Teaching Methods

OrchardSim: An Apple Orchard Design Simulation Using a Multimedia Interactive Computer Program

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Additional index words. teaching methods

Summary. "OrchardSim: Design of an Apple Orchard" is a computer simulation program that was developed as a tool for students and new apple growers to understand the process involved in designing an efficient apple orchard. This program was developed on Toolbook software. It explores key elements involved in designing an apple orchard. Users are introduced to these elements and then asked to make selections for each of the following parameters: soil type, cultivar, rootstock, and management system. The goal of the program is to find compatible selections that will result in an appropriate design of a 1-acre orchard. This full-color program uses text, graphics animation, and still pictures to provide the following: introductory and review information about each parameter, opportunities for the user to make a selection for each parameter, and a check for choices made to determine compatibility. Users receive feedback for each specific choice made for each of the parameters throughout the program. This simulation presents an alternative instructional tool, whereby the user plays an active role in the learning process by practicing and reviewing information at one's own pace. OrchardSim provides users with immediate feedback and an excellent opportunity for making high-risk decisions, with no financial loss that otherwise would have been costly if the learning process were pursued in the real orchard.

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This project was funded by an IBM Innovations grant *received from the* Educational Technologies *Board of the Univ. of Illinois, We acknowledge the invaluable advise of* Paul *Hardin and Mary Michaels and the excellent* technical *expertise* provided *by Raymond* Langely. The cost *of publishing this paper was defrayed in part by the payment of page charges. Under postal* regulations, *this paper therefore must be hereby marked* advertisement *solely to indicate this fact.*

Computer simulation is a powerful tool for teaching science in the classroom (Marks, 1982). A computer simulation usually is defined as a representation of a real-world phenomenon or situation in which the user interacts with the simulation (Kowalski, 1985). The user makes decisions by manipulating various input variables to determine the means to find the best solution for a problem.

Recently, there has been interest in using computerized interactive programs as supplements to horticultural classroom instruction (Shaw, 1993; White et al., 1990). Innovative computerized lessons are effective tools for teaching horticulture students the myriad of issues and problems of horticultural and biological significance. "OrchardSim: Design of an Apple Orchard" is a fill-color simulation that uses text, graphics, animation, and still pictures to explore the key elements involved in designing an efficient and fictional apple orchard. It's use is appropriate for students and growers interested in establishing a new orchard. OrchardSim does not consider all factors involved in apple orchard establishment, such as land topography, scion–rootstock graft-incompatibility, triploid cultivars, or disease susceptibility; however, these factors will be included in future versions of this software program. Users can view the impact of decisions made on the outcome of the design without taking any financial risks or making long-term binding commitments.

OrchardSim was developed on multimedia Toolbook authoring software and may be used on any personal computer with a Windows operating system or any Mac-II system with a Soft-PC program. It is designed for novice and expert computer users. It may be used as a supplemental teaching tool during lessons on orchard establishment and design or as an independent aid for practice and review. This program may be valuable for extension advisors teaching technical fruit-growing workshops offered to potential growers interested in establishing an apple orchard or to seasoned growers interested in establishing new apple orchards. OrchardSim allows users to make decisions and receive feedback about compatible parameter selections. Thus, the goal of this exercise is to find compatible selection combinations that will result in an efficient use of land space and to establish a desired density planting of an apple orchard.

OrchardSim, as well as any instructional simulation, is comprised of three major aspects, including a scenario, an instructional overlay, and a model (Reigeluth and Schwartz, 1989).

The scenario

The scenario offers information to the user on the real-world phenomenon that is being simulated. It presents the context for the simulation. OrchardSim contains its scenario within the first screen following the title screen. It consists of a description of the simulation, user expectations,

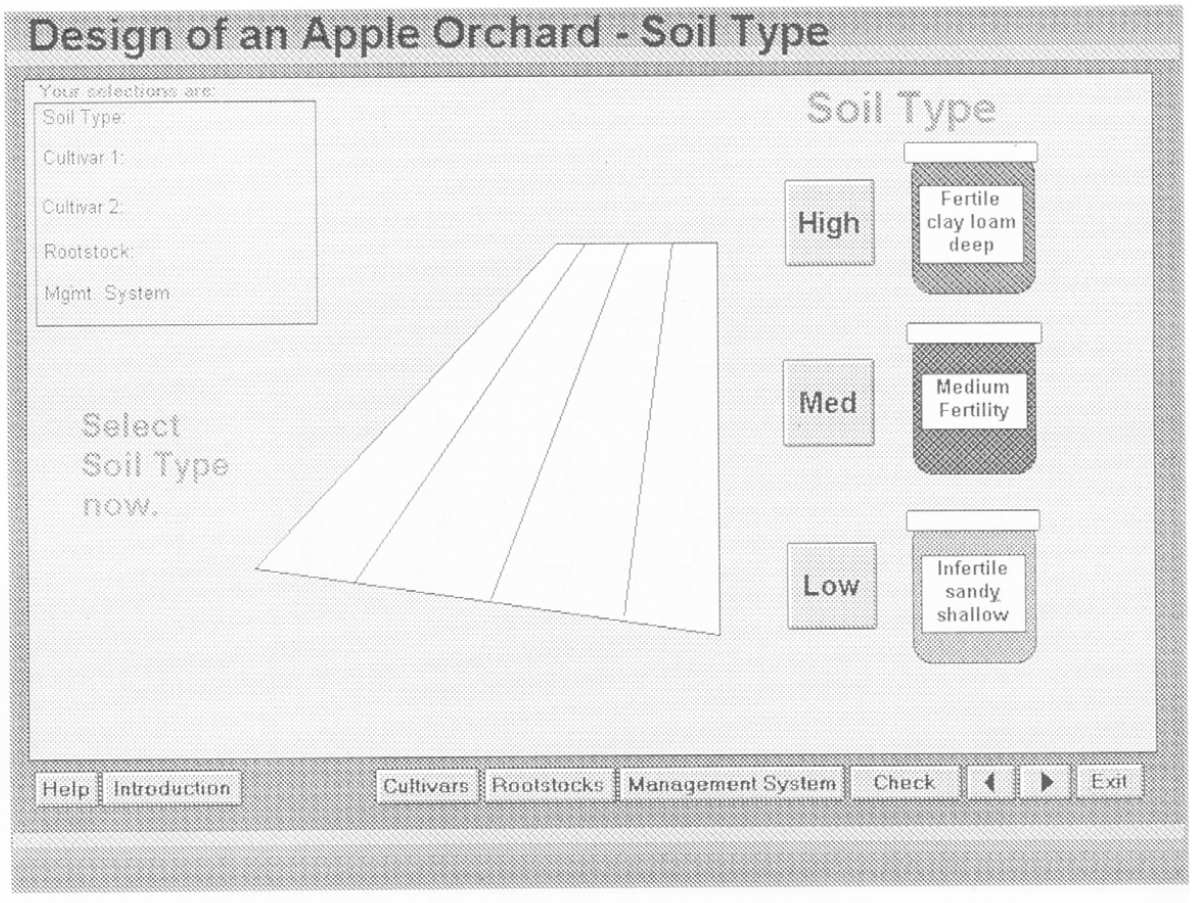

Fig. 1. A *Decision Card to select among thee different soil fertility types.*

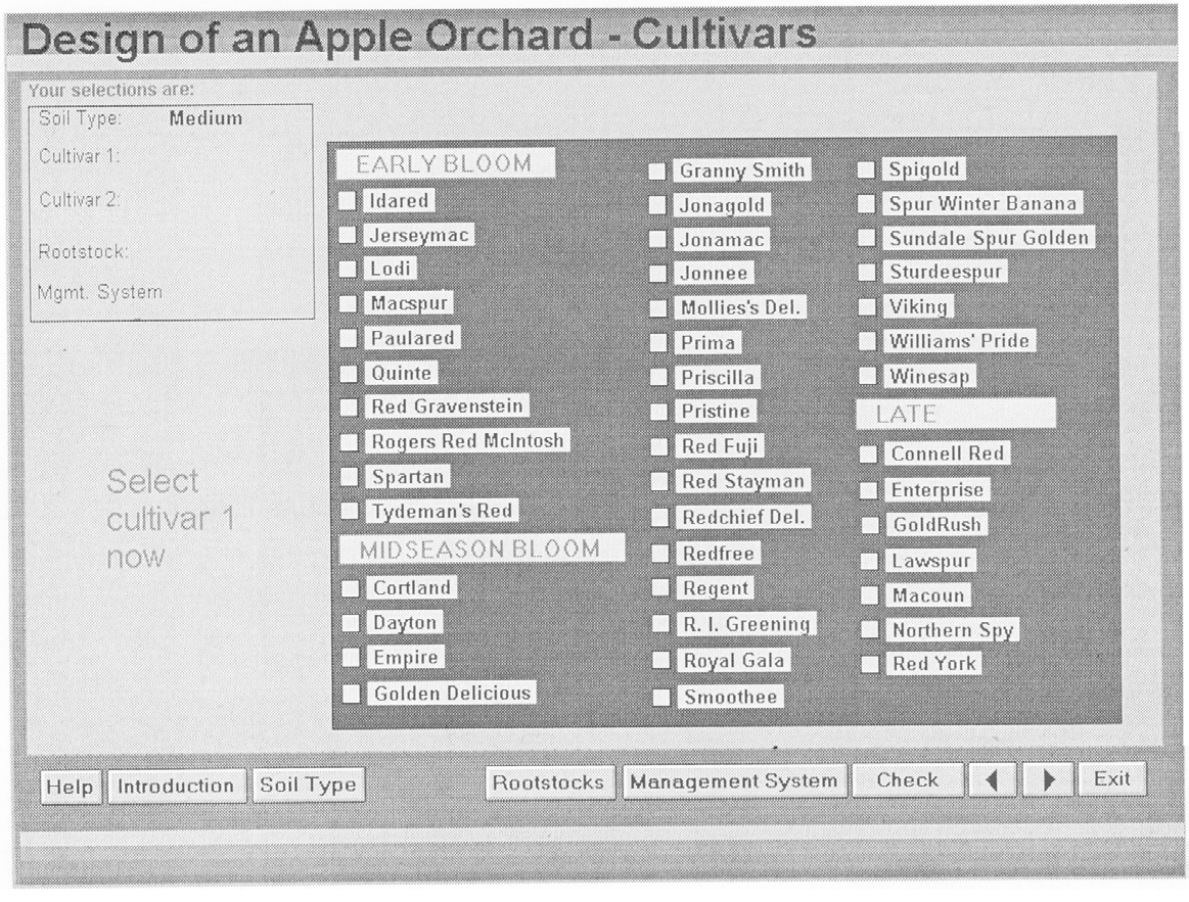

Fig. 2. *A Decision Card to select among varios apple cultivars; this card is displayed twice to allow the user to choose two cultivars.*

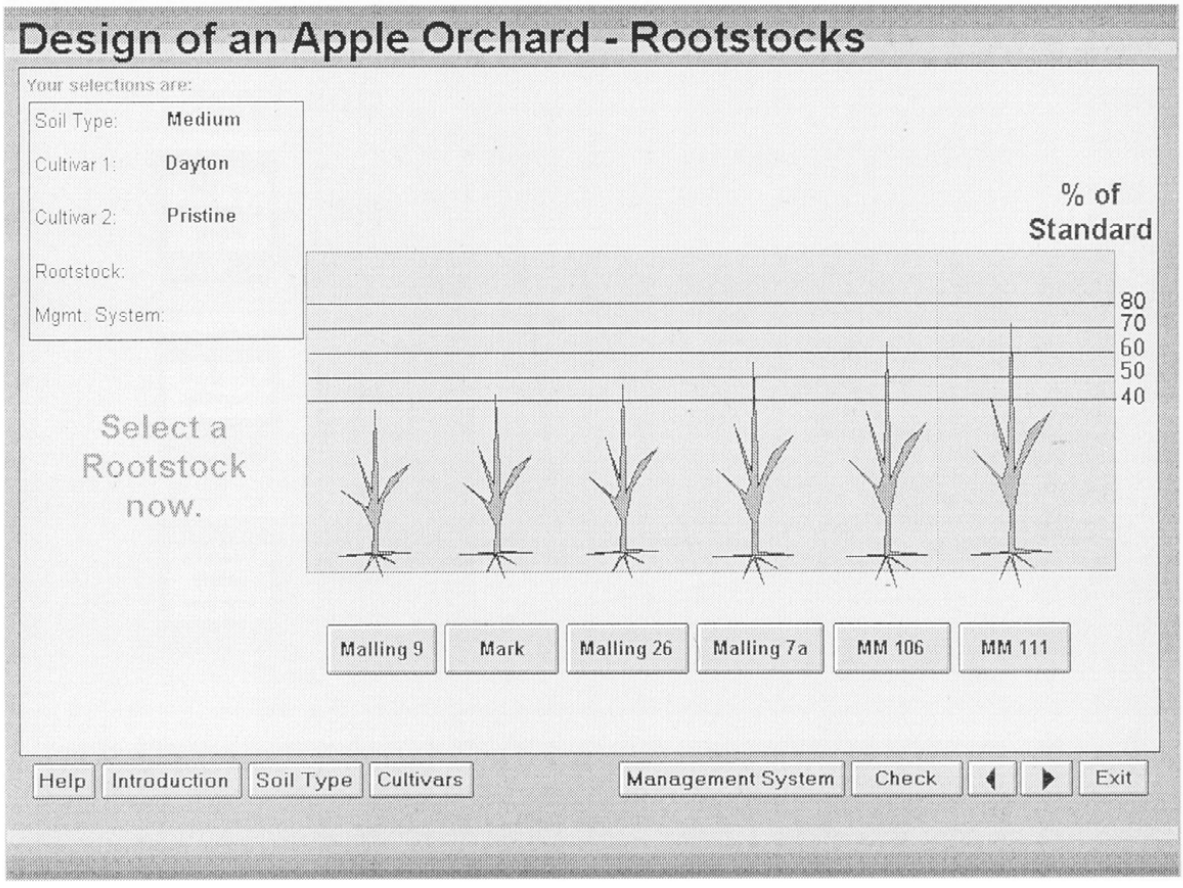

Fig. 3. *A Decision Card to select among various apple rootstocks.*

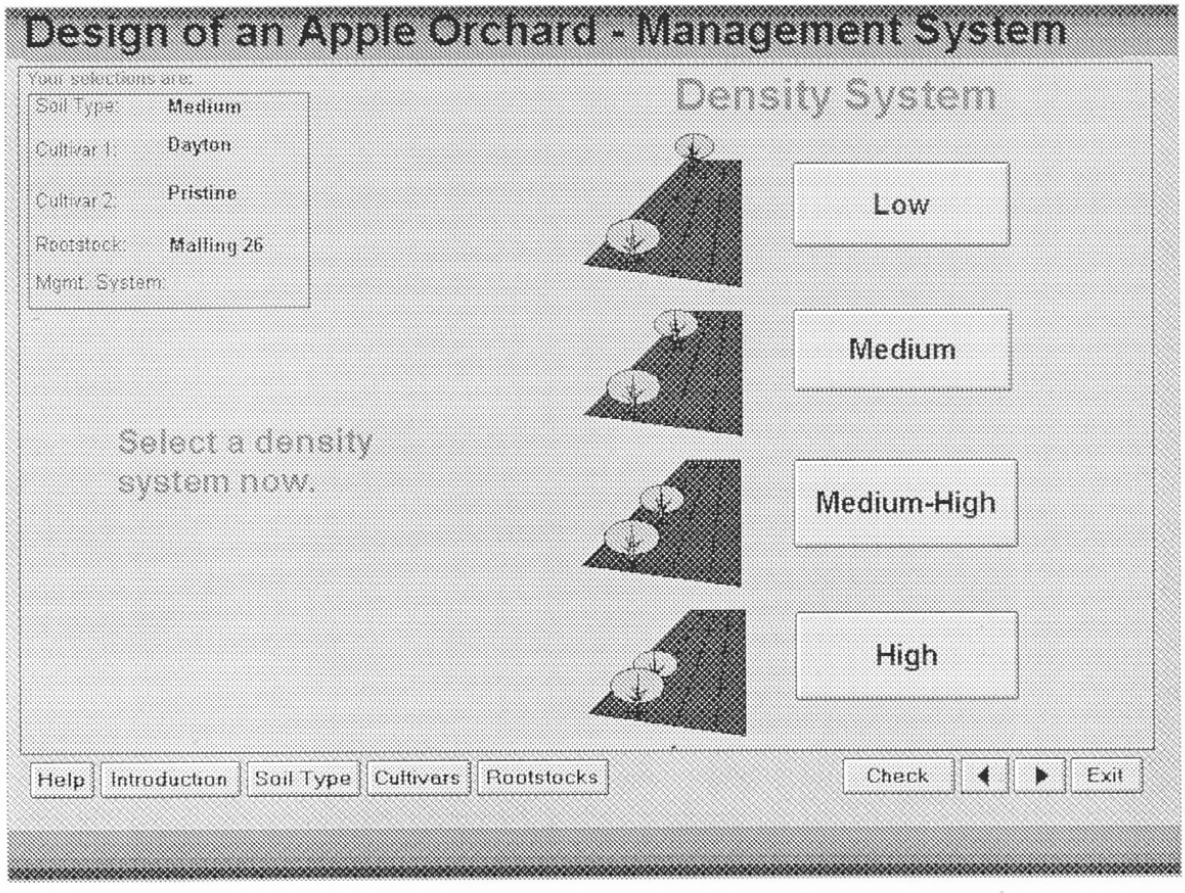

Fig. 4. *A Decision Card to select among four management systems:*

simulation goal and format, and general instructions for moving around the program. This scenario screen reads as follows.

"This simulation will explore the key elements involved in designing an apple orchard. The user will make selections for the following parameters: soil type, cultivars, rootstock, and management system. The goal of this exercise is to find compatible selection combinations that will result in the efficient design of an apple orchard. This program provides the following format:

1) Introductory and review information about each parameter.
2) Actual selection of each parameter.
3) Checking selected parameters for compatibility.

Throughout the simulation, the user will review the computer screen for information and/or instructions for parameter selection. Click on Help or the right arrow to continue through the program."

The instructional overlay

The instructional overlay engages the user in learning the information by implementing interactivity tasks into the program. This is accomplished by a particular method that is recommended at each decision point. The overlay should stimulate cognitive engagement and thereby facilitate comprehension (Reigeluth and Schwartz, 1989).

Users interact with a computer program such as OrchardSim via a mouse. More importantly, the user manipulates the mouse to make variable selections that are stored in the program for future check of parameter compatibility. The following is a description of the simulation's methods for encouraging interaction.

The first screen of OrchardSim consists of an apple tree displayed with the program title. When this screen is viewed, the user can begin the program by clicking on the right arrow button located at the lower right corner of the screen. This also is how the user can move from screen to screen.

The simulation allows the user to make four selections concerning important elements or parameters in designing an apple orchard. The user will review information about each parameter before a selection is requested. Soil-type selection involves choosing among high, medium, and low fertility (Fig. 1). Cultivar selections involve choosing two cultivars within the same bloom period (early, middle, or late) (Fig. 2). Rootstock selection involves choosing among Malling 9 (M.9), Mark, M.26, Malling-Merton 106 (MM.106), and MM.111 (Fig. 3). Finally, management-system selection involves choosing among high, medium-high, medium, and low density (Fig. 4). Four successive parameter selections and a check for compatibility are required during a first run through the program. In other words, users must select a soil type, two cultivars, a rootstock, and a management system. Then they must check for compatibility of the-selections made. It is important to note-that the review information displayed about cultivar and rootstock Parameters emphasizes scion cultivar tree-size differences, rootstock tree-size differences, and the influence of the rootstock–cultivar selection on the final tree size.

To simplify the selection process for the user, each screen in the program consists of graphic elements displayed in common areas on the screen.

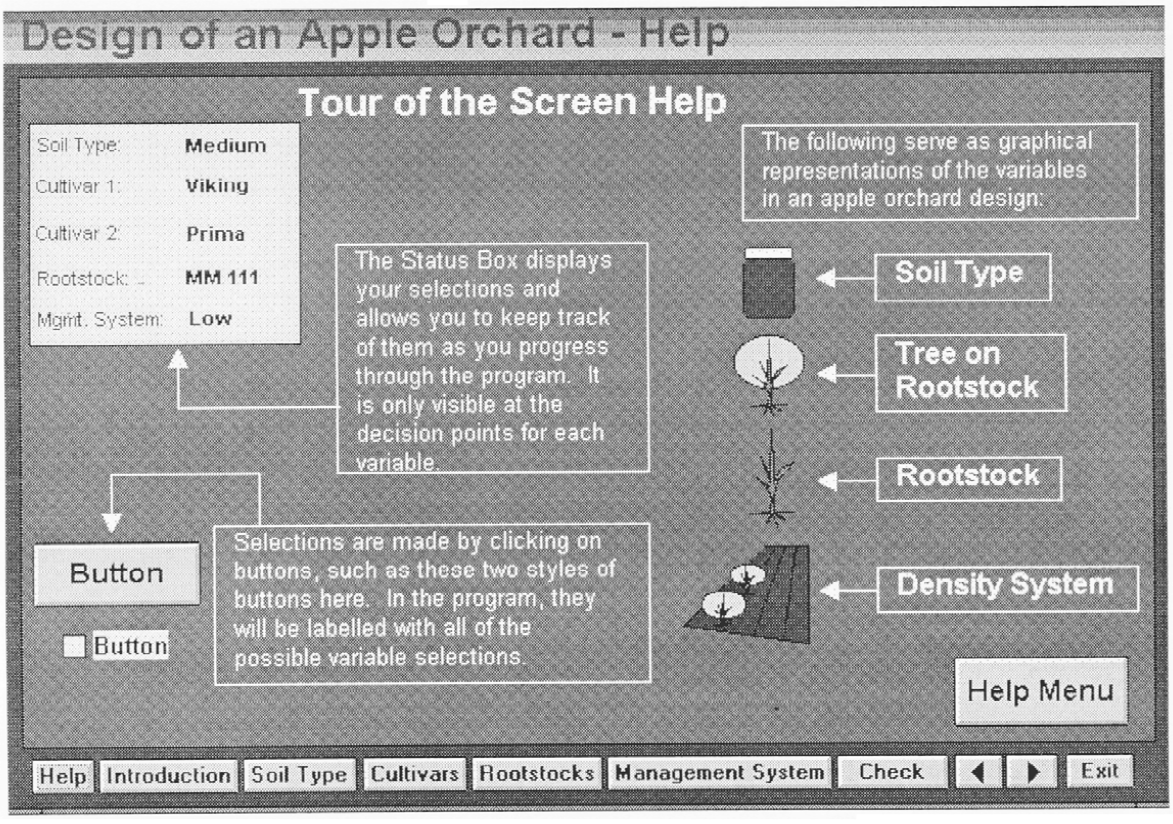

Fig. 5. *A Tour of the Help screen illustrating different parameters involved in orchard design, the status box of selections made, and a brief explanation of buttons and their use.*

For example, various buttons are displayed across the bottom of the computer screen. These buttons are Help, Introduction, Soil Type, Cultivars, Rootstock, Management System, the left and right arrows, and Exit.

All soil-type, cultivar, rootstock, and management-system characteristics and factors used for calculating tree spacing" have been derived from textbooks (Childers, 1983; Hartmann et al., 1988; Westwood, 1993), nursery catalogues (StarkBro's Fruit Tree Catalog, Hilltop Catalog and Handbook, Treco Oregon Rootstock Catalog), and S.S. Korban's data. All this information then was compiled by S.S.K. and included in the programming and screen displays of OrchardSim.

Help. The user should read the Help menu before beginning. The Help menu contains three separate menus: Basic Help, lower screen buttons, and Tour of the Screen.

The Basic Help menu is designed for novice computer users, because it offers an explanation regarding the basic principles of pointing and clicking a mouse. The lower screen buttons menu describes how to use the buttons along the bottom of the screen. The Tour of the Screen menu explains the various graphics and buttons throughout the program (Fig. 5). Included on this screen is the status box, a graphic that displays the user's parameter selections as they are made, allowing users to keep track of their selections as they progress through the program. Also included on this screen are different button styles that are used at each decision point. Finally, a description accompanies graphical representations of the parameters to familiarize users with what will be seen in the program.

Introduction. Clicking on this button allows users to review the scenario and introductory information about parameters involved in the apple orchard design process.

Soil Type. This button allows users to return to the soil type segment of the program to review information about soil types and make new selections.

Cultivars. Clicking on this button returns users to the cultivar segment of the program to review information about cultivars and their bloom periods.

Rootstocks. This button returns users to the rootstock segment where they may review the information and make new rootstock selections.

Management System. Clicking on this button allows users to return to the management system segment of the program to review information about densities and make new selections.

Cheek. After making anew selection, users should click on the Check button to return to the Check screen to check for compatibility of the combination of parameters selected (Fig. 6). This action will result in either an error message or a successful design of an apple orchard. If the parameters are incompatible, an error message providing feedback about the incompatibility of specific selected parameters will be displayed. For example, if the two cultivars are incompatible for bloom, an error message displays the following: "The cultivars that you have selected are incompatible. Would you like to make other selections?" Users then should choose another cultivar. If

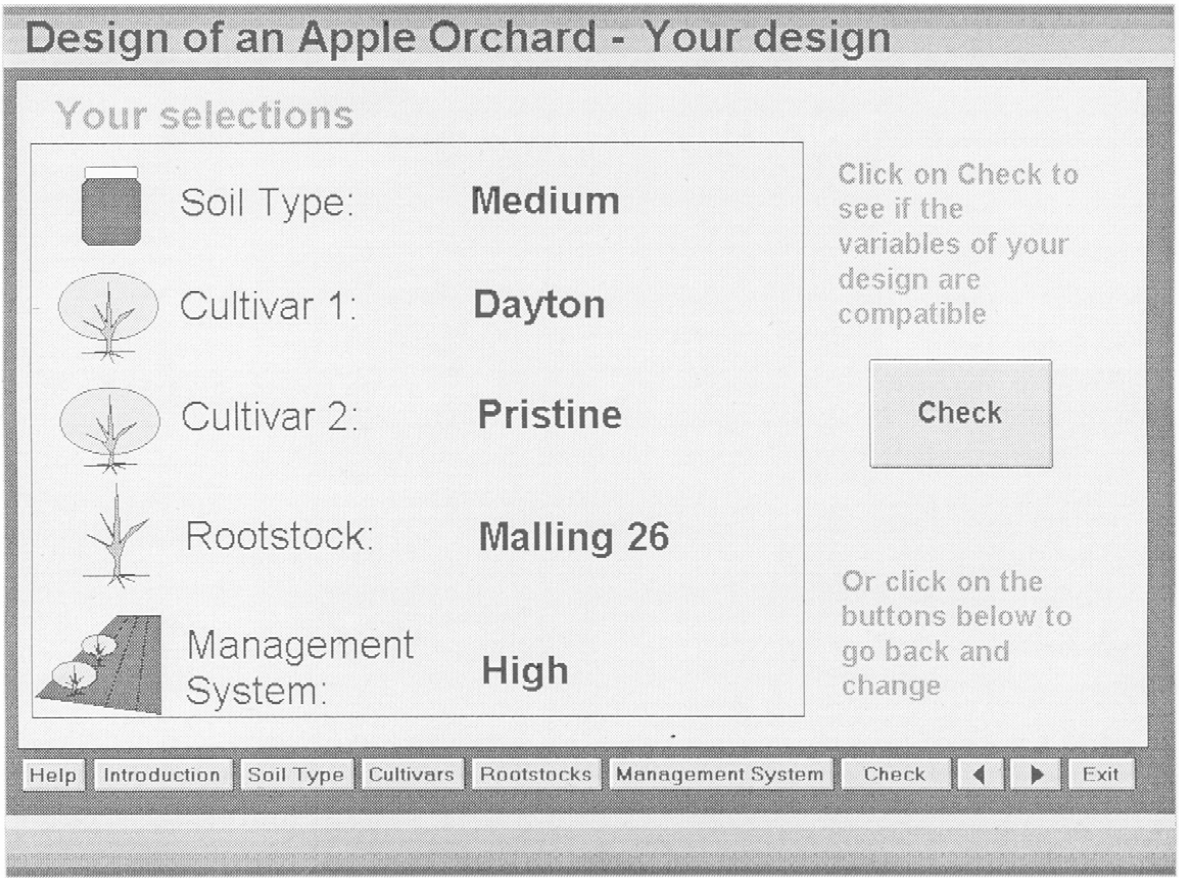

Fig. 6. *A Check screen is displayed after all parameter selections have been made to verify whether or not all selections made are compatible.*

users click on the OK button, the program returns to the introductory information about cultivars for review and provides new selections. This feedback dictates that users review and practice parameter selection for all types of orchard designs. On the other hand, if parameter selections are compatible, a screen displays a fruiting apple tree along with the following statement, "Congratulations! You have designed an apple orchard." In addition, a screen that shows the final simulated apple orchard design will follow (Fig. 7). This screen will illustrate the total number of trees per acre, the distance (in feet) between trees in a row, and the distance (in feet) between rows. Following a successful design, users may go back directly to the selection screens of any parameter and make a new selection without going over the review and introductory material of that parameter, and then view the outcome of the new permutation of parameters.

Left and right arrows. Clicking on the left and right arrows returns users to the previous screen or allows them to proceed to the next screen in the program, respectively.

The model

The model of a simulation represents the casual relationships that govern the functioning of the simulation (Reigeluth and Schwartz, 1989) It is the representation of the phenomenon that is being simulated; that is, the procedure or process that the program is attempting to mimic (Alessi and Trollip, 1991).

OrchardSim represents a logical simulation because its programming code involves a set of if–then statements that function as the check process by which the simulation finds parameter compatibility of users' selections (Alessi and Trollip, 1991). The program checks for compatibility between the two cultivars, soil type and cultivars, soil type and rootstock, and finally rootstock and management system. As explained above, feedback is provided in the form of error messages for each of the compatibility checks. Users may make new parameter selections, if desired.

This simulation functions by assuming a particular logic when selecting apple-orchard design parameters. Users can make compatible parameter selections if they understand some basic principles behind efficient apple orchard design. For example, a higher-density (i.e., more intensive management) system for planting is necessary for highly dwarfing rootstock grown in low-fertility soil types. Conversely, a lower-density system is necessary for invigorating or nondwarfing rootstock grown in high-fertility soil types. Further, because cross-pollination is required for fruit set in an apple orchard, two cultivars should be selected based on at least 50% overlapping or similar bloom periods (i.e., early, middle, or late blooming). This program, however, cannot yet handle triploid cultivars, which require planting at least three different cultivars instead of two.

OrchardSim offers an alternative means of understanding the logic and parameters involved in the designing an economically sound apple orchard. Users play an active role in the learning process by practicing and reviewing information at their own pace. They receive immediate feedback and can make high-risk decisions with no financial loss that otherwise would be

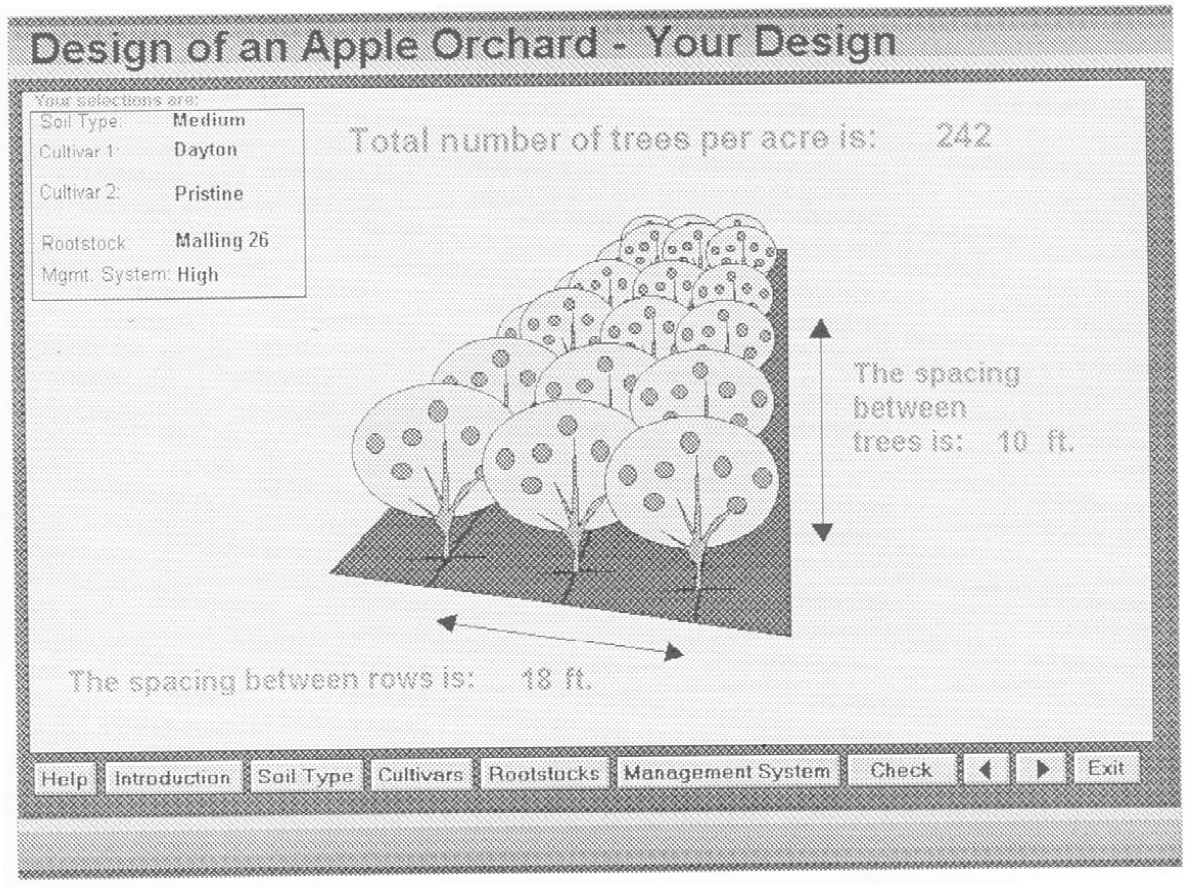

Fig. 7. An illustration of a successful design of an apple orchard displaying number of trees per acre, spacing between rows, and spacing between trees within a vow based on selections made as presented in the Status Box on the upper left hand comer of the screen.

very costly should they attempt to learn by actually designing an orchard in the real world.

OrchardSim was subjected to a pilot test study in Spring 1995, whereby 20 undergraduate students enrolled in a tree fruit science class at the Univ. of Illinois were asked to run the program, complete a survey questionnaire, and provide other comments on the overall quality and content of this software program. The overall program was rated very good to excellent for visual appeal, content, and delivery. Minor screen problems were reported and have been corrected. Moreover, eight horticulturists (Dept. of Horticulture External Advisory Committee members) were asked to view and comment on this program in February 1995. Their response was also very positive and enthusiastic.

"OrchardSim: Design of an Apple Orchard" is copyright-protected. It is available on CD from S.S.K.

Conclusion

OrchardSim is an innovative multimedia computer program that is a novel teaching tool for horticulture classroom instruction and workshop groups. It provides users with a learning tool for designing apple orchards without any financial risk. This program, along with other instructional computer programs, will strengthen our horticultural instructional resources.

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