, and have been diagrammed in Figure 2. Although only one of several nodes, the heart of the program is the tree description section that contains 32 conifer species native and introduced to the Pacific Northwest. Each layer of the tree description is like an index card (i.e. one layer represents one screen of information)-- some cards focus on entire genera of trees while others focus on individual species. Specific cards feature information on identifying characteristics, products and uses, habitat and range, and other interesting facts. In an effort to display information with multiple, complimentary metaphors, in this case text complimented with pictures and audio clips, the amount of text on each window was minimized and complimentary graphics were included.

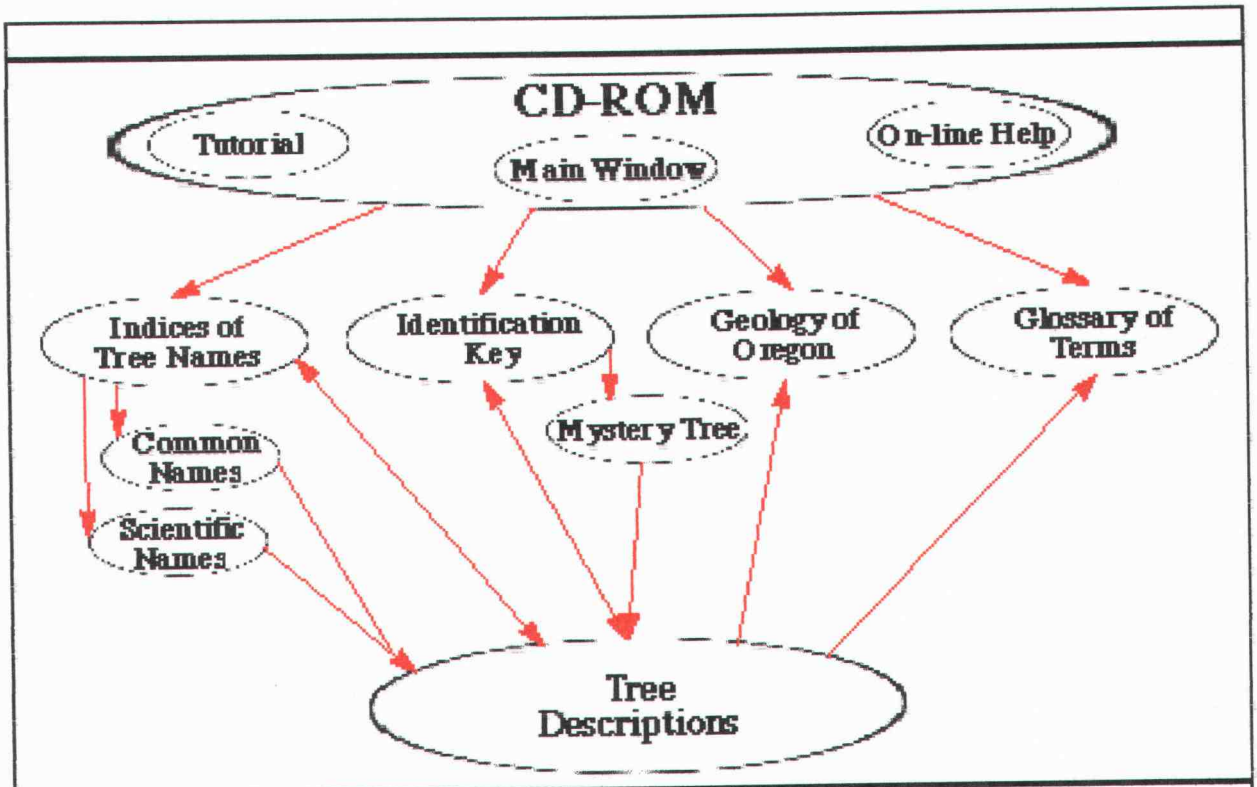

Figure 2: The format for information available on *Conifers of the Pacific Northwest*. In this graphic portrayal, one can see that the heart of the program is the tree descriptions, which can be accessed many different ways. Other information is accessible, including the "help" systems, geological information about Oregon, a glossary of terms, and Mystery Tree.

The second feature of *Conifers of the Pacific Northwest* is an identification key (Figure 3). The identification protocol is based on the dichotomous key found in *Trees to Know in Oregon* (Jensen and Ross 1994). Since the circular's key only identifies trees to the genus level, it was modified to include differentiation to the species level.

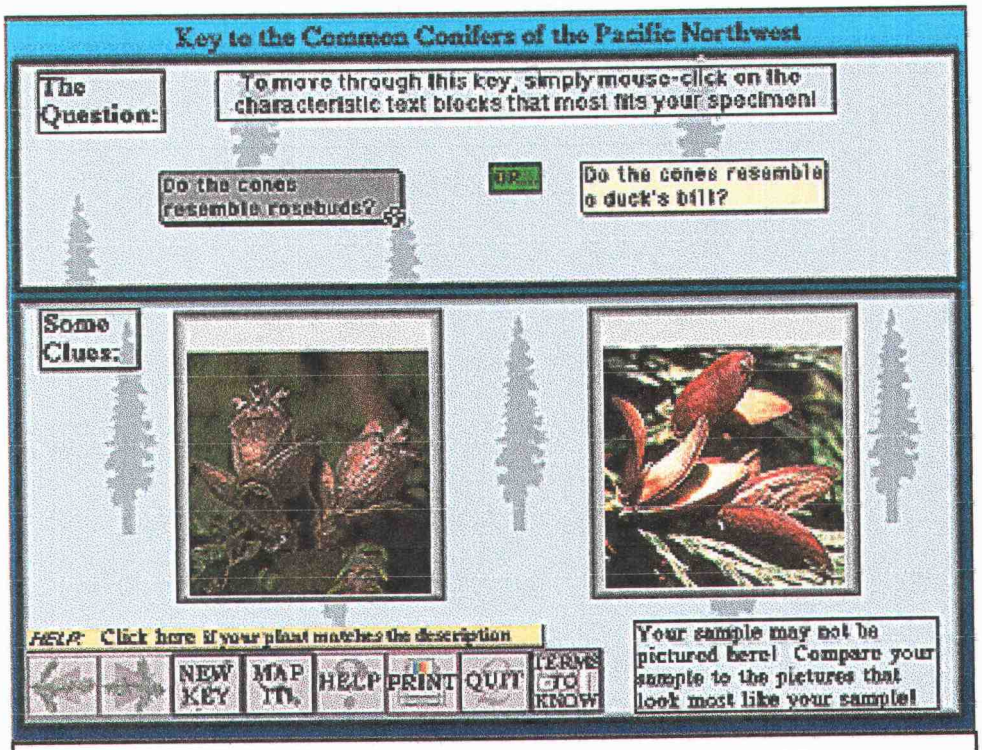

Figure 3. The program's identification key closely resembles a dichotomous key in a book. However, this key is graphics intensive with hypertext links for definitions of difficult terminology.

The ability to make an identification key graphics-intensive is one benefit of using multimedia. Tree identification requires the identifier to gather multi-modal information from the sample. It takes a combination of sensory information, including information based on touching samples and sometimes smelling samples, to correctly identify specimens. Identification of trees is, nonetheless, inherently visual and using high quality color graphics of tree characteristics can facilitate the identification process. Dichotomous keying adds another level of difficulty to the identification process. It is difficult to accomplish due to the obstacle of placing specimens into mutually exclusive groups, yet the keying process is very valuable as a pedagogical framework-- it requires a student to use problem-solving skills in order to complete the task of tree identification. Practice can help alleviate any difficulty that students may have, so a practice key called Mystery Tree was designed and included in the program (Figure 4). In Mystery Tree a user can work through the identification key using samples (i.e., a series of photographic images) provided by the program.

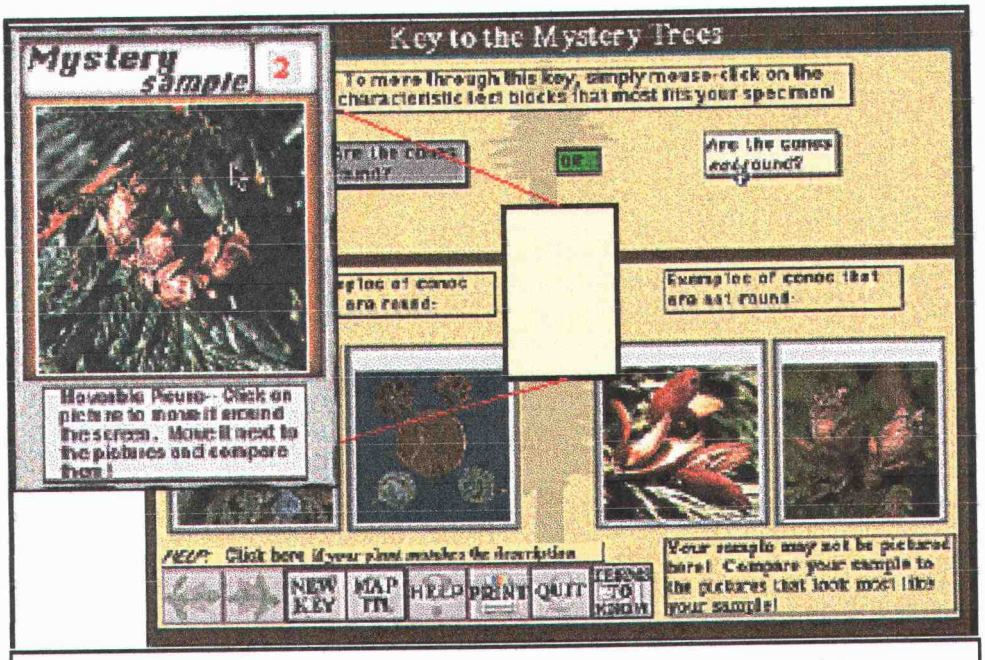

Figure 4. Mystery Tree allows the user to practice using a dichotmous identification key. A user chooses one of four mystery trees, then works through the key using the graphic representations.

Choosing the correct keying sequence will lead the user to a Mystery Tree description, while choosing the improper sequence will open a window that offers "helpful hints" for tree identification.

Students seem to benefit from having a list of their keying decisions available. For instance, if one of their decisions is made in error, they are able to retrace their steps. In order to improve their ability to retrace their steps, as well as to provide a synopsis of their decisions, a component called "Map It!" was included in the program (Figure 5). At any point of the keying process users can review their decisions by clicking on the Map It! button. From the Map It! decision list, users can either click on the forward button to return to the same window of the key, or click on any of the decisions in the list to return to the window of the key where it was made.

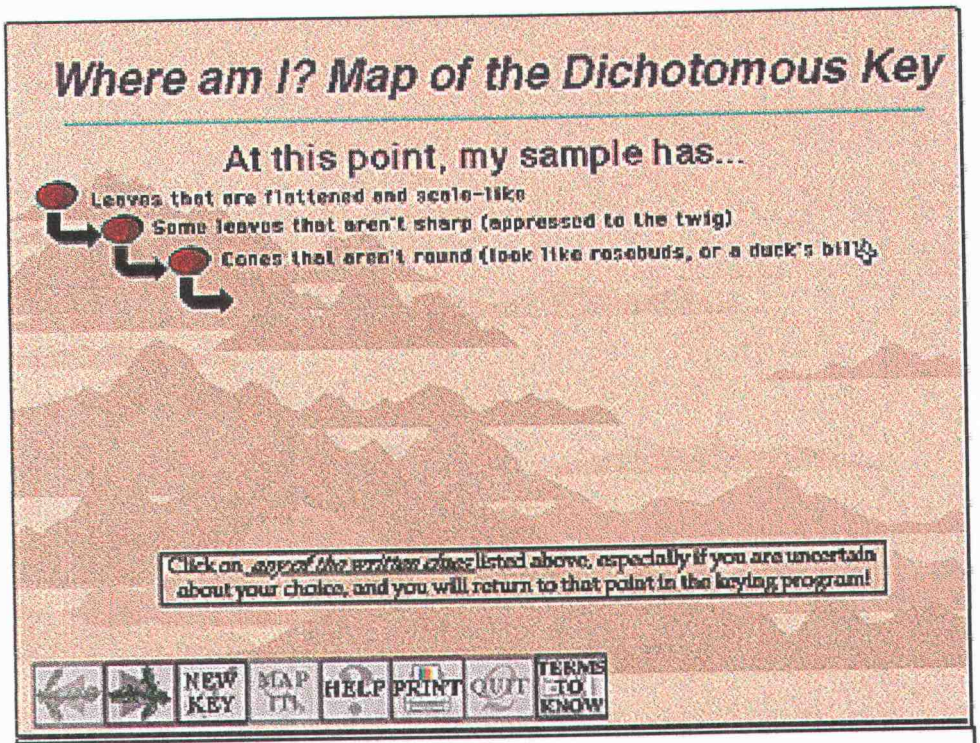

Figure 5. The MapIt! screen associated with the identification screen pictured above.

Plant anatomy and morphology have a language all their own, thousands of terms unique to the study of plants. Some of these terms form the basic vocabulary of tree identification, hence to use many of the identification keys available to students some mastery of these terms must be achieved. In *Conifers of the Pacific Northwest*, terminology cards can be accessed through both hypertext links or by opening the list of terms (Figure 6). Should the student require clarification on any of these terms, a definition accompanied with supporting graphics can be accessed. Another useful feature available through hypertext links is the pronunciation of tree scientific names. Upon clicking a scientific name an audio voice offers the pronunciation found in *Dictionary of Plant Names* (Coombes 1991).

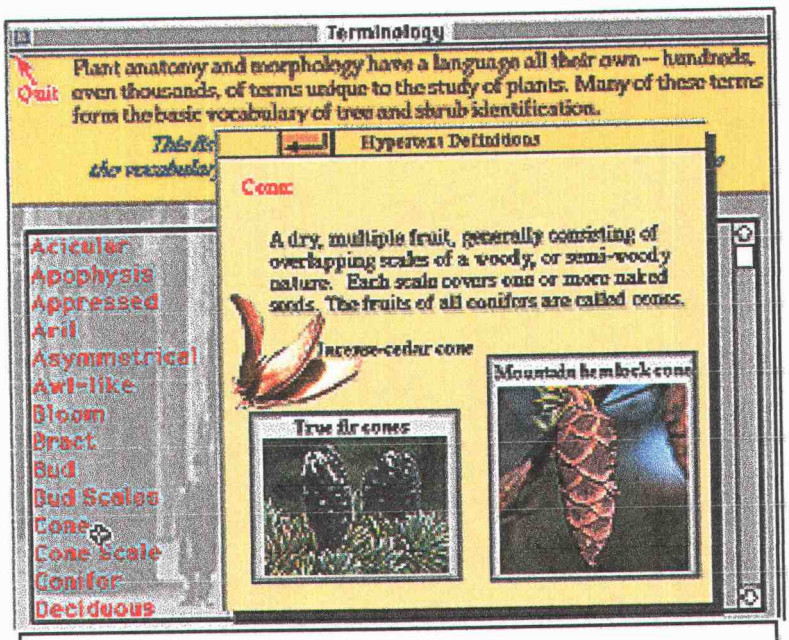

Figure 6. The "Terms To Know" button will open a list of terms for the user. Clicking on a term opens a window containing a definition and supporting illustrations.

Several other on-line resources are accessible in the program. If a user has never used the program before (a response that is asked of the user upon starting the program, on the first screen), the program begins running a tutorial. The tutorial describes the main components of the typical screen as well as the basic layout of the program. If a user needs assistance on using the program, clicking on the Help button, located on the omnipresent control panel, opens a help window through which the user can review the program's structure and function. The tutorial is also accessible through the help window. Geology of Oregon is an interactive map that reveals small pieces of the geologic history of Oregon. By moving the cursor over labeled geographic regions, descriptive text fields appear on the screen. Finally, a user can review a list of references for information used in the program and acknowledgments of the people who helped in the program's development by accessing the Credits window.

Evaluation

In an effort to determine the effectiveness of *Conifers of the Pacific Northwest*, a questionnaire was administered to 12 undergraduates of the College of Forestry (Appendix 2).

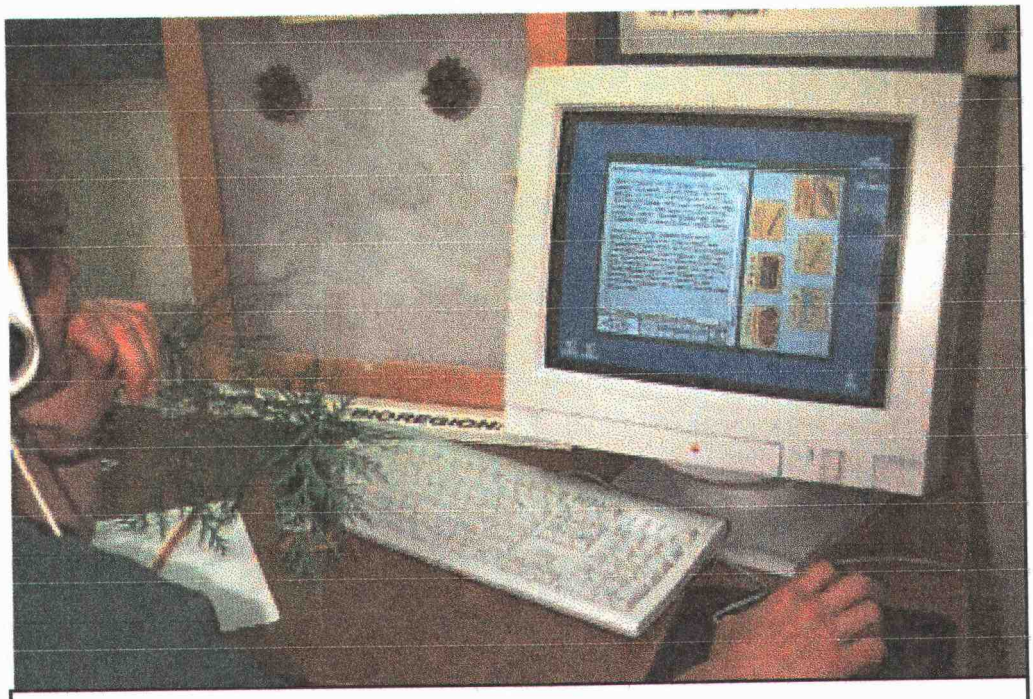

Figure 7. To evaluate the program, student volunteers each completed several tree identification exercises and then completed a questionnaire.

The questionnaire sought feedback regarding the usability of this multimedia program, the value of the program's individual components (terminology cards, identification key, graphics, audio clips, and the on-line help system), and an assessment of the respondent's basic computer skills and familiarity in using identification keys. The questionnaire was designed to provide a summative evaluation of this program. Summative evaluation determines the extent to which the final goals of the program were met. Additionally, receiving qualitative feedback on the questions provided me with responses that can be used to improve the program in the future.

Students involved in the evaluation were chosen based primarily on their tree identification skills. All had completed either the tree identification course or the dendrology

course offered by the College of Forestry, and had received above average marks in the course. None had completed the course more than two years, or less than 3 months, prior to completing the questionnaire. The goal in choosing this sample was to get feedback from students who had been trained in tree identification before, but who had likely not used their identification skills, nor an identification key, within the last three months. No other attributes, such as familiarity with computers or familiarity with multimedia, were controlled.

According to Reeves (1994) testing of multimedia materials should take place in a real setting with meaningful instructional goals, and any observation should be unobtrusive. This practice was followed to test this program. In evaluating *Conifers of the Pacific Northwest,* we applied the tree identification testing strategy traditionally used in the College of Forestry's classes, and altered them to include using the undergraduate study laboratory (Figure 7). Standard testing procedure for the tree identification courses in the College of Forestry is to provide live tree samples in a lab room, and allow students freedom of time and space to identify all the samples. Using this procedure, and given a copy of the book Trees to Know in Oregon to assist them, students were asked to identify two samples. They were also asked to identify two other samples that were located at a computer workstation in the student Self-Learning Center. In both cases the students were given general introductions to the equipment, the questionnaire, and the program (the Trees to Know in Oregon book and its identification key in one case, and a Macintosh computer and *Conifers of the Pacific Northwest* program in the other), then asked to complete the questionnaire as timely and efficiently as possible. Students were also provided the hardcopy user's guide (Appendix 3) as another reference for answering questions about the computer program. Upon completing the questionnaire the students were encouraged to explore the program and make written comments about it. In an effort to observe the behavior of the respondents as they worked with the program, an evaluator not familiar to College of Forestry students sat in an unobtrusive location and recorded the respondent's behavior while completing the questionnaire and timed the keying sequences (Questions 1-4 and 5-8) for comparison.

Results of this testing procedure show promise for the use of *Conifers of the Pacific Northwest.* as an information source for students enrolled in the tree identification courses in the College of Forestry. Many respondents provided helpful feedback regarding the program. Since most of the students already had sufficient computer skills (Questions 16-19) to use the hardware, were familiar with either Macintosh or DOS-Windows platforms, and had used multimedia technology before, it seemed that they were able to focus on the structure and function of the software.

In general, respondents found the program to be easy to use, although one student felt the dichotomous key was not easy to use. 10 students felt that they would prefer to use the multimedia program over the book for the purpose of identifying another sample (Question 9). The observer noted that it generally took students longer to complete the identification sequence using the software than it did when the student used the book (in part a result of the three-minute tutorial that automatically plays for first-time users). The observer also noted that two students used the software and the book simultaneously to identify all four samples, presumably to use the higher quality graphics in the program with the more complete text from the book.

Responses indicated that one of the program's strengths is the glossary of terms, with eleven respondents preferring to use the program over the book (Question 10). As a source of information on trees, eleven students preferred the program over the book, likely due to the number of graphics and non-linear links between information. The program was found to be more effective (11 responses), and much more effective (1 response) as a learning tool than the book, when considering the quality and quantity of graphics (Question 11). Audio clips, which include the pronunciation of tree names as well as helpful hints in using the program, were found to make the program much more effective (1 response) to more effective (10 responses) and "more interesting" (Question 13). One respondent felt that the audio clips did not increase the program's effectiveness, and commented that a couple of the sound clips were repetitive and "annoying."

The on-line "Help" program was not used by the majority of the respondents while completing the questionnaire. Two students did use the on-line help program (Question 15), however, and had contrasting experiences. The question regarding the program was answered for one student by using on-line help, while another student found that "not all my questions" were answered.

Some of the suggestions that students had for improving the CD were to include a position map that graphically portrayed where the user was anywhere in the program (not just in the key), the ability to do full-text searching, and including more animation and video. Several editing suggestions that respondents provided were completed by this author developer in an effort to improve the program.

Lessons for the developer

As a result of completing the multimedia project *Conifers of the Pacific Northwest*, there were several valuable lessons learned. Some of the following lessons are a result of personal experiences with this project, while others are supported by the related literature. In developing this multimedia instructional tool, it was found that one of greatest experiences learned from projects such as these includes learning from others, learning from both mistakes and mastery, and using this learned information to create better multimedia-based educational materials in the future. It is hoped that the lessons that this author learned be read as recommendations to readers interested in designing and developing multimedia educational programs.

Lesson 1: Expertise saves time and costs money. Multimedia program design and development requires unwavering financial and technical support. Over the course of this project's design and development, little financial and technical support were provided for this particular project (i.e. it was an unfunded experiment). This lack of financial and technical support impacted this project in several ways, but mainly with the author's inability to procure expertise on graphics design and computer programming. High quality graphics

and images enhance the usefulness of the program and increase the user's desire to use it. Good programming increases the numbers and quality of interactivity that can be added to the program, and can also increase the rate at which these procedures occur. With financial and technical support it would have been possible to receive instruction to enhance my development skills as well as expertise from others in the campus community.

Lesson 2: Quality takes time. It is important to allow sufficient time for the development of multimedia educational materials. Successful production of these materials requires hundreds of hours of planning, programming, evaluating, revision, and debugging (Sammons 1994). In fact the length of time it requires to complete a multimedia project is often underestimated by 100-200% (Whitten 1992). It is necessary, therefore, to be realistic when development goals are set, and skill levels of the design team and resources available to them must be taken into consideration.

There is also a demand to produce these educational materials in a timely fashion; to avoid what one developer calls "prototype purgatory" (Whitten 1992). Prototype purgatory is described as the state of being constantly caught in prototyping and never being able to finalize a real product. This can result from several different reasons, including constant revision, declining organizational interest, or rapidly changing technology. Prototype purgatory during the development of this project manifested itself as a conspicuous inability to meet production deadlines.

Lesson 3: Take full advantage of multimedia. The value of multimedia is not limited to the fact that it combines individual component media such as images, text, audio, and video. More importantly, interactive multimedia systems can add value to a student's learning experience through enhancing the functions of input, output, processing, and control. The following are several examples that illustrate how to utilize the benefits of multimedia, the majority of which have not been included in the *Conifers* program.

Input. Instructors prefer programs which allow students to add data (Hino 1994). Ideally, students and teachers alike could add text, graphics, audio and/or video to existing

tree descriptions, or even add new trees to the program. Dede (1992) argues that the ultimate potential of multimedia is to "evolve beyond knowledge representation to knowledge construction," where multimedia programs allow the learner to modify or add the "nodes" of data and the "links" between them.

Output. Currently, students using *Conifers of the Pacific Northwest* will be able to use a print button to create hardcopies of information windows. A more valuable process would be to allow students to copy individual component media to a personal file, allowing the student to collect digital information to store and use or review later.

Processing. Multimedia programs can be developed to test and evaluate user performance. For instance, tree identification exams could be provided by the program, evaluated by the program, the responses or scores stored for the instructor's perusal.

Control. The multimedia environment can include a tree identification system that allows a user to create a query by making selections from the query window. The student attempting to identify a sample selects various attributes of interest (e.g. cones, leaves, and bark), specifies values to be associated with those queries (e.g. "upright" cone, "needle-like" leaves, and "furrowed" bark), whereupon only records matching those attributes would be retrieved. This type of query search, the keeping track of hits and misses in query windows, has been developed independently several times, probably because it mimics identification by experts (Estep *et al.* 1993). Another important addition to any program is the availability of full-text searches. Full-text searching allows students to discover information on specific topics independent of the structure of the system.

Lesson 4: Learning about multimedia design and development requires a new curriculum. The process of multimedia design and development forces the designer, particularly if it is an individual and not a team, to use a variety of technologies and to consider many different learning strategies in completing a single project. Creating a program such as *Conifers of the Pacific Northwest*, then, is an appropriate way of applying teaching and learning principles and using new educational technology for higher education students

emphasizing natural resource. Using this technology, however, may require the student developer to emphasize curriculum that is typically not required in a natural resources, or natural resource education curriculum. Taking courses that focus on various aspects of multimedia design and development and on the use of multimedia for educational purposes may allow future developers to remove some of the shortcomings that this author experienced. For instance, the coursework one chooses to take may emphasize innovation and change and the appropriate use of technology. It may emphasize instructional design including presentation design strategies for text-based, graphics, and audio projects. Finally, it may also require the student to learn more about technology (basic hardware and software use) as well as coursework related specifically to the design, development, and evaluation of multimedia. Millheim (1992) discusses these curriculum issues in detail, and provides information that could be helpful for any person considering a project using computer-based educational technology.

Implications

The increased use of computers by natural resource educators will continue to impact the learning environment at our educational institutions. In the past, it was sufficient to finish an undergraduate program with computer skills in basic word and data processing. Currently, it is not uncommon to find students creating slide presentations on computers, searching for information on computer networks such as the World Wide Web, and even establishing Web sites for individual and group projects. As late as 1994 the use of multimedia for program development and communication could be viewed as a "failed revolution" (Solomon 1994). The acceptance of this new technology occurred at a relatively slow rate prior to the mid-nineties. Currently, however, multimedia development technology is improving continuously, and the interest students and faculty have in using multimedia and developing multimedia computer projects is also increasing at all educational levels.

Innovations in computer technology are occurring so quickly that, in the near future, the creation of multimedia programs will reportedly be easily done by novice users. For instance, Java, a simplified, object-oriented, dynamic programming language (van Hott 1995) used to create interactive web pages, will "enhance the appearance of the web by adding animations and other dynamic content (Wingfield 1995). Although Java is considered complex by many and is found to be difficult to learn, the language is being improved upon constantly, and the Java creator, Sun Microsystems, and other companies associated with the tools based on the Java language, continue to develop a suite of development tools and support for Java and the Hot Java browser. It appears that we are seeing the beginning, rather than the end, of the multimedia revolution.

Summary

Conifers of the Pacific Northwest was a first attempt to create a CD-ROM program to be used in conjunction with a course in the College of Forestry. It was also the first attempt by a graduate student, a professional forester by education, in working with multimedia authoring software. This project, then, was both an effort to improve instruction in tree identification through the creation of multimedia educational software, as well as an opportunity for a natural resources graduate student to apply teaching and learning principles to a technologically advanced teaching application.

Multimedia provides a pedagogical framework that has many benefits for the learner. Non-linear networking between content allows learner control. Using multiple, complimentary media improves the prospect for learning since information is presented in different ways. Hypertext and other graphic links between information can improve the process of associating data. Associating data occurs in various forms within a program, from providing the rationale for interface design and tool icon design, to creating a program that reflects the complex relationships found in nature, or the discreet relationships used in the taxonomic classification of trees.

Macromedia Director is only one of a myriad of multimedia authoring tools available for use by both students and multimedia authoring professionals. Director's format is relatively easy to use, and the internal programming language can be used to create basic hypermedia links, such as hypertext and buttons, by even the novice user. Several components that would have improved the program's usability, and were intended to be included in *Conifers of the Pacific Northwest* had to be omitted due to this developer's unfamiliarity with the more complex uses of the language.

Computer software and hardware are being continuously improved, so development and use of multimedia software will likely not be as difficult in the future as many novice developers find it today. Using multimedia authoring software typically requires some investment of specialized equipment, accessible by both the developer and the student. Given the amount of student and faculty interest in this educational medium, increasing numbers of institutions are funding faculty development labs, coursework conversions to multimedia, and computer labs with equipment powerful enough to run multimedia software.

The future in multimedia development, particularly for instructional purposes, seems to be based on the ability to network programs stored on a server with any number of work stations. Although Shockwave is a positive step towards providing that capability, novice developers may find their time best spent using programming languages specific to the World Wide Web, such as the exciting new Hot Java.

This author has found that the design and development of this multimedia educational program has been beneficial for both the developer as well as for the courses in which the completed software will be used. While this was the first CD-ROM based educational project for the College of Forestry, others are pursuing the application of multimedia for educational purposes as well. It is hoped that others will find that one of the greatest experiences in projects such as these is learning from others, learning from our mistakes and our victories, and using this information to create better educational materials in the future.

Acknowledgments

The Conifers of the Pacific Northwest program was made with help from Dr. Edward C. Jensen, director, Forestry Media Center, Oregon State University, Corvallis, Oregon; Mark Kramer, assistant director, Communications Media Center, Oregon State University, Corvallis, Oregon; Dr. Mark Merickel, assistant professor of education, College of Home Economics, Oregon State University, Corvallis, Oregon; and, Mark Reed, instructional media designer, Forestry Media Center, Oregon State University, Corvallis, Oregon.

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APPENDICES

APPENDIX 1

Software Specifications

Software Specifications

The *Conifers of the Pacific Northwest* multimedia tree identification program was developed using Macromedia's Director multimedia authoring software. The Director program is multi-faceted and includes word, graphics, and audio processors, and an internal programming language called "Lingo." Minimum computer requirements to run *Conifers* are a Macintosh 68020 processor or greater,with minimum memory requirements are 4 MB RAM (8 megabytes recommended), with system 7.0 or higher. Playback of Director 4.0 for Windows files requires a minimum 386-based PC with 4 MB RAM and Windows 3.1 running DOS 5.0 or higher. The program is designed to be run on a computer with audio capabilities and at least an 8-bit monitor. The *Conifers of the Pacific Northwest* CD-ROM is designed to run directly from the CD-ROM. For more information on *Conifers of the Pacific Northwest* CD-ROM, contact the Forestry Media Center, Peavy Hall 248, Oregon State University, Corvallis, OR 97331; or, call (541)737-4702. Also, find the Forestry Media Center "World Wide Web" home page, at *http://www.orst.edu/Dept/fmc/* .

APPENDIX 2

Questionnaire used for student assessment

Evaluation of Conifers of the Pacific Northwest

The purpose of this questionnaire is to help me evaluate the computer program that I've been working on. I would greatly appreciate your answering the questions as completely as possible. Feel free to make any comments you'd like in the margins or within the space provided. Thank you for your time.

Usability of *Conifers of the Pacific Northwest (CPN)* multimedia program: complete the following tasks using the *CPN* program:

1. Access information on the cones of Engelmann spruce.
2. Access information on the cypress genus.
3. Locate a definition for the term "decussate".
4. Using the real plant samples in the box next to your monitor;
   a) identify sample A (incense-cedar)
      Sample A's common name
   b) identify sample B (ponderosa pine)
      Sample B's common name

Comparison to "TTK": this section of the questionnaire describes tasks for you to complete using the text, <u>*Trees to Know in Oregon*</u>.

5. Access information on the cone of Sitka spruce.
6. Access information on the pine genus.
7. Locate a definition for the term "compound".
8. Using the real plant samples in the box next to your monitor;
   a) identify sample A (western redcedar)
      Sample A's common name
   b) identify sample B (knobcone pine)
      Sample B's common name

Usability: the following questions ask you to reflect on your use of the software *Trees of the Pacific Northwest: the Conifers*. The questions encourage you to compare the program to your use of the text, <u>*Trees to Know in Oregon.*</u> **Number of responses to each question are included within parenthesis.**

9. If you were given another set of plant samples to identify, which would you prefer to use, the multimedia program or the book?
   a) the multimedia program *Conifers of the Pacific Northwest* **(10)**
   b) the book <u>*Trees to Know in Oregon*</u> **(2)**

10. If you were given a list of terms to define and comprehend, which would you prefer to use, the multimedia program or the book?
    a) the multimedia program *Conifers of the Pacific Northwest* **(11)**
    b) the book *Trees to Know in Oregon* **(1)**

11. If you were given the task of collecting information on trees native to the Pacific Northwest, which would you prefer to use, the multimedia program or the book?
    a) the multimedia program *Conifers of the Pacific Northwest* **(11)**
    b) the book *Trees to Know in Oregon* **(1)**

12. Do the color graphics (quality and quantity) increase the program's effectiveness as a learning tool? (circle one)
    a) much more effective **(9)**
    b) more effective **(3)**
    c) no change **(0)**
    d) less effective **(0)**
    e) much less effective **(0)**

13. Do the audio clips improve the usability of the program? (circle one)
    a) much more effective **(1)**
    b) more effective **(10)**
    c) no change **(1)**
    d) less effective **(0)**
    e) much less effective **(0)**

14. Is the dichotomous key easy to use?
    __ yes **(11)**
    __ no **(1)**

15. Did you use the "On-Line Help" program on the CD-ROM?
    __ yes **(2)**
    __ no **(10)**
        If so, does the on-line help window answer your questions regarding the program? __yes **(1)** __ no **(1)**

General Questions

Basic Computer Skills: This section of the questionnaire asks a few questions about your use of computers and related technology.

16. How would you describe your ability to use computers? (circle a letter)
    a) I generally need help turning computers on and off; **(0)**
    b) I am able to turn computers on and off, but generally have difficulty loading and running computer programs; **(0)**
    c) I can load and run programs from both the hard drive and the disk drive; **(3)**
    d) I can use computer programs with little assistance; **(3)**
    e) I am able to use DOS commands (on IBMs) or use Macintosh windows to

troubleshoot printing, network, and disk problems. **(6)**

17. What type of computer platforms are you comfortable with using?
    a) IBM's or IBM compatibles (runs Windows or uses DOS commands) **(11)**
    b) Macintosh **(4)**
    c) Other **(0)**

18. Have you ever used the following technologies? (circle those you have used)
    a) CD-ROM drive **(11)**
    b) A "multimedia" program **(10)**
    c) The "Word Wide Web (e.g. Netscape)" **(11)**

19. If you circled 18a. and/or 18b., then how would you describe your comfort level when using them?
    a) very uncomfortable; **(0)**
    b) uncomfortable; **(0)**
    c) No more or less comfortable than when I use any other type of computer program; **(2)**
    d) comfortable; **(5)**
    e) Very comfortable. **(4)** **no response: (1)**

Identification Skills: this section of the questionnaire asks a few questions regarding your skills in plant identification and your use of plant keys.

20. Do you have any previous experience with using identification books of any sort (e.g. birds, rocks, flowering plants)?
    __ yes **(12)**
    __ no **(0)**

21. Do you have any previous experience with using dichotomous identification keys?
    __ yes **(12)**
    __ no **(0)**

22. How would you describe your ability to identify trees native to Oregon?
    a) I know very few, if any, trees by name; **(0)**
    b) I know some common trees by their names; **(4)**
    c) I know most of the trees by their names; **(1)**
    d) I know most of the trees by their common names and know many by their scientific name. **(7)**

23. Have you ever used the tree book *Trees To Know in Oregon*

__ yes **(2)**
__ no **(10)**

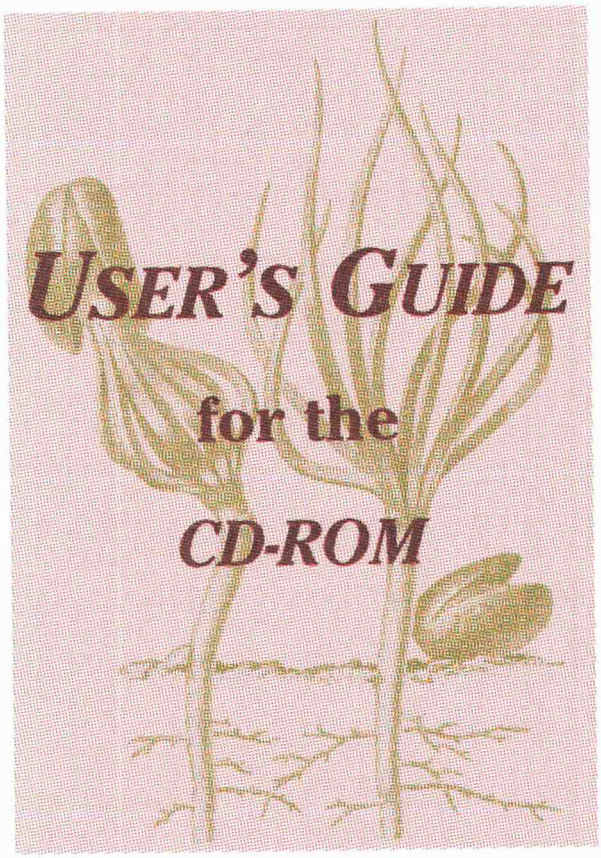
23A. If so, for what reason(s)? (circle a letter)

a) As a source of information about trees native to Oregon.
b) To key out trees native to Oregon. **(2) no response: (10)**

APPENDIX 3

User's Guide

Conifers of the Pacific Northwest



USER'S GUIDE

for the

CD-ROM

Forestry Media Center
College of Forestry
OREGON STATE UNIVERSITY

What's In this Guide

This guide has several sections. The first section provides a brief description of what the program *Conifers of the Pacific Northwest* does. Subsequent sections describe how the program works, including descriptions of both basic layout of program content and how to navigate.

Conifer of the Pacific Northwest

The CD-ROM program *Conifers of the Pacific Northwest* provides learners comprehensive tree information with all the benefits of CD-ROM and multimedia technology. The program provides information on about thirty species of conifers native to the Pacific Northwest, and a few trees commonly planted as ornamentals in this region.

In *Conifers of the Pacific Northwest* you can access layers of increasingly specific information. The heart of the program, **comprehensive tree descriptions**, are accessed through either indices of tree names, or through an **identification key** that guides you to a particular tree genus or species based on various plant characteristics. Each layer of the tree description is like an index card. Some cards focus on general tree information and others on specific tree characteristics. Specific cards feature information on identifying characteristics, products and uses, habitat and range, and other interesting facts.

Each window of *Conifers of the Pacific Northwest* provides nonlinear access to other key components of this program. Hypertext links and an "on-line" **terminology list** provide definitions of more than 50 terms. Brief **audio clips**, accessed by clicking on hypertext, assist in pronouncing scientific names. A "**Mystery Tree**" sub-program allows you to practice keying unidentified samples provided by the program itself. An **interactive map of Oregon** describes the geologic history of Oregon. Animated features support other text within the program.

Hardware Requirements

The CD-ROM version of this program requires a CD player, either internal or external, attached to the computer hard-drive. The CD-ROM contains two program files: one that plays on a Macintosh computer, and one that runs on a PC running Windows. This program requires 4 megabytes of RAM memory to be available during its use.

Graphics in this program, for the most part, were created using thousands of colors. Running the program on a computer monitor with "thousands of colors" capabilities will allow the graphics to be displayed with high quality. On a computer monitor with only "hundreds of colors" capability, the graphics will appear with lower quality.

This program contains audio clips. Computers running this program should have either an internal speaker or have external speakers. Without speakers you will not be able to hear the audio clips, including the tree name pronunciation.

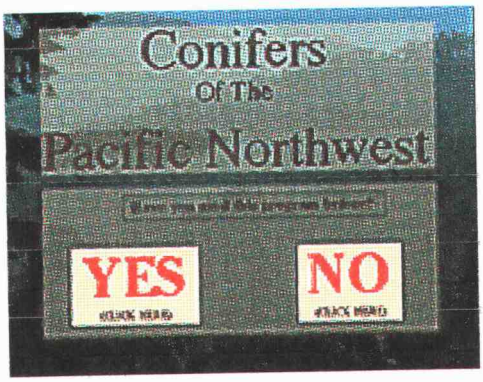
The *Conifers of the Pacific Northwest* CD is designed to run directly from the CD-ROM, so you do not need to drag any of the files to your hard disc.

Beginning the Program

On a Macintosh: Start *Conifers of the Pacific Northwest* by double-clicking on the icon contained on the CD.
In Windows: Start *Conifers of the Pacific Northwest* by double-clicking on the file name CONIFERS.EXE

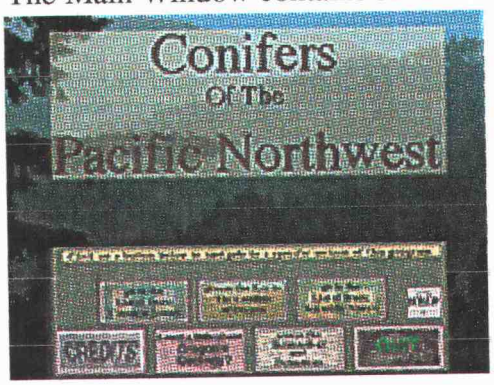
The Beginning

The first screen of the program contains one question and two buttons. If you have used the program before, click on the "yes" button, and the next screen to appear will be the Main Window. If you have not used the program before, click on the "no" button and the program will present you with some of its key features.



The Main Window

The Main Window contains seven buttons that you can click on to access different parts of the program.

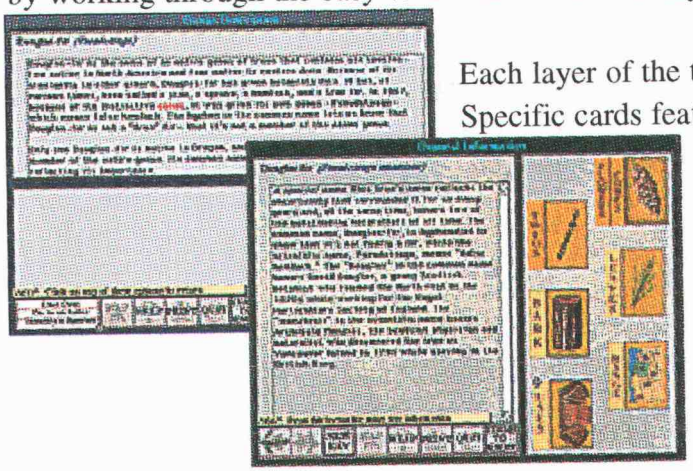


Please experiment! If you become lost in hyperspace, click on any "QUIT" button to return to the Main Window. Clicking on any "backward" button will also return you, in several steps, to the Main Window. Descriptions of these buttons can be found in the section entitled *"Control Panel."*

Tree Information

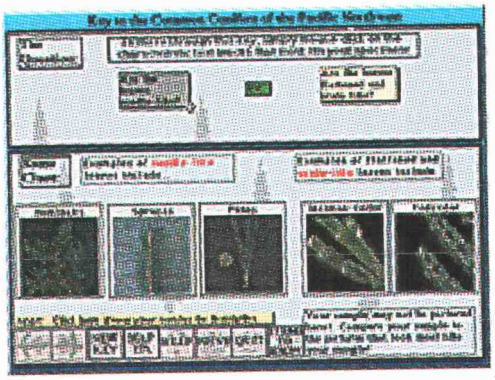
Information on trees can be accessed from the Main Window of the program. To go to the Main Window, click on the "QUIT" button in the control panel.

You can access tree information by knowing the tree's common name, scientific name, or by working through the easy-to-use identification key.



Each layer of the tree description is like an index card. Specific cards feature information on identifying characteristics, products and uses, and other interesting facts. There is at least one card per species for each of the following characteristics: bark; needles or leaves; twigs and buds; flowers; fruit; tree uses; tree ranges.

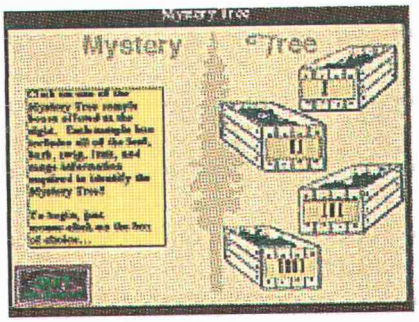
The Identification Key



To identify a plant using the key in this program, click the "NEW KEY" button in the control panel, or return to the Main Window by clicking on the "QUIT" button.

To use the key, simply click on the question box (*) as it applies to your specimen.

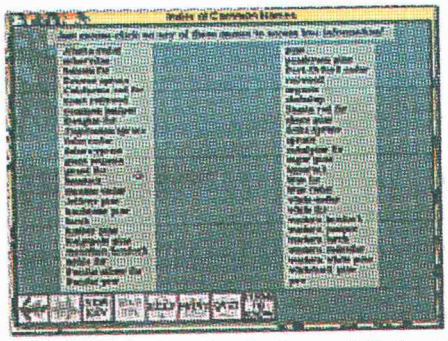
Mystery Tree



Mystery Tree is a program that allows you to practice using the identification key. At Mystery Tree's main window, clicking on one of the Mystery Tree boxes will begin an identification key that includes pictures of an unidentified sample. Your goal in Mystery Tree is to identify the sample correctly by comparing your sample with the the text and graphics of the key, and then clicking the correct clue button. The same control panel buttons are active in Mystery Tree that are active in the main identification key.

Mystery Tree sample cards are moveable-- move them around the screen for easy comparisons to the other graphics.

The Indices of Tree Names

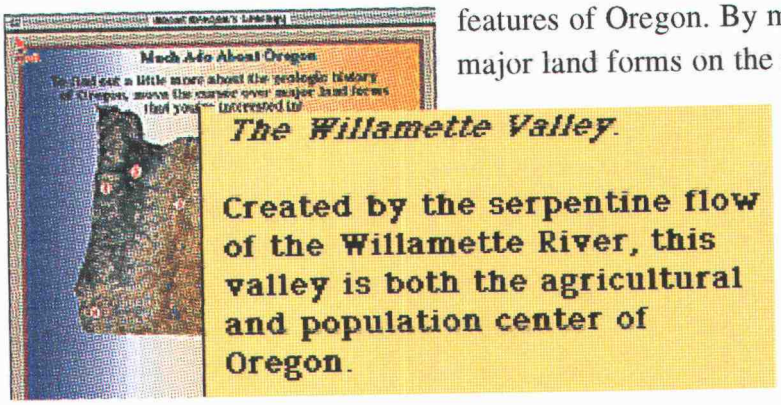


Each name in the Index of Common Names is "hypertext"; click on the name of the tree you're interested in, and the program will take you directly to its tree information. For some trees, more than one common name is listed.

Each name in the Index of Scientific Names is also "hypertext;" click on the name of the tree you're interested in, and the program will take you directly to its tree information.

Geologic History of Oregon

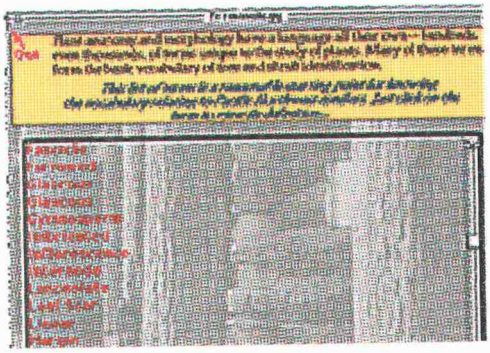
This movie-within-a-movie allows you to discover a little more about the major geologic features of Oregon. By moving the mouse cursor over major land forms on the map, text boxes describing these features will appear.



To exit this and any other movie window, click the box on the upper left-hand part of the frame.

Macintosh Windows

List of Terms



This movie-within-a-movie allows you to look up definitions of commonly used tree identification terms. Just click on the hypertext word you want defined, and a definition card will appear! To exit this and any other movie window, click the box on the upper left-hand part of the frame.

Macintosh Windows

Navigating From the Main Window

Index of Common Names

On the Main Window, click the button seen at the left if you would like to access a list of common names for the conifers described in this program. In this list, mouse-clicking on any of the names will allow you to access information for any of the trees.

Key to the Conifers of Oregon

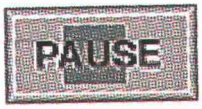
On the Main Window, click the button seen at the left if you would like to access the identification key for the conifers described in this program. Working through the key will allow you to identify any of these trees. **From the key**, click on the "Mystery Tree" button to practice your keying skills! *(see the section on Mystery Tree for more information)*

Index of Scientific Names

On the Main Window, click the button seen at the left if you would like to access a list of scientific names for the conifers described in this program. In this list, clicking on any of the names will allow you to access information for any of the trees.

Credits

On the Main Window, click the button seen at the left if you would like to review the list of sources for text, graphics, and other information used in this program, as well as the names of the design team. *While looking at the credits*, you can click the "PAUSE" button in order to look more carefully at the text, then click on the "CONTINUE" button to finish reviewing the information. Hit the "SKIP" button at any time to get to the Main Window.



Geology of Oregon

From the Main Window or, from any tree's description of range, click the button seen at the left if you would like to access an interactive map describing the geologic history of Oregon. By holding the mouse cursor over areas of interest on the map of Oregon, descriptive text will appear to tell you a little more! To exit this and any other movie window, click the box on the upper left-hand part of the frame.

Macintosh Windows

Terminology List

On the Main Window, click on the button seen at the left if you would like to access a list of terms and definitions helpful to the study of plants.

Plant anatomy and morphology have a language all their own-- hundreds, even thousands, of terms unique to the study of plants. Use this section of the program to improve your comprehension of these dendrological terms. To exit this and any other movie window, click the box on the upper left-hand part of the frame.

Macintosh Windows

Quit

On the Main Window, click on the button seen at the left to leave the program and return to your normal operating system.

The Control Panel

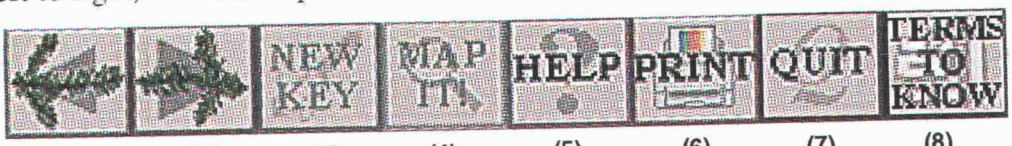
The control panel is the standardized row of buttons seen on the lower left-hand side of the computer screen. It contains eight buttons, all similar in color.

A button can be active or inactive, depending on which screen is shown on the monitor. Active buttons are easily readable, and when the cursor is moved over one, a help-line *(a line of text that appears when the cursor is over buttons)* appears that describes its function.

Inactive buttons are veiled with white *(see buttons (3), (4) below)*. When the cursor is moved over a button that is inactive, a help-line appears that reads "this button is inactive."

Normally, the cursor shape is an arrow. However, over buttons and some text blocks the cursor changes to a cross-hair as a hint for you to look for active buttons and text.

From left to right, the control panel buttons are:



Backward button (1): to move back one screen. The "Backward" button may not send you to the exact screen that you had just accessed-- this is the computer's failure, not yours. Just use the control panel buttons to navigate until you are reoriented.

Forward button (2): to move ahead one screen;

New Key button (3): to begin the identification key at the key's first screen;

MapIt! button (4): this button is only active while you are working in the dichotomous key. If you are in the key and you would like to see a list of the characteristics that you have ascribed to your sample while keying, just click the "MAP IT!" button to view this list;

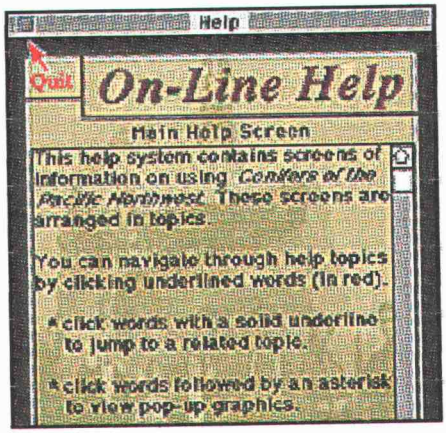
Help button (5): to access the on-line "HELP" window;

Print button (6): to print the screen that is displayed. This button will send the screen image, scaled to 50 percent, to your local printer;

Quit button (7): to return to the Main Window;

Terms to Know button (8): to access the "Terminology List" window.

On-Line Help



The on-line help system is a computer-based user's guide. If you have problems finding information or navigating through the program, then you can click on the "HELP" button to access "On-Line Help."

"On-Line Help"contains screens of information on using *Conifers of the Pacific Northwest.* These screens are arranged in topics. You can navigate through help topics by clicking underlined words (they also appear in red).

Click red-colored words with a solid underline to jump to a related help topic. Click words followed by an asterisk(*) to view pop-up graphics.

These are the topics that are covered in On-Line Help:

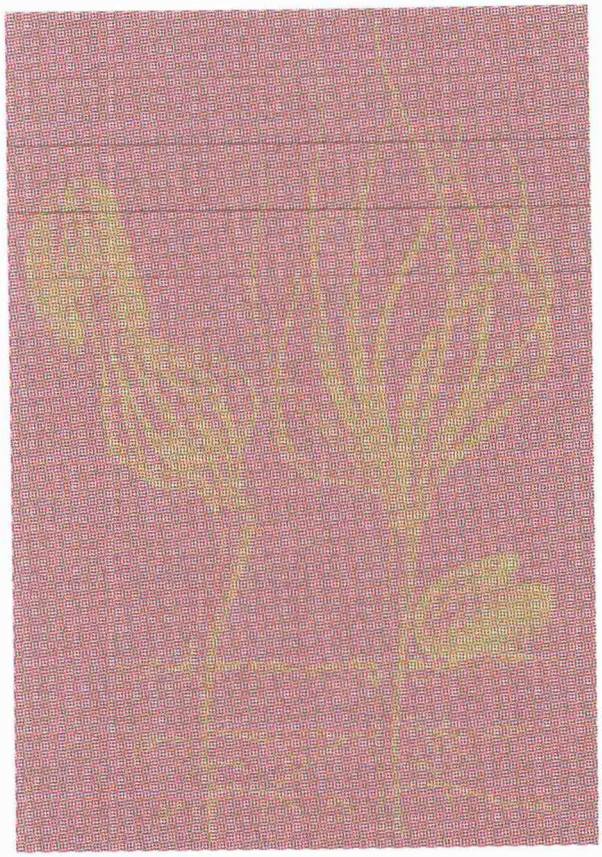
Balloon Help
Buttons
Control Panel Buttons
Cursor
Dichotomous Key
Geologic History of Oregon
List of Common Names
List of Scientific Names
Mystery Tree
Terminology
Tree Information
Viewing the Introduction

Hypertext

Red text and dark-blue text are both a type of button called "hypertext." Words in red are "hypertext" words that are linked to terminology cards. If you need a red "hypertext" word defined, such as the word "cone," just click on it. To remove the terminology card from your view, click on the arrow on it's upper-left hand corner (*).

Words in blue are "hypertext" words that are linked to audio clips. These are used on the tree information cards to help you pronounce the trees' scientific name. To listen to the pronunciation of a tree's name, just click on the scientific name highlighted in blue. Fore instance, upon clicking on the scientific name ***Pseudotsuga menziesii,*** you will hear a voice say, "Douglas-fir, soo-doe-soo-gah men-zee-zee-eye."

Enjoy this program. We hope you get good use from i



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