

SIMULATION STUDIO™

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ABSTRACT

Simulation Studio™ is the optional component of the GPSS World™ Simulation Environment responsible for user-created graphics and the animation of simulations. It can operate in any of three modes: closely linked online with a simulation, as a Post-Processor, or as a stand-alone draw and animation program. It is currently scheduled for release in the second quarter of 1993.

We briefly consider some of the concepts incorporated into Simulation Studio™ and survey some of its features as the primary animation component of GPSS World™.

1. INTRODUCTION

There is a very definite difference between the design requirements of presentation animation packages, and those of simulation animation software. Whereas the former application is closely controlled by the user, who effectively defines every frame in the presentation (possibly with computer aids), the latter application requires the user to set up a universe of possibilities, which is often played out with unexpected results. Photo realism is much more important to the Presentation Animation, which is itself the primary product of the user's effort. However, the role of the Simulation Animation is not an end in itself. It is part of a bigger picture, in which answers to "what if?", "what happened?", and "what's best?" questions must be found and presented. It is less important to be photo-realistic than to deliver correct answers with minimal effort and expense. Perhaps a symbolic representation of the state of the simulation can be more revealing than a high degree of irrelevant visual complexity. This is the basis

upon which the design objectives of Simulation Studio were established. Although visual effects are important, usability and understandability are even more so.

2. OVERVIEW

Simulation Studio is currently an OS/2 2.0 process which can communicate with the other processes of GPSS World. It can be operated as an Online Animator providing a visual expression of a GPSS World simulation, as a Post Processor for visualizing previously traced information, or as a stand alone Animator based on self-contained instructions incorporated directly into the Picture.

Simulation Studio is a 2 1/2 D vector based Simulation Animation Subsystem. It has features which allow the user to create an extremely realistic animation with 3D appearance, while only having to conceptualize the visual elements in the simpler 2D User Coordinate Space.

A Simulation Studio Picture is easily understood as a hierarchical structure. Very simply: A picture is a collection of Shapes, a Shape is a Group of Elements, and Elements have attributes of Outline and Fill. Outline has properties of Color and Width, while Fill has properties of Color and Pattern. In creating a visualization, the user is charged with the creation and manipulation of a small set of graphical elements, and their combination into groups called Shapes. The elements can be defined such that an arbitrary object can be very closely realized.

3. SHAPES

Shapes are the most important component of a Simulation Studio Picture. Very simply stated, a Shape is a group of Elements. The assembly of a Shape, then, requires the creation, and possibly alteration and grouping, of one or more Elements.

3.1 Elements

Elements are the building blocks of all Shapes. Each shape can be classified by its structural composition, and by membership in a class called an Element Type.

There are currently 9 Element Types in Simulation Studio: Polylines, Polycurves, Polygons, Figures, Boxes, Ellipses, Dynashapes, Paths, and Textboxes. The user normally selects an Element Type by clicking the mouse on a Tool in the Toolkit.

The Studio Toolkit is a graphical menu window containing the current color palette and a distinct tool button for each Element type. A square subwindow called the Sample Box shows the Outline and Fill currently selected.

3.2 Element Creation

Since a Shape is an Element Group, to create a Shape of more than one Element the user creates each Element using the Toolkit, then groups them.

It's relatively easy to create elements using the Toolkit. For each element, the user first sets up the Sample Box, then clicks on the Tool Button of the Element Type desired. Any choices of attributes, and/or color mixing is done prior to the Tool selection.

The user proceeds with the creation of an element by using the mouse to place, and initially size, the Element in the Picture. The Outline and Fill Attributes are taken from those currently set in the Toolkit. The result is an Element Group (i.e. Shape) of one Element, which may be resized, recomposed, or grouped.

After creation, the Element remains selected. It may be repositioned or resized by dragging it, or one of

its Frame Handles. The Shape Editor offers additional alteration power.

3.3 Element Groups

More complex Shapes are built by grouping a set of Elements. First, each Element is added to a collection known as The Selection Set, and then a GROUP command creates the new Shape, which can then be manipulated as a single entity.

3.4 The Selection Set

The Selection Set is the set of all Shapes in the picture which are in the Selected State. During the course of creating a picture and its Shapes, the user brings Shapes into and out of the Selected State. Each selected Shape has a Handle Frame around it to indicate its state and to provide for additional operations on the Shape. The Handles are solid, draggable square markers which can be used to stretch or compress the Shape. The whole Selection Set can be moved as a unit by clicking on any selected shape and dragging with the mouse, before releasing the mouse button. When the Shape Editor is not active, and any animation is Halted, there are several operations available for specifying the Selection Set. These are discussed next.

The user can create a Selection Set of a Single Shape by clicking on the desired Shape. There are several ways to create Selection Sets containing more than one Shape, after exiting the Shape Editor. A click on a Shape with no keys depressed replaces any existing Selection Set with a Selection Set of a single Shape. If the Ctrl key is held during the click, the new Shape is added to any previously existing Selection Set. Actually the Ctrl key operates as a toggle, in that it may also be used to remove a Shape from the Selection Set.

The Drag Select operation allows the user to click on an open area, and, keeping the mouse button depressed, drag open a dynamic dotted line rectangle (i.e. "a marquee") which when the mouse button is released will enter all Shapes partly within, into the Selection Set.

An imaginary anchor point may also be used to select and deselect shapes. This method uses a second

click with the Shift key held down. A single click sets the Anchor Point. Then, the next click, with the Shift key held, creates an imaginary bounding rectangle with the Anchor Point on the diagonal corner. This second click does not change the Anchor Point. The corresponding action depends on whether the Ctrl key is also held down during the second click. If not, then Shapes all or partly within the rectangle become the Selection Set. However, if the Shift key AND the Ctrl key are held, those Shapes are toggled into or out of the Selection Set, depending on the previous state of each Shape.

Dragging and sizing have two modified conditions which affect their operation. In “Ortho Mode” dragging and sizing is restricted to horizontal, vertical, or 45 degree changes in position. On the other hand, the “Snap To Ruler” condition limits mouse point selection to those represented by a ruler hatch mark. Ortho Mode is set by pressing and holding the Shift key during a mouse move operation, while the Snap to Ruler condition is toggled by a menu command. Combined with Zooming, the Snap to Ruler feature provides for the whole range of point granularity. This allows accurate coordinate selection using the mouse. The Ctrl key provides a temporary escape from Snap To Ruler so that the mouse may be easily positioned prior to setting the point.

In the construction of a Picture, Shapes are Selected and manipulated. Normally, only the group of Shapes in this “Selection Set” may participate in actions such as grouping, ungrouping, sizing, dragging, drag-copying, and element modification. The Selection Set is depicted in the Picture by adding a temporary rectangle with 8 draggable handles around each Shape in the Selection Set. A shape may be deselected, may be part of the Selection Set, or may be opened by the Shape Editor, which provides for the alteration of Elements in Shapes.

3.5 Manipulation of Selected Shapes

There are several direct operations available for use on the Selection Set. A set of Menu Commands can be applied, or a set of straight forward mouse dragging operations can be applied.

Menu Commands exits for moving, sizing, rotating, grouping, and ungrouping Shapes. Additional

Menu commands exist to bring a Selection Set to the Top of the Picture, or to send it top the rear.

A Selection Set can be dragged to a new location by using the mouse. Further, the Handles appearing around each Shape in the Selection Set can themselves be dragged, thereby resizing the Shape. When the user drags a corner handle, changing both the height and width of the Shape, an “Ortho Mode” is available to preserve the Shape’s aspect ratio.

3.6 The Shape Editor

The Shape Editor is a component of Simulation Studio that allows the Element Attributes of existing Shapes to be altered without UNGROUPing the Shape. For Polypoint Elements, the defining points can be moved and deleted, or even created.

A “Point and Shoot” feature using the Toolkit allows the user to set the Element Attributes in the Toolkit, and then to transfer them to any Element opened by the Shape Editor.

The Shape Editor completes the operation set. Together with Selection Set operations, the Shape Editor empowers the user with the ability to make arbitrary modifications to most existing Shapes. Element Attributes can be changed, and polypoint Elements can be arbitrarily reshaped.

4. PICTURES

A Picture is a savable collection of one or more Shapes (Element Groups). To create a Picture, the user starts by defining Elements and grouping them into Shapes. The totality of Shapes comprise a Picture. In addition, some Shapes are given special properties allowing their motion and other properties to be directed by a GPSS World simulation, or other means discussed below. In addition, the user designates certain Shapes to be templates of “Shape Classes”. These classes allow Shapes to be created automatically. These new Shapes are instances of previously defined Shape Classes, thereby providing an inexhaustible supply of Shapes for an animation.

4.1 Picture Properties

In addition to the graphical components, a Picture has a set of global attributes which apply to its overall appearance. All elements in a Picture are embedded in a Coordinate Space defined either explicitly by the user, or by default. A set of rulers along the margin of the Picture can be made visible, showing hatch marks corresponding to the user's coordinate system. Cursors traverse the rulers to indicate the precise location of the mouse pointer in the Picture. A "Snap-to-Ruler" feature takes the uncertainty out of mouse positioning, if so desired.

The Color Palette is another attribute of the picture. It provides for definitions for 64 colors at a time, each of which can be defined (i.e. "mixed") as a 24 bit RGB color by the user. Actually, the user can apply any number of colors (over 16 million) by changing the palette before defining the element. In practice, 16 colors are often too few for the palette, and 256 are usually too many, so the Simulation Studio palette was given 64. The actual appearance of the colors depends on the capabilities of the user's video adapter and monitor, and the choice of Fill pattern. Dithering is used by the Presentation Manager to approximate unrealizable colors.

4.2 Views

Simulation Studio pictures can be quite large, much larger than the screen of a PC or workstation. Although it depends to some degree on the maximum zooming level desired, a maximum picture could be drawn in a 60 foot square, with the computer monitor viewing a small detail at any time. However, the computer overhead of searching a dense Picture of that size would be felt as a limit first.

A different starting point might allow the user to use the zoom so that the total picture could come into view. In this latter orientation a zoom of over 100 times is available. The user can trade off maximum zoom for maximum pan, and vice-versa.

Scroll bars can be used to pan to any position within the current Zoom level. Single clicking on the scroll bars causes the view to move by paging, whereas

the slider can be dragged, causing the view to jump immediately to the chosen location.

Views can be named, so that they can be restored easily. View definitions are stored with the other Picture attributes.

4.3 Controls

Several Zooming and Viewing options can be chosen. The VIEW/ZOOM Menu allows a Zoom In by a factor of 2, Zoom Out by a factor of 2, Zoom All to encompass all drawn Shapes, Zoom Origin to take the original view, Zoom Previous to return to the last View used before the current one, Zoom Window to zoom in to a window drawn by the user by dragging, or Zoom Name to a view which was previously named. If the user attempts to Zoom beyond the effective limits, the best approximate view is given and an audible warning is given.

The VIEW/FULL DESKTOP Menu Item expands the current view so that only the picture, with no scroll bars or other windowing controls, is visible. The Esc key returns to the normal windowing appearance.

In addition, there are several selectable items that can be shown or hidden, as desired by the user. The VIEW/SHOW Menu allows the Toolkit, the Rulers, or the Paths on the Picture to be shown or hidden.

5. ANIMATION

Simulation Studio has additional features which permit the animations, both stand-alone and visualizations of simulations. Shapes can be named and addressed by command. They can be used as templates in Shape Classes, they can be given properties of motion, and they can be placed on Paths which can automatically control their behavior.

Named Shapes have several additional built-in properties specifically designed for use during animations. Level is a nonnegative integer that allows one shape to occlude another, and the kinematics of animated motion are also Shape Attributes. Both kinds of attributes can be controlled by Paths and by simulations.

5.1 Dictionaries

The Shape Dictionary is the set of all Named Shapes in a Picture. Named Shapes are important in an Animation because a Shape must be addressable in order for it to be given commands, or associated with a Path.

A Shape Class is a set of Shapes created as copies of a single template. Shape Classes provide an inexhaustible source of Shapes for use during an Animation. A method is needed to create Shape instances during an animation. For this purpose Simulation Studio provides for the creation of Shape Classes. When a Shape Class is defined, an invisible shape definition is registered in the picture. Thereafter, any number of copies of this Shape may be created interactively or during an animation. It is often convenient to think of a Shape Class as an invisible shape template. The set of all such classes is grouped into a Class Dictionary.

5.3 Paths

A Path is a polypoint Element which can control the behavior of Shapes during an animation. Each path line segment is headed by a Station, which can specify a wide range of dynamic alternative for Shapes which arrive there. Paths are a powerful mechanism for easily creating complicated Animations. They are sufficient to drive stand-alone Animations, or they can be used to generate an Animation from minimal information from either a running simulation, or a trace from one previous completed.

5.5 Direct Control

The last, and finest level of control over Named Shapes during an Animation is provided by the embedded programming language PLUS[™], evaluated during a simulation. Statements are available which permit a simulation to directly specify the appearance and kinematics of Shapes existing in the Animation. This level of control permits an extremely wide variety of visualizations of the simulated system.

6. SUMMARY

Simulation Studio is an animation system based on a powerful "Draw" Program. Pictures are built up in a hierarchical structure from extremely simple elements. A very natural naming and path definition operation completes the animation specification.

A nearly arbitrary dynamic visualization can be created by GPSS World's powerful animation partner, Simulation Studio.

AUTHOR BIOGRAPHY

SPRINGER COX received his degrees in Physics and Computer Science from Cornell University and Syracuse University, respectively, and has completed an advanced study program at MIT. He worked in computer performance evaluation and modeling for IBM and Xerox, and, in 1977, went to the R & D Group at Digital Equipment Corporation to simulate virtual memory operating systems. In 1982, he founded Minuteman Software for the purpose of creating a microprocessor based interactive simulation environment. He has published over a score of papers, and has spoken at technical conferences in North America and Europe.