NeXT Public Domain CD-ROM For Education
Submission for PhaseScope 3.0

a. Software Developer:

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b. Software Catagory:

Mathematica Front-End

c. Software Description:

PhaseScope provides a comprehensive user-interface and general graphical display for analyzing dynamical systems. It serves as a specialized front end to Mathematica's kernel, and can be used as a general purpose modeling tool, where one can easily check the qualitative behavior of the assumptions before proceeding to a detailed analysis. In addition, PhaseScope can also be used as a learning tool supporting several topics in a typical course in differential equations.

PhaseScope allows a user to specify up to 6 coupled, ordinary differential equations, including the variables, the initial position, the final value of the independent variable and various percision control parameters. PhaseScope provides 2D and 3D graphical displays of the dynamical system, and allows the user to specify the color for background, axes, and individual functions.

e. Software Developed under NeXTSTEP 2.1.

f. Installation Instructions: (see following pages)

PhaseScope

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Version 3.0

(*Mathematica* Versions 1.0- 2.0)

PhaseScope is a comprehensive user interface and general graphical display program for qualitatively analyzing the stability characteristics of dynamical systems. Since it serves as a specialized front end to ***Mathematica's*** kernel, the kernel must be properly installed in its usual location on the NeXT computer, the "math" shell script must located in

/usr/bin/math

By design, additional integrators can be easily incorporated, since this application was written to be used as a learning tool supporting several topics in a typical course in differential equations. Two additional experimental integrators have been included with this release. One is an implicit Runge-Kutta routine for stiff systems and the other is an nth order classical Taylor Series method. In addition, ***PhaseScope*** can be used as a general purpose modeling tool, where one can easily check the qualitative behavior of the assumptions before proceeding to a detailed analysis.

Although some knowledge of differential equations is required to fully understand the various ways this application can be used, no knowledge whatsoever is required to "play" with it. After launching ***PhaseScope***, select one of the examples from the Examples menu, say Linear Sink, and then click on Run. Notice that some of the fields will become defined and then this dynamical system is sent to ***Mathematica*** to be integrated. After the solution is generated, you may experiment with various ways to display the result. The default display for Linear Sink is the classical phase plane plot where "y" is plotted against "x", each being parametrically driven by the variable "t" (observe the entries in the Plotting cells). If you want to see an individual solution, say "x" versus "t", enter "t" for the x-axis (horizontal axis) variable and "x" for the y-axis (vertical axis) variable. If you want to see both "x" and "y" superimposed as a function of "t", enter "x,y" for the y-axis variables. Finally, if you would like to see an example of a complete 3D display showing all of the variables, enter "t" for the x-axis, "x" for the y-axis and "y" for the z-axis. As with 2D displays, you may also superimpose 3D solutions by entering sets of variables for the y-axis and z-axis variables. With 3D plots, you may change your view point by either entering specific values in the appropriate cells or by simply moving one of the sliders. Also, you may put any 3D display into "movie" mode with the Rotation option. In general, when entering values in one of the cells, you must click on Run to cause the new entry to become active.

Once you obtain a solution to the system of equations defined in the cells at the bottom of the window, the function of each display control cell or button or slider will become obvious. A Styles panel has been added to allow you to change the display style of any function. Also, when the linearized solution is requested,

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PhaseScope obtains the exact solution from ***Mathematica*** and displays the primary attributes of this solution in another window. Other options and additional help can be found by selecting Help from the main menu. You may print any display you generate on the "scope screen". If you wish to develop a library of solutions, you may save and later redisplay any solution at any time by using the options available in the File menu. All files created by ***PhaseScope*** are assigned a ".phs" extension by default and it is recommended that you use this default, since the Open option will attempt to display only these files in each directory you select and double clicking on one of these files will automatically launch ***PhaseScope*** and display the solution.

New Features

1) ***PhaseScope*** **3.0** includes complete support of the new *Mathematica* command **NDSolve**, an addaptive procedure for solving O.D.E.'s, including stiff systems. This method is now the default, as seen in the pop-up-list of supported numerical integrators. Since the solution from NDSolve is in the form of InterpolatingFunctions, you must select the sampling interval used in the display. Note that the precision control options for NDSolve are different from those for the other integrators (see the documentation for details).

2) An additional example from differential geometry has been added.

3) Additional error checking has been implemented. Check the console for untrapped error conditions.

4) PhaseScope now reads the file **PhaseScope.init** into *Mathematica's* kernel. You may use this file to conveniently define any custom functions, set output options or perform any other meaningful *Mathematica* initialization operation. Options which change the input/output format, however, could place the communications channel into an unknown state and thus disable the link.