All Purpose Particles

Sisyphus Software

Copyright Notice

Acknowledgement to

We went from post-alpha versions to heavily tested production-candidate code in an extremely short interval this time, in the hopes of getting users versatile particle systems for MAX as soon as possible. This is in no small way attributable to our beta test team, who provided critical feedback and testing services for one very short and hectic time:

Todd Bruno
Robert Cloutier
Alan Iglesias
Tim Kelley
Jim Lammers and his staff
Tim Miller and the folks at Blur
Lee Steel

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1.0 Introduction

Thank you for purchasing ALL PURPOSE PARTICLES Version 1.5 from Sisyphus Software. The purpose of ALL PURPOSE PARTICLES is to provide generalized and highly controllable particle systems for Kinetix 3D Studio MAX. MAXHALO and MAXPHASOR are enhancements of our HALO and PHASOR routines available in Sisyphus Particle Pack #1 for 3D Studio Releases 3 and 4. The ALL PURPOSE EMITTER (APE) is an enhancement of the single particle system provided with our Particles II package. TNT, the third routine supported under Particles 1, is not provided for MAX.

Initially we promised simple ports of our products so those customers would have particle systems in MAX as early as possible. However, as the port development progressed into re-engineering efforts we discovered that while 3DS R3/4 is optimized for particle systems that operate in the local coordinate space of the emitter, MAX is optimized for routines that operate in the world coordinate space. These meant that TNT, were we to port it to MAX, and would operate more slowly than a port of Particles II while providing less capability. We believed that this would not be in the best interests of our customers. Thus, we deleted TNT and combined

Particles I and II into a single package -- ALL PURPOSE PARTICLES. These are NOT simple ports There are significant enhancements in addition to the inclusion of the two Spacewarps, MOLASSES and VORTEX.

Our goal is to provide low cost but effective tools that pay for themselves with a minimal number of uses, and which provide reasonably priced procedural options for the casual, as well as for the professional user.

Sisyphus was the legendary king of Corinth, in mythology, who was doomed to perpetually manhandle a boulder up a mountainside in Tartarus - the bottomless pit below Hades - only to have it roll back down every time. We wanted to use Whelping the user up thy long, steep hill to obtain inexpensive software tools" as a motto, but it's too long and boring. But that's the point we wanted to make, anyway. Our motto now is "We Don't Have a Motto; It Helps Keep the Overhead Down."

2. 0 How To Reach Us

We check the message areas in CompuServe's AMMEDIA and KINETIX forums at least three times daily. Our CIS address is 74461,157. We're also on America Online, using the screen name SisyphusSW. Internet mail addressed to SisyphusSW@aol.com will reach us there. You can also leave a message for us at our web page, www.sisyphus.com CompuServe mail will reach us most quickly, however.

Our phone number is:

1-210-543-0665

We no longer take direct sales orders except for site licenses and upgrades because we want to concentrate on development and support and not sales. Other firms - our diverse and ever-growing dealer network - is both better suited and better organized to handle sales. We maintain a current listing of our dealer network on our web page and in the AMMEDIA/IPAS USAGE and KINETIX/PLUG-IN areas under the listing SISYPHUS.TXT.

Our mailing address is:

Sisyphus Software
6402 Stable Drive
Leon Valley, TX 78240

We can't guarantee that there will be someone available 24 hours on the phone line, but if we get a call in the middle of the night looking for technical support, we'll try to return it. If you have a project coming up, give us some advance notice and we'll arrange to be available at any time leading up to your deadline.

3.0 System Requirements

ALL PURPOSE PARTICLES runs under the 3D Studio MAX Release 1.1 SDK specification involving Visual C++ 4.1 and Windows NT Version 3.51. If your system supports Kinetix 3D Studio MAX, it will support ALL PURPOSE PARTICLES. However, complex scenes involving several Spacewarps multiple emitters and large numbers of particles will consume vast amounts of memory and processor time, in addition to requiring fast video update rates. We recommend that 64 megabytes be considered the practical minimum amount of RAM and that a P120 or faster machine be used for these applications On some machines note that increasing the display resolution can drastically increase the display update times required.

4.0 License

You have purchased a single-user, single-station usage License for the Sisyphus ALL PURPOSE PARTICLES. You may install ALL PURPOSE PARTICLES on those machines, either singly or in a network slave configuration, which operate(s) under a single-user Kinetix 3D Studio MAX license. If you intend to install multiple copies of ALL PURPOSE PARTICLES, each functioning with a separate licensed copy of 3D Studio MAX, then you must purchase an equal number of ALL PURPOSE PARTICLES licenses or a single Site License. Contact Sisyphus Software for details. See additional warranty and license terms on the media envelope.

4.1 Warranty and Disclaimer

Sisyphus Software and the program authors have no liability to the purchaser or any other entity, with respect to any liability, loss, damage caused, directly or indirectly by this software, including but not limited to, any interruptions of service, loss of business, anticipatory profits, or consequential damages resulting from the use of or operation of this software. See additional warranty and license terms on the media envelope.

Updates may be made to this documentation and incorporated into later editions.

5.0 Upgrade Policy and News

This is our first product package for 3D studio MAX running under Microsoft Windows NT. There will be significant upgrades to this product in the future, including the capability to instance any object as a particle source With this version 1.5 release APP gains the ability to provide facing quad and rangeless pixel particles.

6.0 Installation

Before proceeding you should make a back-up copy of your distribution diskette. Note that critical files exist on the diskette in back-up form, but that that protects you only against bad sectors on the diskette, and not against the destruction or loss of the diskette itself. For information about recovering the back-up files, please refer to section 6.0.3

6. 0.1 Automatic Installation

We assume you have either a default installation directory structure that looks like:

\3DSMAX
\3DSMAX\MAPS
\3DSMAX\PLUGINS

\3DSMAX\SCENES

and so on, or that you have an alternate installation that looks like

\3DSMAX
\MAPS
\PLUGINS
\SCENES

To run the automatic installation process, select the RUN option from your Windows NT "FILE" pull-down menu and browse to the installation diskette. Select the file INSTALL.BAT Click on "OK" to return to the "RUN" dialog. Add the path to your 3DSMAX installation as an argument. For example, if you have a default installation on c:, your command line in the "RUN" dialog would be:

a: \INSTALL .BAT c:\3dsmax

Click on OK. If you have an alternate installation, use the path to the location of the support directories. ALL PURPOSE PARTICLES installs nothing in the 3DSMAX root directory.

6.0.2 Manual Installation

If you want to only install some of the components of ALL PURPOSE PARTICLES, for example, if you only want to install the main program and the maps but not the sample files, use the MS-DOS prompt from your MAIN group to log into the appropriate directory and execute the self-extracting archive from there For example, to install only the main program containing the Spacewarp and particle system definitions, log into the 3DSMAX\PLUGIN subdirectory and type:

C:\3DSMAX\PLUGIN>A:\program<return>

6.0.3 Recovering Backup Piles

Each of the three self-extracting archives on the distribution diskette are duplicated unchanged as .BAK files. If any of the .EXE files become corrupt, copy the batch file and the .BAK files on the distribution diskette to another diskette and rename the .BAK files as. EXEs. If the batch file is also corrupted, perform subsequent installs manually per 6.0.2 above.

6.O.4 Installation Notes

The distribution diskette is write-protected to prevent the user from inadvertently damaging or erasing the distribution files. There is no copy protection of any kind.

In the unlikely event you already have a plug-in routine, map, project file, or image whose name is the same as one supplied with ALL PURPOSE PARTICLES, it will become necessary to rename either the existing files or the ALL PURPOSE PARTICLES file with the duplicate name. See your Windows NT manual for the use of the RENAME command in the File Manager.

6.1 Files Included on the Diskette

The files included on the distribution diskette will include a varying list of sample files and maps which change with new releases. While the contents of each self-extracting archive may vary, however, each file will always be present

INSTALL.BAT - Installation batch file, which invokes and directs the self-extracting archives.
MAPS.EXE - New textures. Extracts into your MAPS subdirectory. Mostly gradients and color changes for use with APE, but there are also some radial maps for use with HALO.
PROGRAM.EXE - Archive of plug-in files. All five routines supplied with ALL PURPOSE PARTICLES are defined in a single DLO plug-in executable.

SCENES.EXE - Many simple sample project files illustrating the effect of the various presets available in the three particle systems. Each scene's filename will define which particle system it illustrates.

If present, README.NOW is a text file containing information that changed subsequent to publication of the manual.

7.0 Common Features

The three particle systems included in ALL PURPOSE PARTICLES share a number of features and operational methods. First, APE, PHASOR, and HALO particle systems share the method of emitter creation established by the default plug-ins, SPRAY and SNOW. After selecting the CREATE button from the main MAX menu to the right of the screen, select the GEOMETRY button just below CREATE and then select PARTICLE SYSTEMS from the pull-down list. HALO, PHASOR, and APE will appear as buttons with other available particle systems.

The emitter for each, unlike the flat emitters for SPRAY and SNOW, will be a rectangular solid which appears as a normal MAX box. Each is built the same way. Select a viewport to define two dimensions, and then define the third dimension with mouse movement in any viewport in which the box is visible.

APE is a generalized EMITTER, which implies that particle behavior is independent of the emitter object once the particle enters the scene. However, HALO and PHASOR are generalized particle systems, which means that the entire particle system moves with the box in the scene. For this reason, the particles of APE respond correctly to particle Spacewarps. The particles of HALO and PHASOR do not.

7.1 Axis Location

A specific feature shared by HALO and PHASOR is the way in which they locate the particle system with respect to the emitter box. These two routines are intelligent enough to locate themselves within the stand-in based on stand-in proportions. That is, the axis of HALO will always be directed along the shortest dimension of the stand-in object. Likewise, particles will always appear at **one end** of the object, travel along the longest dimension, and disappear at the opposite end for PHASOR. These routines ignore the displayed local axis.

However, APE always emits particles at angles of 0 degrees vertical along the displayed local z-axis. Vertical angles are **measured with respect** to this direction.

7.2 Object Form and Scaling

Because HALO and PHASOR locate and scale the particle systems within the local coordinate system of the stand-in object, the shape of the stand-in doesn't matter except insofar as it determines the shape and proportions of the particle effect. That is, the particle system is scaled within the bounding box of the object as well as orienting itself with respect to the object's proportions. A box 6 units by 4 units by 2 units used, as a stand-in for HALO will result in an oval-shaped HALO particle system.

7.3 Invoking the Particle Systems

All particle system emitter boxes are created through the CREATE/GEOMETRY/PARTICLE SYSTEM command path. HALO and PHASOR and APE will appear as buttons within the particle system dialog area. Once parameters are defined, the emitter box created will assume the settings in the particle system roll-up. To modify parameters, use the MODIFY command with the selection cursor to select the emitter box. The particle system roll-up, or the applicable transform stack, will reappear and the parameters may then be changed.

7.4 Precise Single-Frame Capability

All three particle systems supplied with ALL PURPOSE PARTICLES are disk-access free and still-image precise. This means that the routines require no disk access besides whatever virtual memory is provided by Windows NT, and that each still image rendered out of sequence should appear exactly the same way as the same frame of a corresponding animation.

7.5 Field-Render Sensitivity

All three particle systems are sensitive to field render timing issues. Simply put, if the rendered animation is to fields rather than frames, then the particles will move halfway between frame positions for odd fields. This is true regardless of the timing parameters selected.

7.6 Presets

All three routines include 'Preset' Buttons on the dialog roll-up to provide a basis for particular effects. These effects are normalized for a default 100 frames, so some adjustment will be necessary to make the effect perfect for your time scale.

7.7 Mapping Options

All three particle systems provide for various mapping options. This means that textured materials may be applied to the particle system according to various rules. Creating the emitter box automatically handles all mapping coordinate issues.

7.8 Running Multiple Copies of the Particle Systems

None of the three particles system supplied with ALL PURPOSE PARTICLES will conflict with other, simultaneously running copies of the same or other particle systems.

7.9 Termination and Error Messages

Unlike the versions of these routines for 3DS Releases 3 and 4 , the user will rarely see a range alert box or a particle quantity allocation error . MAX imposes no limit on the number of particles in a system , so there are no errors associated with defining particle systems that are too large. Furthermore , if the user enters values too large for the entry in the roll-up, the entry will be capped by the interface at the maximum value. Hopefully, you'll never see an error message arising from the use of our routines.

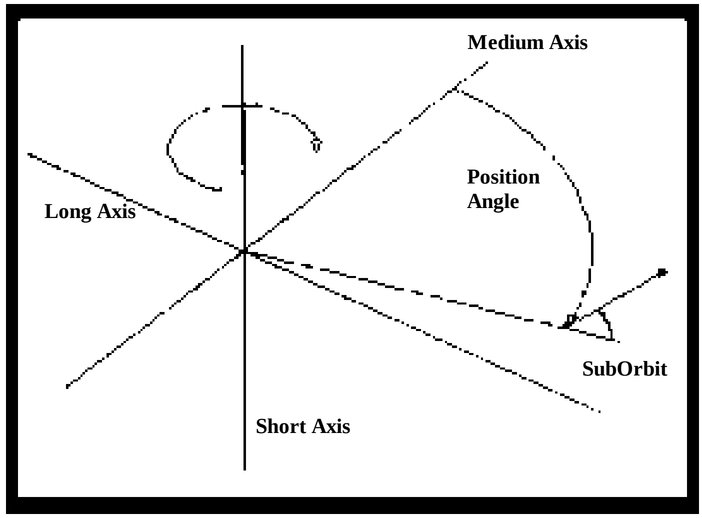

Figure 1 - HALO Terminology

8.0 Instructions for Specific Modules

8.1 HALO

HALO creates a system of particles moving with generalized circular motion about an axis. When a HALO emitter is created, the particle system controls locate the axis of rotation along the shortest dimension of the object. Thus, if a stand-in box is 5 units by s units by 4 units, the axis of rotation will be parallel to the side 4 units long and located in the center of the objects bounding box. Figure 1 is a diagram depicting some of the terms we'll be defining momentarily.

8.1.1 General Terminology

The Radius of the HALO system is the distance from the center of the Suborbital Rotation to the Short Axis. Suborbital Rotation is motion of the particle along a circular path about a point which is itself sweeping about the Short Axis. Suborbital Radius is the radius of that second circular path. The easiest way to visualize this relationship is to look at a donut: the Short Axis goes through the hole, and particles move within the volume of the donut. Particles moving with a fixed Suborbital Radius travel along the surface of the donut.

' Phase' variables refer very specifically to the position of a particle 'when it starts out'. That is, in the Figure 1 above all particles might orbit the Short Axis at the same rate, but if they're spread out around the axis, they are said to have different orbital phases. Likewise, it is possible for a group of particles to have the same suborbital motion, but different suborbital phases.

' Periods ' are parameters, which define how long, in frames, it takes for something to happen. For example, an Orbital Period of 30.6 frames means that it will take 30.6 frames for any given particle to move all the way around the Short Axis. Note that frame values in terms of absolute time are dependent upon your settings for ticks per frame.

’ Variation ’ parameters allow another setting to vary.
For example, Variation in Orbital Period allows the Orbital Period of any given particle to be defined randomly near but not necessarily at the specified Orbital Period value. If the Orbital Period setting is 30.6 frames and variation is Sol, then the Orbital Period of any single particle may be between 30.6 minus 15.3 and 30.6 plus 15.3 frames.

’ Concentration ’ parameters affect the distribution of values within an allowed variational range. A high Concentration means that most values will fall very near or at the specified value, but a low concentration -near unity - will allow values to range linearly over the variational limits. In some cases we allow Concentration values of less than l, which forces the values to distribute unevenly towards the endpoints of the variational range.

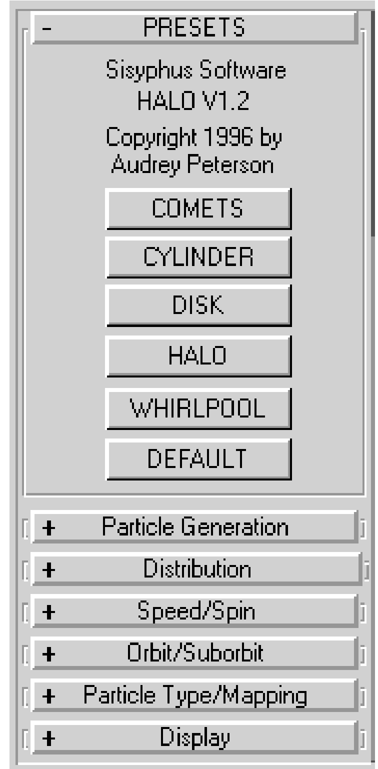

Figure 2 - HALO Top-Level Roll-Up

8.1.2 The HALO Main Roll-Up

Figure 2 depicts the HALO roll-up as it appears when accessed through the creation menu. As you can see, there are seven distinct areas in the HALO top level roll-up.

8.1.2.1 The PARTICLE GENERATION Roll-Up

The settings in this area control the number and size Of the particles, and the manner in which they are created over time. We’ll cover each field separately. Figure 3 depicts this control panel.

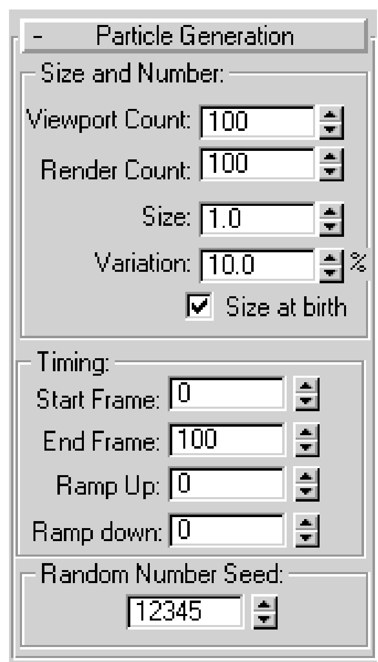

Figure 3 - Particle Generation

Viewport Count - This is the maximum number of particles shown in real-time in the MAX display. This number must be larger than the number of frames over which the particles appear.

Particle Count - The maximum number of distinct particles that are created and maintained by the particle system throughout the run of the animation.

Size - A positive floating point entry that describes the overall size of the particle.

Variation - The permissible variation in particle size.

Size At Birth - Size is an animatable parameter. Size may be animated in two ways, however. Either all particles will be the same size at the same time, or each particle will assume a stable size at birth and remain that size for life. The box indicates the latter option is active.

Start Frame - The first frame on which particles appear.

End Frame - The last frame on which particles appear.
Ramp Up - The number of frames over, which the number of particles displayed, increases from a low of zero to the maximum value. A setting of zero creates all particles on the frame indicated in Frame Start.
Ramp Down - The number of frames over which the number of particles displayed decreases from the maximum number to zero. A setting of zero indicates that all particles are displayed up to the frame indicated in Frame End and thereafter disappear.
Seed - A random number generator seed value, which determines the sequence of psuedorandom numbers, generated throughout the animation. For a set of particles to be consistent whenever a single animation is spread across machines or sessions, this seed must be the same.

8.1.2.2 The DISTRIBUTION Roll-Up

The settings in this area control the initial distribution of particles in angle about the Short Axis at Frame Start. Note that whatever configuration exists on Frame Start may change due to the particles having different orbital periods or polarities. Figure 4 depicts this set of controls.

Additionally, it is possible to control the degree to which the particles spread along the short axis of the emitter box.

USE CLUMPS - A setting, which determines whether or not particles are spread evenly and randomly about the Short Axis, or if instead they are concentrated into 'Clumps' spaced around the Short Axis in angle. For halos and whirlpools and disks this setting should be set to off. For comet-like objects it should be set to on.

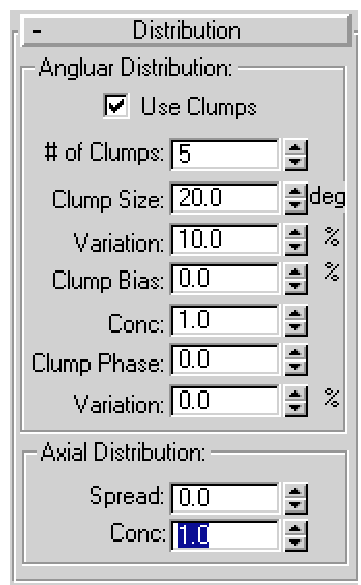

Figure 4 - Distribution Control

Number of Clumps - The number of groupings of particles, which will be spaced around the Short Axis. This setting has no meaning for non-clump distributions.
Clump Size - A value in degrees, which defines the angular length of the clump in the orbit around the Short Axis. This setting has no meaning for UNIFORM distributions.
Variation - A percentile value which describes the range over which the size of each clump may vary. For example, if Size of Clump is set to 10 degrees and variation is set to 30‘, then each clump will be from 7 to 13 degrees in length. This setting has no meaning for nonclump distributions.
Clump Bias - A percentile value that describes how the particles in each clump are distributed within the clump. For example, if a clump is 40 degrees in length ~ and Clump Bias is set to 80% then half the particles will be in the leading 80% of the clumps length and half the particles will be in the trailing 20% of the clump's length. This setting has no meaning for UNIFORM distributions.
Concentration - A positive floating point value which describes how particles are distributed within the clump. The default is 1, which provides a uniform distribution within the bounds set by the Bias parameter. A value of 4 will result in a tight ball of particles with a few trailing to either end within the bounds

set by Bias. To make a comet-like collection of particles, Bias must be skewed towards one end, typically in the range of from 15% to 25% , and Concentration is set to 1.8 to 3.0 - a combination of parameters resulting in both a ’ tail ’ and a ’spike ’ This setting has no meaning for nonclump distributions.

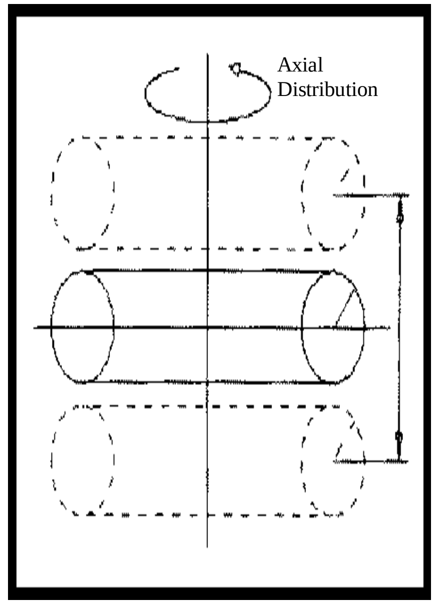

Figure 5 - Axial Distribution

Clump Phase - A value in degrees, which defines the offset in the clump’s angular position from its base position in angle in the orbit around the Short Axis. For example, if Number of Clumps is 4, then there will be four clumps of particles at 0, 90, 180, and 270 degrees off the Medium Axis. If Clump Phase is set to 45 degrees, then the clumps will appear at 45, 135, 225, and 315 degrees off the Medium Axis. This setting has no meaning for UNIFORM distributions.

Variation - A percentile value, which describes the range over which the clump location phase, may vary. For example, if the Clump Phase is 45 degrees and the Variation is 100%, then each clump will be randomly displaced from 0 to 90 degrees from its base position. It is possible, using this parameter, to define clumps, which will overlap. This setting has no meaning for UNIFORM distributions.

Figure 5 depicts how the axial distribution parameters, described below, apply to the emitter box and the particle system.

Spread - This parameter determines the extent of the object along the Short Axis over which the particle axial positions lie. A small value implies that the particles are located along the midplane of the bounding box; a large value implies that the particles range over the entire length of the stand-in.

Concentration - This parameter defines how tightly the particles lie near the midplane of the bounding box. A value of unity defines linear distribution along the Short Axis. Larger values - up to 4 - define increasingly large concentrations of particles near the midplane.

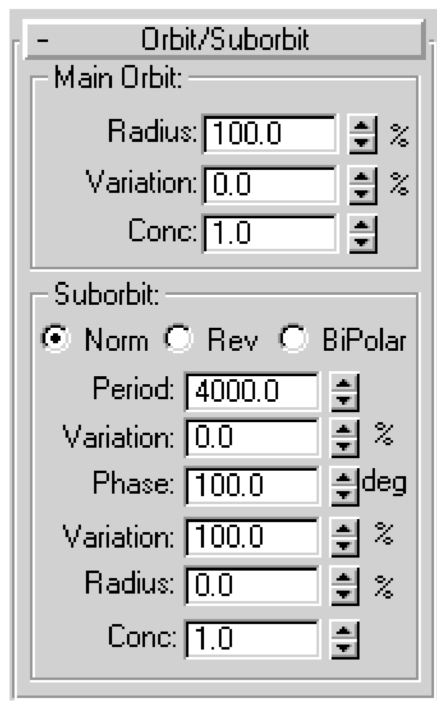

Figure 6 - Orbital Controls Roll-Up

8.1.2.3 The ORBIT/SUBORBIT Roll-Up

The Orbit/Suborbit control panel defines the direction and rate with which the particles orbit the main orbital path. It also controls the relative location and sizes of the orbits. Figure 6 depicts this control panel.

Orbital Radius - A percentile value that defines the proportion of the stand-in objects width and length used by the HALO routine. If this value is set to 100%

then the base Orbital Radius is along the outer edges of the stand-in object's bounding box.

Variation - The bounds over which the base radius, may vary. For example, if Orbital Radius is set to 100% and the Variation is set to 100%, then particles will form from the origin of the stand-in object out to twice the radius of the stand-in.

Concentration - The manner in which the radius varies within the limits set by the Variation. If this value is unity, the variation in Radius will be linear. When this value is increased, the Orbital Radius will be more likely to fall on or near the specified value rather than near the limits set by the Variation.

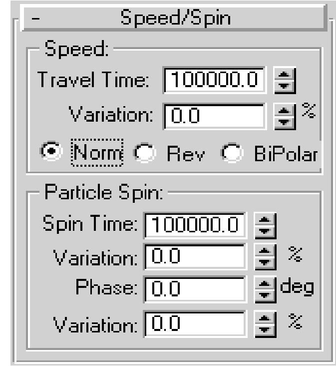

Figure 7 -
Speed/Spin Control

NORMAL/REVERSE/BIPOLAR - As with the major particle orbit about the Short Axis, it is possible to choose the direction of the suborbital motion. NORMAL implies that the particles will move towards the positive end, of the Short Axis on the outside surface of the 'donut' and down through the ' hole ' REVERSE forces the particles to move upwards on the inner surface. BIPOLAR forces half the particles to move in either direction.

Period - This is the amount of time it takes - in frames - a particle to complete one suborbital cycle. That is, the amount of time it takes for the particle to move around a cross-section of the ' donut '

Variation - A percentile value that sets limits on the range of possible Suborbital Period values. For example, if the Suborbital Period is set to 10 frames and the Variation is set to 40% then all particles will have suborbital periods ranging from 6 to 14 frames.

Phase - Unless the Suborbital Phase is nonzero, all particles will be created on the midplane of the stand-ins bounding box. Thus, it is possible to have smaller groupings orbiting within clumps, or whole systems of particles ' turning themselves inside out ' when the phase is constant for the whole system of particles.

Variation - A percentile value that sets limits on the range of possible Suborbital Phase values. This parameter is used to distribute particles around the suborbital path

Radius - This is the Suborbital Radius as a percentage of the base Orbital Radius

Variation - A percentile value that sets limits on the range of possible Suborbital Phase values.

8.1.2.4 Speed/Spin Roll-Up

Figure 7 depicts the control panel roll-up which defines orbital period, direction, and particle spin parameters.

NORMAL/REVERSE/BIPOLAR - These settings define the direction of rotation of the particles about the Short Axis. **NORMAL** implies that all particles travel counterclockwise as viewed from above the stand-in object. **REVERSE** implies clockwise. A setting of **BIPOLAR** forces half the particles to orbit clockwise and half-counterclockwise.

Travel Time - A value in frames *which* defines the amount of time it takes a particle to move completely around the Short Axes.

Variation - A percentile value which defines the range within which the Orbital Period may vary. For example, if the Period is set to 40 frames and Variation is set to 25% then each particle will move around the Short Axis in times ranging from 30 to 50 frames. Note that the use of nonzero Travel Time Variation and Clumps is usually contraindicated, unless the user wants the clumps to break up during the animation.

This area sets particle spin parameters. If each particle of the system were to remain fixed in orientation in space, the particle system would lose some of its dynamic appearance. Each procedural face each particle has a randomly generated spin axis assigned at creation time. Over time, the particle is set to spin about this axis, which passes through the center of the particle. When the user assigns single-sided materials, the particle ' sparkles '. When the user assigns a two-sided material, the appearance of the particle system varies over time because of individual particle spin. Note that the spin axis for facing quads is always along the central normal of the quad. Spin axis has no meaning for rangeless pixels, and the spin axis for other particle types is random.

Spin Time - A number in frames which defines how long it takes for the particle to spin about its own local axis. A very large number here - the maximum is 100,000 - will ' freeze ' the particles orientation.

Variation - The percentile limits over which particle spin will vary. A small value will result in a more uniform particle system appearance.

Phase - Initial particle rotation. This value serves little value except as a base to be varied by the subsequent parameter. In most cases individual particle phase will be invisible.

Variation - The limits over which the spin phase of the particles will vary. Used in conjunction with Phase, this parameter sets the degree to which the particles randomly ' sparkle ' time

8.1.2.5 The MAPPING **and** *PARTICLE TYPE Roll-Up*

This area sets mapping and particle type options. Two mapping alternative are available within HALO. First, it is possible to 'project' a textured material over the entire halo particle system in the top view - or the view from the end of the Short Axis. The other option maps u, v coordinates to a cross-section of the halo, with u assigned based on total radius and v assigned based on distance along the Short Axis. The controls are shown in Figure 8.

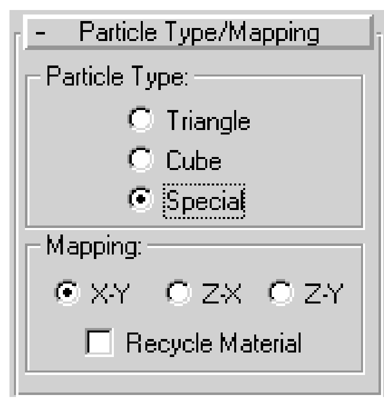

Figure 8 - Particle Type and Mapping

X -Y/R -Z - This is the setting that selects the two mapping options. X-Y indicates mapping from above, along the direction of the axis of rotation - the Short Axis. R-Z forces mapping to be applied along the cross-section of the particle system.

Particle Type - This selection defines the type of particle the particle system will use. For version 1.5 there are five choices: triangular fragment, complete cubes, Yost-type special particles consisting of three orthogonal squares faces, rangeless antialiased pixels, or facing quads . Note that the vertex order of cube, facing quad, and special particles is arranged to correctly assume face mapping for face mapped materials. Also, note that rangeless pixels WILL ONLY OPERATE IN A CAMERA VIEWPORT.

RECYCLE MATERIAL - If a compound material is assigned to the emitter then each sub-material in turn is assigned to the particles on a frame-by-frame basis. When the emitter cycles through all the available sub-materials and when this checkbox is ON, the emitter begins assigning sub-materials from the first one on again. If the checkbox is OFF, the last sub-material is used for all subsequent particles.

8.1.2.6 DISPLAY Control Roll-Up

New for particle systems for MAX is the ability of the environment to display the particles in real time in the main display. These parameters of the control area of Figure 9 control some associated options.

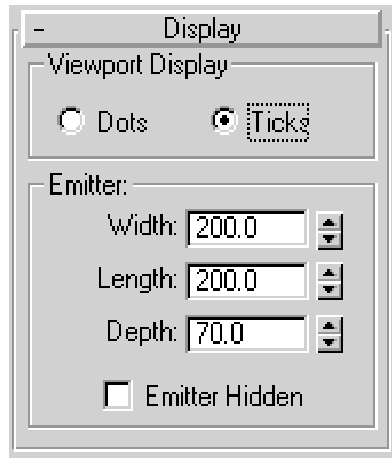

Figure 9 - Display

DOTS/TICKS - This is a selection that controls how the individual particles appear in the main display.

Emitter Size fields - These are the dimensions of the particle emitter in world coordinates. Changing these values changes the dimensions of the emitter in the scene.

Emitter Hidden - a control, which allows the animator to suppress the display of the emitter box, does not affect rendering parameters.

8.1.2.7 The PRESETS Dialog Area

The Presets area contains a number of buttons, which modify the necessary control parameters to predefine a particular effect. There are six presets provided within the HALO roll-up as visible in **Figure** 2.

Comets - This button sets up two comet-like objects orbiting around the Short Axis.

Cylinder - This button defines a cylindrical force field of sparkling, rotating particle ’ noise ’.

Disk - This preset provides for a slowly turning particle disk onto which may be mapped various patterns. This could be the basis for a spiral galaxy effect.

Halo - A classic sparkling angels halo, with both orbital and suborbital particle motion, lots of sparkle, and lots of period variations - but with very little or no variation in geometric parameters.

Whirlpool - It is possible to make whirlpools with Halo through careful control of both speed and geometric parameters - and with multiple stand-in objects.

Default - Returns settings to Default values.

8.1.3 HALO TUTORIAL

Now we’ll take a look at some of the variations possible by building up from scratch some simple setting combinations.

Let's start with a clean slate - cleaner than the default configuration. Go into the FILE pull-down and reset MAX. Now select the CREATE/GEOMETRY/PARTICLE SYSTEMS/HALO command sequence and build a cube about a hundred units on a side. In the front view scale the cube vertically to maybe 90% or 95% of its original size. That will ensure that the HALO appears in a convenient orientation in the default user view. Default lighting will work fine.

The object will be assigned the default material. That's fine. Now go into the MODIFY control and select the emitter cube if it isn't still selected from being created. Expand the roll-up areas and compress the PRESETS area.

Let's make some changes. Run Particle Count to 1000, and then slide time Size Variation to 0. Set the Viewport Count to about 200. Also, set the Travel Time to 100,000 and its Variation to 0. Set Particle Spin Period to 100,000 and its Variation to 0, but run both the Spin Phase and the Spin Phase Variation all the way up. That will ensure that the particle system is always visible because particles will be facing all possible directions. Spin Axial Distribution Spread to 0. Turn CLUMPS off. Spin the Suborbital Radius down to 0, but run the Orbital Radius up to 100%. Render a frame; frame 0 will work just fine. What you get is a simple ring of particles. If you rendered this animation, neither would they appear to move because of the large values we assigned to the various periods.

Save the scene file as ***'HALOBASC.MAX'***.

8.1.3.1 Making a Cylinder

Now spin the Axial Distribution Spread up to 100% and re-render. Now we have a static cylindrical shell. If we now enter a Travel Time to 30 frames and render the animation, we'll get a spinning shell with no motion other than the primary rotation of the shell. Save this project file if you want to.

8.1.3.2 Making a Disk and Exploring Simple Mapping

Starting with ***'HALOBASC.MAX'***, run the Orbital Radius Variation to 100% and render a frame You may need to increase the number of particles to see the effect, but what you have now is a fixed disk-shaped collection of particles. If you run the Orbital Period down to 30 as in the previous example, you'll get a slowly spinning disk. Make certain that the X-Y mapping option is on. Go into the Material Editor and Create a white material similar to default - with full white ambient, diffuse, and specular values, but put a texture map in the first slot. A Canadian flag or US works well. Name the material and put the material to the current selection set. The texture map is applied to the center of the disk, but not to the entire disk. Why? Because we have an Orbital Radius of 100% and a Variation of 100% as well, the radius is twice the size of the box. Run the Orbital Radius down to 50% and leave the Variation as is. Now render a frame. The map just fits the disk. If you render the animation with the period set to 30 frames, the disk will rotate once while the map stays fixed. Save this file if you wish.

8.1.3.3 Making a Particle Donut

Start with ***'HALOBASC'***. Enter 5000 particles. Spin the Suborbital Radius to 25%, and leave its Concentration at 1. Enter a Period of 100,000 and spin the Variation down to 0. Why didn't we do this before? Because with the Suborbital Radius set to zero we didn't need to modify the period - it didn't matter how fast it was moving if it couldn't go anywhere. Enter both a Suborbital Phase and its Variation at maximum values - to disperse particles around the volume of the donut uniformly. Leave the other values alone. Save the scene as ***'HALODNUT.MAX'***. Render a frame and you should get a static toroidal volume composed of particles.

8.1.3.4 Making a Whirlpool Segment

In order to make a whirlpool - with particles moving faster as they approach the bottom center - we'd need to have several HALO stand-ins stacked up correctly. We've provided a sample file like that, but here's how you make one of those segments.

Start with ***'HALODNUT.MAX'***. Set the Suborbital Phase at 45 degrees and set that Variation at ZERO. Now run the Suborbital Radius down to 10%. Render a frame. All we've done is concentrate all the particles along one Suborbital Phase, and we get a conical shell. Set the Orbital Period to a small value, around 20, and we have a segment, a single level of a whirlpool. Save the projects file if you want to.

8.1.3.5 Making Clumps

Start with ***'HALODNUT.MAX'***. Select CLUMPS. Set the Number of Clumps to 10 and the Clump Size to s degrees; leave its Variation at zero. Set Clump Bias to 50%. Leave all other values at the default settings. Save this project file as ***'HALODNUT.MAX'***. Render a frame. You should have ten short arcs uniformly spaced around the Short Axis of the stand-in object.

8.1.3.6 Making Orbiting Disks

Start with ***'HALODNUT.MAX'***. Set Clump Size to 0 and turn Suborbital Radius up to 10%. Render a frame. You should have ten uniform disk-shaped collections of particles with their center normals aligned with their orbit's circumference. Set the Orbital Period to 30 frames and render the animation. You'll get ten internally static disks orbiting the stand-ins Short Axis. Modify Clump Phase and re-render a frame; observe how the disks have moved around the circle. Now add some Clump Phase Variation; observe how the disks are no longer evenly distributed.

8.1.4 Usage Notes

HALO was originally designed to do just that - Halos. In development we discovered that minor enhancements to the code allowed a great deal of flexibility in the final results. By using multiple stand-ins with varied settings, truly bizarre special effects are possible. Study the Whirlpool project file supplied, and the settings of the nested emitters. Render the Halo project file animation, and observe the complex particle motion.

8.2 PHASOR

PHASOR creates and animates particles moving along the long dimension of the emitter object. As they travel from one end to the other they are forced to follow a sinusoidal path. We control the initial position of the particle at the end of the box, the speed of the particle, the shape of the sinusoidal waveform, and the manner in which the individual particles spin. Figure 10 is a diagram depicting some of the terms we'll be defining momentarily.

8.2.1 General Terminology

The Long Axis of the PHASOR stand-in is that direction along which the particles will move. The Short Axis is that direction along which the particles will move along the sinusoidal curve at zero polarization. The Medium Axis is unimportant unless the Emitter is distributed; the default settings will produce a concentrated emitter - the point from which the particles issue -at one end of the Long Axis. It is possible to spread the emitter along both the Short and Medium Axes.

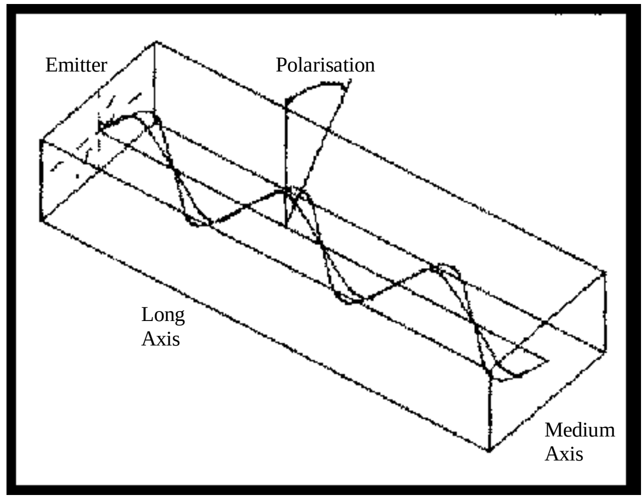

Figure 10 -PHASOR Terminology

'Spatial Frequency' is the number of cycles in the sinusoidal curve spaced out along the Long Axis of the stand-in. The particle path shown has a Spatial Frequency of three; there are three full cycles of the curve from one end of the box to the other.

'Polarization' is the angle through which the sinusoidal curve rotates about the emitter point and the direction of propagation. There are two curves - particle paths - shown in Figure 9. One has a polarization of zero. The other has a nonzero polarization angle.

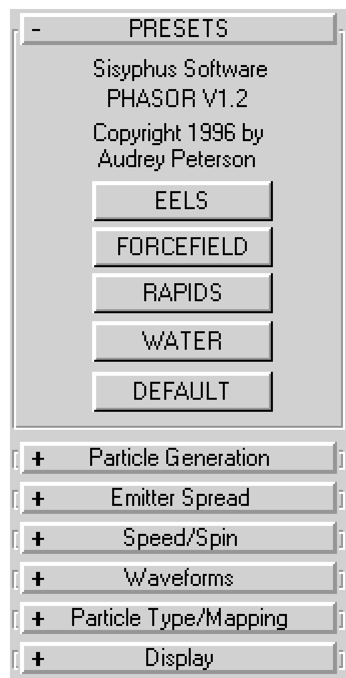

Figure 11 - PHASOR

'Amplitude' is the degree to which each particle deviates from the line of propagation in order to follow the sinusoidal curve. Amplitude of zero means that the particles will move along a straight line.

' Phase ' variables refer very specifically to the position of a particle 'when it starts out'. That is, in the **Figure 9** above all particles might follow a path shaped like the one shown, but some might start out with a slightly different amplitude than others. The effect of this is that there are multiple particle paths 'shifted' along the direction of propagation.

'Periods' are parameters, which define how long, in frames, it takes for something to happen. For example, a Particle Period of 30.6 frames means that it will take 30.6 frames for any given particle to move all the way along the Long Axis.

'Variation' parameters allow another setting to vary.
For example, Vatiation in Particle Period allows the Particle Period of any given particle to be defined randomly near but not necessarily at the specified Orbital Period value. If the Particle Period setting is 30.6 frames and Variation is 50%. then the Particle Period of any single particle may be between 30.6 minus 15.3 and 30.6 plus 15.3 frames.

'Concentration' parameters affect the distribution of values within an allowed variational range. A high Concentration means that most values will fall very near or at the specified value, but a low concentration - near unity - will allow values to range linearly over the variational limits. In some cases we allow Concentration values of less than 1, which forces the values to distribute unevenly towards the endpoints of the variational range.

8.2.2 The PHASOR Top-Level Roll-Up

Figure 11 depicts the Dialog box of PHASOR. As you con see, there are seven distinct areas in the PHASOR Dialog box.

8.2.2.1 The PARTICLE GRNRRATION Roll-Up

The settings in this area, shown in **Figure 12**, control the number and size of the particles, and the manner in which they are created over time. We'll cover each field separately.

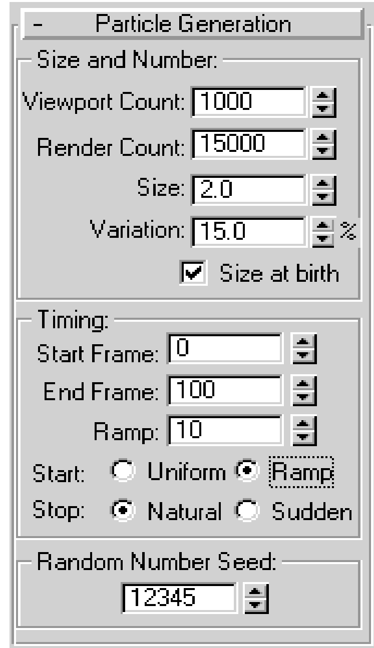

Figure 12 Particle Generation Control

Viewport Count - The maximum number of particles. Shown In the MAX main display to represent the appearance of the rendered particles. Should be more than the number of frames over which particles are emitted.

Particle Count - The maximum number of distinct particles that are created and maintained by the particle system throughout the run of the animation. Defaults to 100.

Size - A positive floating-point entry, which describes the overall size of the particle in drawing units.

Variation - The permissible variation in particle size.

Size At Birth - This control operates exactly like the identical control for HALO.

Start Frame - The first frame on which particles appear.

End Frame - The last frame on which new particles appear.

Ramp Frames - For a setting of RAMP, this is over how many frames the number of particles increases until the maximum number is reached.

START -These buttons control the initial particle distribution. A setting of UNIFORM creates particles throughout the box on the first frame. RAMP creates all particle at the emitter, so that they ' flow ' into the stand-in volume.

STOP - These buttons control how the particles disappear after the last active frame in which new particles are created. A setting of NATURAL forces is existing particles to linger after Frame End until they reach the opposite end of the box. SUDDEN makes all particles disappear after Frame End.

Seed - A random number generator seed value, which determines the sequence of psuedorandom numbers, generated throughout the animation. For a set of particles to be consistent whenever a single animation is spread across machines or sessions, this seed must be the same.

8.2.2.2 The EMITTER SPREAD Roll-Up

The settings in this area, shown in **Figure 13**, control the distribution of positions at which particles are created at the Emitter end of the Long Axis.

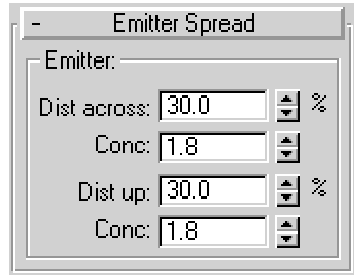

Figure 13 - Emitter

Distribution Across - A setting which defines the width of the Emitter along the Medium Axis. A setting of 100% will distribute particles along the entire Medium Axis of the stand-in box, and a value of 0 will create all the particles along the vertical midplane of the box shown in Figure 10.

Concentration - The degree to which particles are Spread concentrated along the vertical midplane of the box of **Figure 10**. A value of unity spreads the emitter linearly. A higher value, approaching 4, will concentrate virtually all of the particles in the center of the box and allow for only a few outlying particles.

Distribution Up - A setting, which defines the height of the Emitter along the Short Axis. A setting of 100% will distribute particles along the entire Short Axis of the stand-in box, and a value of 0 will create all the particles along the horizontal midplane of the box shown in **Figure 13**. Note that creating the particle along the midplane and constraining it there are two different things; the particle may still follow the sinusoidal curve away from the plane in which it was created.

8.2.2.3 The PARTICLE SPEED/SPIN Roll-Up

The Particle Speed/Spin controls define the rate at which the particle crosses the stand-in from the emitter end to the opposite end and the rate at which the individual particles spin about their own axes. There are also additional options. The control panel is shown in **Figure 14**.

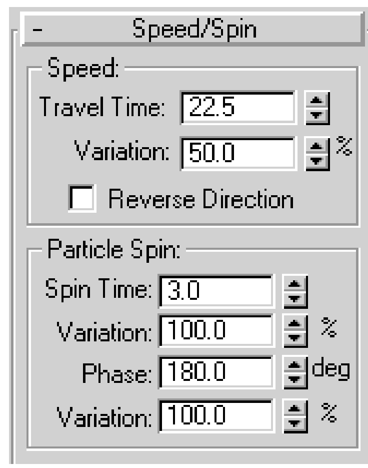

Figure 14 -
Speed/Spin Controls

Travel Time - A value in frames which defines the amount of time it takes a particle to move completely along the Long Axis.

Variation - A percentile value which defines the range within which the Travel Time (Particle Period) may vary. For example, if the Travel Time is set to 40 frames and variation is set to 25% then each particle will move along the Long Axis in times ranging from 30 to 50 frames.

REVERSE DIRECTION - This setting defines the direction of travel of the particles along the Long Axis. If the box isn't checked, all particles travel from the emitter end to the opposite end. (Technically, the emitter end is that end with lower-numbered vertices.) REVERSE DIRECTION flips the behavior of the particles end-for-end within the box.

Spin Time - A number in frames which defines how long it takes for the Particle to spin about its own local axis. A very large number here - the maximum is 100,000 - will ' freeze ' each particle's orientation. Note that the spin axis for facing quads is always along the central normal for the quad. The spin axis for other particle types is random.

Variation - The percentile limits over which particle spin will vary. A small value will result in a more uniform particle system,

Phase - Initial particle rotation. This value serves little value except as a base to be varied by the subsequent parameter. In most cases individual particle phase will be invisible.

Variation - The limits over which the spin phase of the particles will vary. Used in conjunction with Phase, this parameter sets the degree to which the particles randomly ' sparkle ' with time.

8.2.2.4 The WAVEFORMS/POLARIZATION Roll-Up

The Waveforms Area defines the shape of the path each particle follows from one end of the box to the other. It is very important to understand that the shape of the waveform and the speed of the particle are unrelated. Think of the Waveforms parameters as defining the shape of a tube and the Travel Time as the description of how long it takes the particle to travel along the tube from one end to the other.

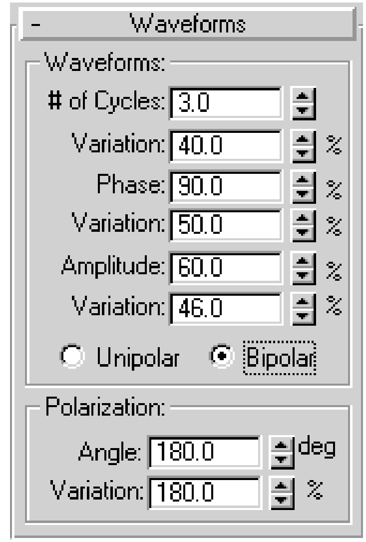

Figure 15 - Waveform

Number of Cycles - This is the 'Spatial Frequency', of the waveform, the number of times the Amplitude varies from minimum to maximum and back again over the length of the stand-in box. The wave of Figure 10 has three cycles.

Variation - A percentile value representing the bounds over which the base cycle counts may vary. For example, if Number of Cycles is set to B and the Variation is set to sat, then particles will follow curves with from 4 to 12 cycle counts along their lengths.

Spatial Phase - This is the Phase of the spatial frequency curve expressed in terms of a percentage. One hundred percent is 360 degrees.

Variation - A percentile value representing the bounds over which the Spatial Phase may vary.

Amplitude - This is the Amplitude of the wave as illustrated in Figure 14. The value is expressed as a percentile representing the amount of the distance along the Short Axis.

Variation - A percentile value representing the bounds over which the Amplitude may vary. If this value is set to 100%, the result will be a waveform 'colored in', as for any given curve all possible amplitudes will exist.

UNIPOLAR/BIPOLAR - Settings which define whether the amplitude of a given waveform is single sided or ' enveloped '. If BIPOLAR is turned on then for any given set of parameters both the wave above and the wave below the axis of propagation will exit.

Angle - This is precisely the angle illustrated in **Figure 10.** It defines the 'tilt' of the waveform from being aligned with the Short Axis.

Variation - A percentile value, this parameter determines the range of polarization angles within which any single particle's waveform might fall.

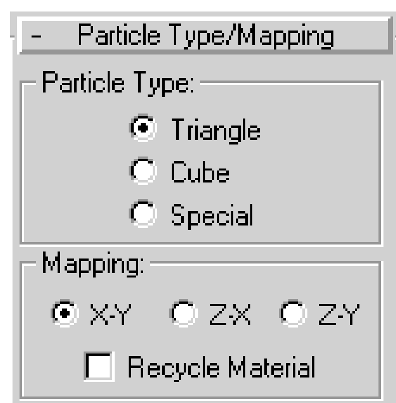

Figure 16 - Particle Type/Mapping control

8.2.2.5 The PARTICLE TYPE/MAPPING Roll-Up

This area sets particle type and mapping options. Three mapping alternative are available within PHASOR. First, it is possible to ' project '. A textured material across the emitter end, with mapping coordinates based on the position of the particle in the Medium Axis-Short Axis plane. Secondly, it is possible to assigned mapping coordinates projected over the top of the entire particle system. Third, mapping coordinates may be assigned from the side of the particle system. Figure 16 depicts the controls available.

X-Y/Z- X/Z-Y - This is the setting that selects the three mapping options. X-Y indicates. Mapping across the emitter surface. Z-x forces mapping coordinates to be scaled based on particle position in the Long Axis-Medium Axis plane. Z-Y assigns mapping coordinates to particles in the Long Axis-Short Axis plane.

PARTICLE TYPE - Phasor provides for the same five particle types supported by HALO. Note that "Recycle Material" has the same effects as well.

8.2.2.6 PHASOR DISPLAY Control Roll-Up

Figure 17 depicts the display controls for PHASOR. They are identical to the comparable controls for HALO.

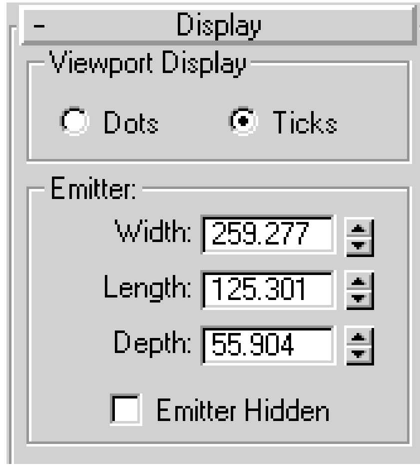

Figure 17 - Display Contr

8.2.2.7 The PRESETS **Control** *Area*

The Presets area contains a number of buttons, which modify the necessary control parameters to predefine a particular effect. There are five presets provided within the PHASOR top-level roll-up.

Eels - This button sets up a slow-moving transient particle system with ramped generation and natural cut off that has an uncanny resemblance to an undulating eel.

Forcefield - This button defines a rectangular planar force field of sparkling, vibrating particle 'noise'.

Rapids - This preset provides a dense array of fast moving noisy particles which in total resemble water flowing over rocks. The emitter is spread out across the rectangular emitter end of the stand-ins bounding box, and the polarization is predominantly vertical with a small setting and variation.

Water - A particle field related to the Rapids, this is a tightly defined emitter with random polarization to produce a circular beam of particles rather than a rectangular cross-section. Emitter Concentration values are increased to produce 'spray' at the edge of the effect.

Default - Returns settings to Default values.

8.2.3 PNASOR TUTORIAL

Now it's time to develop some basic understanding of the available within the PHASOR dialog box.

8.2.3.1 Setting Up a Basic Configuration

Let's start with a stripped-down project file - a particle system configuration even simpler than that provided by any of the presets.

From the FILE pull-down menu, select Reset to clear MAX of unwanted geometry. Now select CREATE/GEOMETRY/PARTICLE systems, push the PHASOR button, and create a box that's about 40 units high in the Front and side views, 120 units wide in the Front view, and about 60 units wide in the side views. Given this configuration, the box will display conveniently in the default perspective viewport. Default lighting is fine.

Select the MODIFY button and click on the emitter box if it isn't still selected from being created. Enter the Number of Particles as 1000. Spin the Size Variation down to zero. Make sure both UNIFORM and SUDDEN are selected. Under Particle Speed, enter a value for Travel Time of 30 frames. Spin Variation to zero. Under Spin enter 100,000 for a time, and spin the variation down to zero. However, spin both Spin Phase and Spin Phase Variation to maximum values. This guarantees that there are particles facing in every possible direction. Spin both Emitter Distribution values to zero. Enter 4 for the Number of Cycles, and slide its Variation down to zero. Zero also Spatial Phase and its Variation. Set Amplitude to 100% and run its Variation to zero. Set both Polarization and its Variation to zero. Save the scene file as ***'PHASBASC.MAX'***.

Render a frame. You should get a neat sinusoidal curve with four complete cycles.

8.2.3.2 Making a Solid Wave

Start with ***'PHASBASC.MAX'***. Spin the Emitter Distribution Across all the way to 100%. Render any single frame. Note that the single thin line has dispersed across the stand-in box to become a solid wave-shaped particle surface with four cycles along the stand-ins Long Axis. Save this configuration as '***PHASWAVE.MAX***.'

8.2.3.3 Making a Curvilinear Wall

To illustrate the effects of Emitter Distribution and Polarization and how they relate to stand-in orientation, start ***'PHASBASC.MAX'*** again. However, this time run the Emitter Distribution Up to 100%. Now render a single frame. Note that the thin white curve has dispersed vertically. Now set Polarization to 90 degrees and render another frame. Now we have a sinusoidal surface again, but it's rotated with respect to the stand-ins bounding box. Try different combinations of Emitter spread and Polarization. One combination - zero distributions, a Polarization of 180 degrees and maximum Polarization Variation - yields a particle surface of revolution whose generator curve is the thin sinusoid we started with.

8.2.3.4 Exploring Spatial Phase

Reload ***'PHASBASC.MAX'***. Now render frames with various Spatial Phase settings: 12, 25, 37, 50 percent. Note how the curve translates along the direction of particle propagation. Set the Spatial Phase to 25 percent and set the Variation to 5%. Render a still frame. Note that all the phases from approximately 85 to 95 degrees are present, resulting in simultaneous curves and a blurring of the sinusoid. Now enter a value of 50 percent for the Spatial Phase and a Variation of 100%. Since all possible values for Spatial Phase are present, no single curve is visible. Instead, a solid surface of particles appears. Save this configuration as PHASWALL.MAX.

8 2.3.5 Particle Noise Volume

Starting with '***PHASWALL.MAX'***, increase the number of particles and the Distribution Across. Render a frame. The only way to make this configuration 'noisier' would be to vary the Number of Cycles. Do that. Observe the results.

8.2.4 Usage Notes

It's important to note that PHASOR has no specific purposes. PHASOR can approximate flowing and running water, 'transporter' fields, particle beams, and other effects requiring the addition of noiselike or periodic transverse motion to streaming particles. Review the configuration and stand-in contents of the five project files provided. The only way to understand what PHASOR can do is to ' experiment '

8.3 ALL PURPOSE EMITTER

8.3.1 General Terminology

The ALL PURPOSE EMITTER (APE) creates particles which are then allowed to stream away from their point of creation according to fundamental equations of motion. Because APE accounts for both the EJECTION velocity - the speed and direction with which the particles leave the emitter - and the EMITTER velocity -the speed and direction with which the emitter travels through space - the actual motion of each particle will be a combination of the two vector components.

The combination of ejection and emitter velocity is commonly called 'secondary motion. in the literature. Secondary motion data is that information needed to account for the motion of the emitter at the instant the particle leaves the emitter. To understand this concept, picture a hose on a fire engine spraying water. If the hose is pointed straight upwards as the fire engine moves forward, each bit of water as it leaves the nozzle is moving both UP and FORWARD. The UP part of the motion comes from the EJECTION velocity, but the FORWARD part of the motion comes from the 'secondary motion data', or from the motion of the fire engine at the instant the water left the nozzle. The rooster-tail shaped spray of water is a product of BOTH components

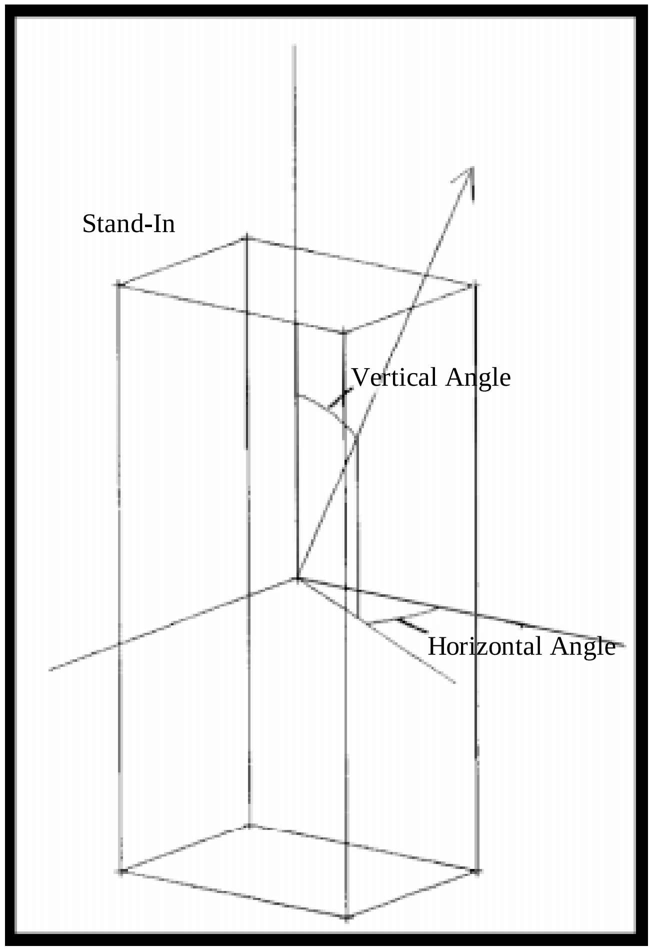

Figure 18 - Directions Concepts

8.3.1.1 Axis Location

The animator builds the emitter for APE with the CREATE/GEOMETRY/PARTICLE SYSTEMS/APE command sequence irrelevant to its operation. The size and proportions of the box are completely However, **Figure 18** depicts how the angles defining.

the ejection direction are measured with respect to the z-axis of the emitter.

9.3.1.2 Motion Offset

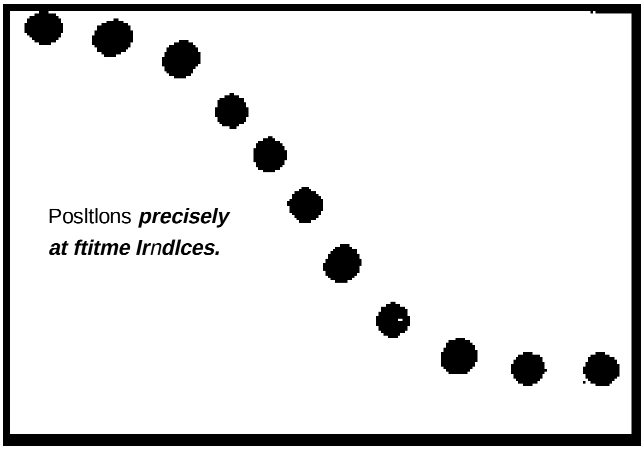

Figure 19 - Emitter Motion Offset

As the particle emitter moves through space in the *3D* studio MAX scene, particles flow from the ’nozzle’ of the emitter. However, if the equations of motion of the particles account for only whole-numbered frames, then the particles will appear to ’burst’ from the emitter at those positions where the emitter is present at precise time intervals concurrent with whole-numbered frame counts. **Figure 19** depicts particle clouds produced with this technique.

However, if the particle system accounts for the motion of the emitter and ’ smoothes ’, the emission of particles over all points along the path of the emitter, then the particle trail will more closely resemble the results of **Figure 20**. Most applications, attempting to simulate a real effect will be more closely aligned with the algorithm represented by Figure 20.

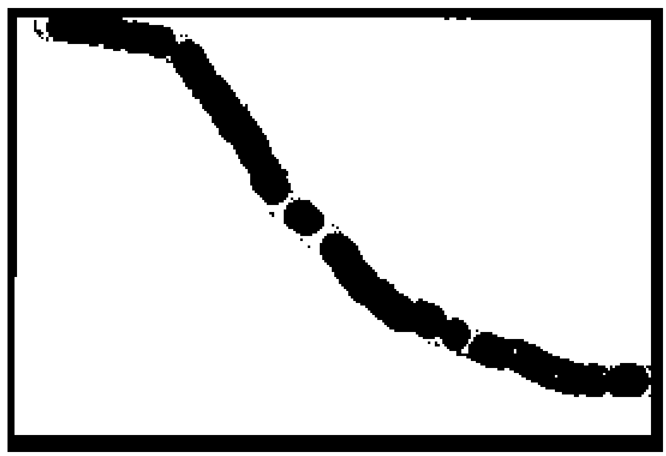

Figure 20 - Emitter Motion Offset

Likewise, if the equations of motion account for only the creation of particles at precise frame counts, then a single burst may resemble the results depicted in **Figure 21**. What this figure depicts is the presence of waves of particles each created precisely one frame away from the nearest adjacent group of particles. This approach may also be adjusted to provide a smooth source of particles streaming from the emitter more in line with the representation of **Figure 22.**

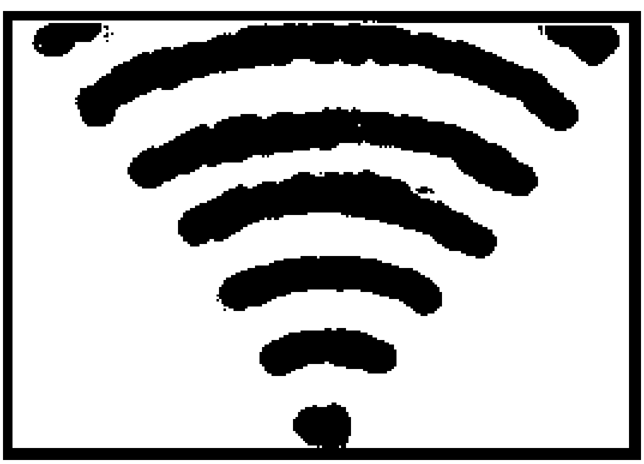

Figure 21 - Ejection Motion Offset

8.3.1.4 Other Concepts

MAX supports gravity Spacewarps and collision detection in its basic form, but because Particles II for Releases 3 and 4 already had these features built in, we chose to provide them in APE as well. You needn't use them, and you can get similar, and sometimes more versatile, results by using the built-in Spacewarps.

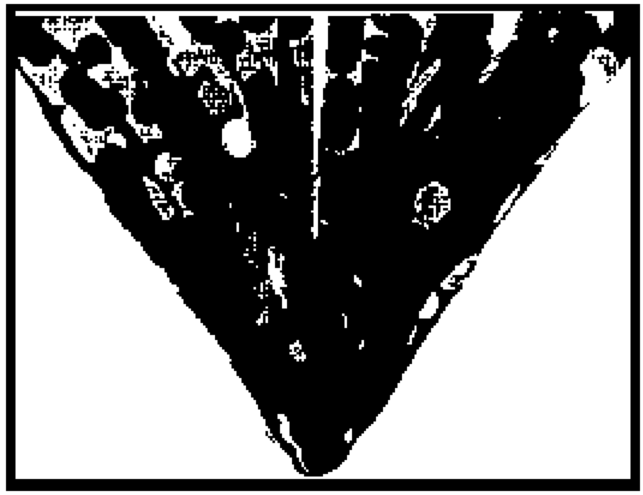

Figure 22 - Ejection Motion Offset

The 'Bounce Plane' is an arbitrary location in space - not a physical object or geometry - which defines where particles will bounce if BOUNCE is turned on and particles cross the boundary. The Bounce Plane is most useful when used in conjunction with Gravity. Note that Bounce Location is defined in terms of the fixed global coordinate system.

'Gravity' is a tendency of the particles to accelerate along a direction parallel to a specific axis. APE allows for multiple gravity vectors aligned with the three principal axes.

8.3.2 The APE Top-Level Roll-Up

Figure 23 depicts the top-level roll-up for APE. As you can see, there are seven distinct expandable sections.

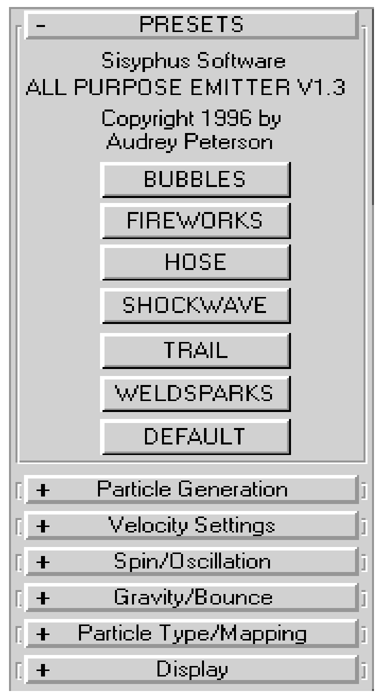

Figure 23 - APE Top-Level Roll-Up

8.3.2.1 The PARTICLE GENERATION Roll-Up

The settings in this area control the number and size of the particles, and the manner in which they are created over time. We'll cover each field separately. The control panel area is shown in **Figure 24**.

Viewport Count - This is the maximum number of distinct particles visible in the MAX main display. This value should be larger than the number of frames over which particles will be created by the particle system.

Particle Count - The maximum number of distinct particles that are created and maintained by the particle system throughout the run of the animation. Defaults to 100. Note that the number of particles MUST BE GREATER than the number of frames between START and STOP inclusive, else the number of particles will usually round down to zero on each active frame.

Size - A positive floating-point entry, which describes the overall size of the particle in drawing units. The size of the particles is NOT related to the size of the stand-in. Variation - The permissible variation in particle size.

Size At Birth - This parameter operates ad does the identical parameter for HALO and PHASOR. Size is an animatable parameter, but can vary two ways. Either all particles are the same size range at any given frame or each particle is born with a constant size. If this button is active the latter condition prevails.

Start Frame - The first frame on which particles appear.

End Frame - The last frame on which new particles appear.

Life - The number of frames a particle will live after its creation.

Variation - A percentile value describing the range of Life values particles may take on at creation time. For example, if Life is 30 and Variation is 33%, then any given particle will be displayed for a number of frames between 20 and 40.

Bias - This parameter has a complex mathematical Interpretation, which is best, described qualitatively. When Bias is set to zero, the number of frames divides the total number of particles so that a fixed number are created at the Emitter each frame. However, when Bias is displaced from zero, the number of particles created with time skews. A Bias of -100% results in a very large proportion of the particles being created at Frame Start and none being created at Frame End. When Bias moves to 100%, the reverse is true. This is very useful when an effect stretches over several frames and it is necessary to reduce or to enhance the intensity of the effect over time.

Seed - A random number generator seed value, which determines the sequence of psuedorandom numbers, generated, throughout the animation. For a set of particles to be consistent whenever a single animation is spread across machines or sessions, this seed must be the same.

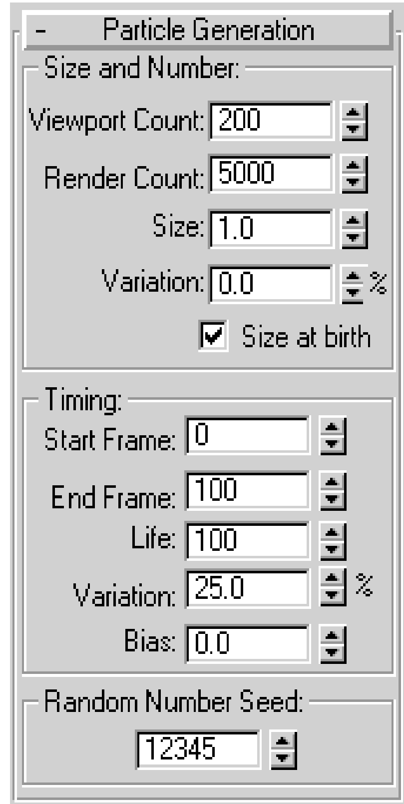

Figure 24 - Particle Generation Controls

8.3.2.2 The PARTICLE VELOCITY Roll-Up

The Initial Particle Velocity Dialog Area is the heart of APE. It is this box more than any other that contains those parameters most crucial to the appearance and behavior of the effect. Note that ’ velocity ’ in the strictest sense completely defines both speed and direction. That is indeed what this area defines. This area controls not only the speed and direction of the particles as they are expelled from the nozzle, but it also controls how much of the emitter’s own speed and direction are adopted by the particles as they leave the nozzle. The dialog area is shown in **Figure 25**. Specific entries are described below. All angles and speeds are animatable parameters.

Vertical Angle - Vertical is defined as that direction aligned with the longest dimension of the stand-in. The Vertical Angle defines an inclination with which particles are ejected with respect to the direction of the emitter’s local z-axis. Since 0 degrees equates to ’up’, 180 degrees must equate to ’down’. Thus this spinner runs only from 0 to 180 degrees. Note that this angle by itself is insufficient to define ejection particle velocity, since a "Vertical Angle, could define a conical range of paths enclosing the vertical axis.

Variation - A value in degrees which defines the range within which the Angle off Vertical may vary. For example, if the Angle is set to 20 degrees and variation is set to 5 degrees, then all particles will be ejected at an inclination from between 15 and 25 degrees off the vertical axis.

Concentration - A measure of how the possible inclination angles of all particles are organized within the allowable variation. A value of 1 produces a linear variation. A value of 4 produces a tight stream centered on the Vertical Angle with some few particles being ejected at the limits of the angle's variation.

Speed - As velocity requires both direction and speed information, we set the speed with which the particle is ejected from the Emitter here. This value is in world coordinate system units per frame. The speed is measured along the Vertical Angle.

Variation - A percentile value, which defines the range within which the Speed as measured along the angle of ejection, may vary.

Horizontal Angle - Horizontal is defined as that direction aligned with a vector directed from the emitter's center along the local x-axis The Horizontal Angle defines an azimuth with which particles are ejected from the emitter with respect to that direction. This value may range a full 360 degrees.

Variation - A value in degrees which defines the range within which the Angle off Horizontal may vary. For example, if the Angle is set to 90 degrees and Variation is set to 90 degrees, then all particles will be ejected over a half-circle from 0 to 180 degrees off the positive-direction Horizontal Axis.

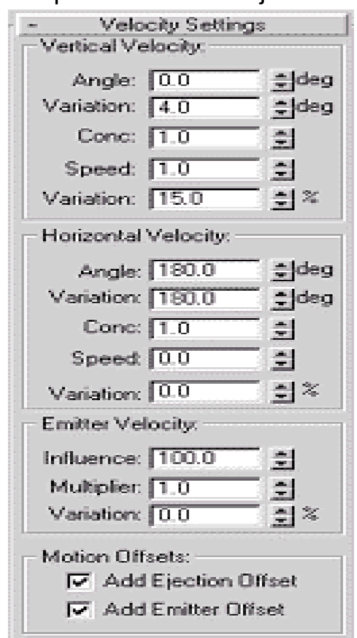

Figure 25 - Velocity Controls Roll-Up

Concentration - A measure of how the possible azimuth angles of all particles are organized within the allowable Variation. A value of 1 produces a linear variation. A value of 4 produces a tight stream centered on the Horizontal Angle with some few particles being ejected at the limits of the angle's Variation.

Speed - As velocity requires both direction and speed information, we set the speed with which the particle is ejected from the Emitter here. This value is in world coordinate system units per frame. The speed is measured along the Horizontal Angle.

Variation - A percentile value, which defines the range within which the Speed as measured along the angle of ejection, may vary.

Notes On Velocity And Angle Relationships:

It is absolutely vital to understand the relationships between the two angles and the two speeds as defined by the above text. As the Vertical Angle becomes nonzero, a component of that speed is directed along the horizontal. This means that the angle settings in the horizontal direction have meaning EVEN IF THE HORIZONTAL SPEED IS ZERO. For example, if the Vertical Angle is 60 degrees and its Variation is 6 degrees, then all particles will be ejected from the Emitter at inclination angles between 54 and 66 degrees off the axis aligned with the stand-ins long dimension. However, that doesn't define the full motion of the particle stream, since it must be defined in the horizontal direction as well. Thus - even if the Horizontal Speed is zero, the direction of the stream will be defined by the horizontal angle specifications. Note further that if Horizontal Speed is nonzero that speed will be added to the horizontal component of the Vertical Speed, and that the resultant angles will not precisely match those specified for vertical direction. Contrarily, Horizontal Speed is always purely horizontal, and thus vertical angle settings have no meaning if Vertical Speed is zero. Use this rule: If there is no vertical direction component, set Horizontal Speed and ignore Vertical Speed. If there is vertical motion, set Horizontal Speed to ZERO!

Both speed components are provided to allow for complex variations in the construction of conical and elliptical blast patterns.

The following parameters control how much of the emitter's motion at the time each particle appears is absorbed or adopted by the particle. That is, it is possible to produce particles that leap from the emitter and immediately assume their own path due to the ejection velocity while ignoring any momentum that should have been imparted by the emitter. Contrarily, it is possible to produce particles that assume ALL of the emitter's speed and direction at the time they were created, and which then add that speed and direction to their own ejection velocity. This is the situation that more closely resembles actual physics.

Influence - This is the percentage of the particles which absorb emitter speed at creation time.

Multiplier - This is the value used to determine what percentage of the emitter speed is adopted by the particles. For example, if a particle has ejection speeds of Zero and is created by an emitter traveling at 30 units per frame, and if the multiplier is one and the particle is influenced, then the particles speed will be 30 units per frame. If the multiplier is 0.5, its speed would be 15 units per frame. Note that negative and larger-than-one values are allowed, which provides for some very unusual special effects.

Variation - This is the percentage of the multiplier by which each particle's particular multiplier is allowed , to vary.

"These parameters control the offsets described in section 8.3.1."

Ejection Motion Offset - These are radio buttons, which define the mode in which particles appear outward from the emitter. The method of **Figure 21** corresponds with a setting of OFF, and the method of **Figure 22** corresponds with the setting of ON.

Emitter Motion Offset - These are radio buttons, which define the mode in which particles appear along the path taken by the emitter. The method of **Figure 19** corresponds with a setting of OFF, and the method of **Figure 20** corresponds with the setting of ON.

Figure 26 - Spin and Bubble Noise Control

***8.3.2.3 Spin/Transverse Oscillation Control* Area**

This area sets particle spin and transverse oscillation, or "bubble noise" parameters. If each particle of the system were to remain fixed in orientation in space, the particle system would lose some of its dynamic appearance. Each procedural face - each particle - has a randomly generated spin axis assigned at creation time. Over time, the particle is set to spin about this axis, which passes through the center of the particle. When the user assigns single-sided materials, the particle ’sparkles’. When the user assigns a two-sided material, the appearance of the particle system varies over time because of individual particle spin. **Figure 26** depicts this roll-up control area. As in HALO and PHASOR, note that the spin axis of rangeless pixels has no meaning and that the spin axis of facing quads is always along the quad’s central normal. Spin axis for other particle types is random.

Spin Time - A number in frames which defines how long it takes for the particle to spin about its own local axis. A very large number here - the maximum is 4000 - will ’freeze’ the particle’s orientation.
Variation - The percentile limits over which particle spin will vary. A small value will result in a more uniform particle system appearance.
Phase - Initial particle rotation. This value serves little value except as a base to be varied by the subsequent parameter. In most cases individual particle phase will be invisible.
Variation - The limits over which the spin phase of the particles will vary. Used in conjunction with Phase, this parameter sets the degree to which the particles randomly ’sparkle’ with time.

’Transverse’ means ’across’, and ’Oscillation’ means ’vibration, so this area’s purpose is also to control the vibration of particles in a direction across the direction of travel. This control is used mainly to make ’bubble noise’, or the small psuedorandom chaotic motion of bubbles as they push through the denser medium in which they reside. Applicable parameters appear below.

Amplitude - This sets the total distance each particle vibrates as it follows its own path.

Variation - This slider controls the amount by which the Amplitude is allowed to vary over all particles.

Phase - This control the degree to which the particle is along the vibration cycle at the first frame the particle appears. Used in conjunction with Phase Variation, it is used to give the set of all particles different vibrations, or to induce apparent chaos in the ’bubble noise’ perturbation.

Variation - This slider controls the amount by which the Phase is allowed to vary over all particles.

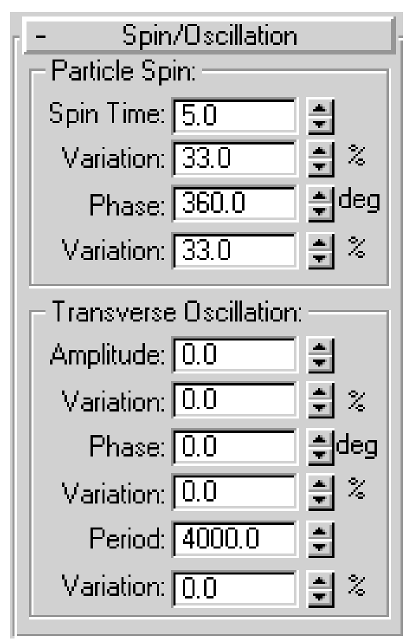

Figure 27 - Gravity

Period - This is the total amount of time - in frames - one vibration cycle requires.

Variation - This slider controls the amount by which the Period of all particles is allowed to vary.

8.3.2.4 The GRAVITY Roll -Up Controls

This area can completely change the character of the effect. There are actually two separate sets of information defined here. One is the strength, direction, variation and influence of gravity. The other is the definition of the Bounce Plane. **Figure 18** depicts the Bounce/Gravity Dialog area.

Gravity Buttons - These are NOT radio buttons The animator can select one, two, or all three of these gravity vectors Each button activated a gravity vector aligned with a principle axis. Two or three buttons turned on can produce extremely unusual motion.

REVERSE DIRECTION - Let's say that you've spent a lot of time carefully arranging the emitter box in your scene but when you render for the first time you find your box is upside down. Rather than spending the time to reverse its orientation, it's possible to flip the gravity vector's direction. This button does that. Note that it flips all three gravity vectors at the same time.

Strength - This is the strength of the gravity vector in world coordinate units of acceleration per frame. Some experimentation to find the proper values of Strength will almost always be necessary. Take a look at the sample project files for values compared to stand-in size. The larger this value is, the faster particles will fall.

Variation - This is the percentage by which gravity will vary for each particle. This has the effect of making some particles behave as if they were lighter or heavier than the normal particle whose gravity will be the same as the nominal set value.

Influence - This is the proportion of particles affected by gravity. This means that some particles will fall and some will appear to be weightless.

BOUNCE ON - This option activates or deactivates the Bounce Planes.

Bounce Plane Buttons - These radio buttons activate one of the bounce places available - all of which are aligned parallel to the principal axes. For example, turning on the 'X' button will mean that particles will bounce when they try to cross the coordinate location X=<location> as set in the adjoining location field. The particles will rise to the proportion of their speed and height prior to the bounce according to the factor set in the associated Height field.

Notes on Gravity and Spacewarp Usage: When using both gravity and Spacewarps, in general using a MAX gravity well in conjunction with a deflector will be more effective than using APE built-in gravity in conjunction with a MAX deflector. Furthermore, when using both gravity and deflector Spacewarps the particle system should be bound to the deflector FIRST and then to gravity in order to reduce particle leakage across the deflector.

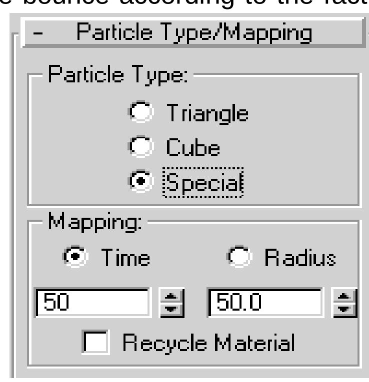

Figure 28 - Particle Type/Mapping Control

8.3.2.5 Particle Type and MAPPING METHOD Control Area

More than any other parameter these radio button settings and associated fields has vast impact on the appearance of the rendered effect. APE provides three methods for applying mapped textures to the particles, and for two of the methods the routine provides detailed control over the method by which mapping coordinates are applied to the particles. The dialog area is shown in **Figure 28**.

Time-Based mapping allows the animator to apply a portion of a texture map scaled with respect to the time at which the particle is being rendered as compared to when it was created. For example, if the animator applies a material to the stand-in which carries a texture map which is only a gradient fading from red to black from left to right, then Time based mapping allows the animator to change the color of the particles as each travels through the scene based on the number of frames each particle lives. When particles are born, they'll be red, and as each particle lives a number of frames equal to the entry in the associated field, it will change gradually to black. Thereafter the particle will be black.

Radius-Based mapping works in a similar way: the u-coordinate of the bitmap is chosen based on the amount of the distance entered in the associated field the particle has traveled with respect to the point at which it was originally created. When the particle moves farther than this distance, the right-end of the bitmap is mapped to the particle.

Cube, facing quad, and Special particles are also capable of accepting a FACE MAPPED material properly.

8.3.2.6 Display controls

The Control Area of **Figure 29** is identical to the display controls for HALO and PHASOR

8.3.2.7.7 The PRESETS Dialog Area

The Presets area contains a number of buttons, which modify the necessary dialog box parameters to predefine a particular effect. There are seven presets provided within the APE roll-up at top level.

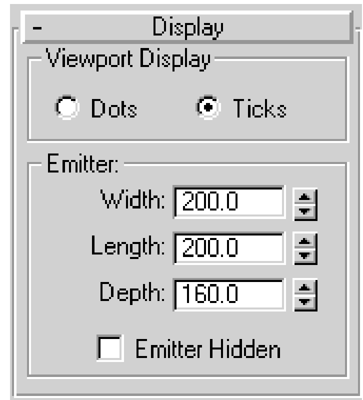

Figure 29 - Display

BUBBLES - This button sets up slowly rising bubbles which are mostly unaffected by emitter velocity. That is, bubbles streaming from a SCUBA diver may absorb some of the diver’s motion, but it decays so quickly in the water that the secondary motion required is almost nil. **Figure 20** depicts this preset screen parameter set. Note the transverse oscillation setting and how they compare with particle size.

Random Cubes - This button defines a particle a slow burst of spreading, vibrating, rotating cubes fully mapped with the stand-in’s material applied over all square faces. We’re not sure what this setting is good for, but it produces odd animations. Note the slow rotation and vibration settings and the large particle size.

Fireworks - This preset provides spectacular shaped spherical bursts similar to fireworks explosions. Note the short active range and the limited use of gravity and secondary motion influence to simulate light, floating embers.

Hose - This is simply a directed spray of particles which assume mapping to provide a color change and which assume all of the emitters motion to produce an effect very much like water leaving a swinging hose.

Shockwave - This is a segment of spherical shock wave. Note the use of ZERO motion offsets or provide a very sharp-edged blast wave from the emitter outward. Trail - This setting provides a trail of ’pixie dust’ following the emitter.

Welding Sparks - This button provides for densely packed particles, which fall and bounce with gravity. Since APE provides for secondary motion, the particles created with this setting provide very realistic motion as they bounce and skitter across the ground plane.

Default - Returns settings to Default values.

8.4 ALL PURPOSE PARTICLES SPACEWARPS

We provide you with two Spacewarps within the single plug-in executable. Either may be accessed using the CREATE/SPACEWARPS button sequence. "MOLASSES" and "VORTEX" will appear in the ‘Sisyphus Spacewarps’ selection in the CREATE/SPACEWARPS scrolling roll-up. This is a change for APP 1.5.

8.4.1 MOLASSES

Molasses is a particle Spacewarp, which provides viscous damping forces. That is, it slows particles in proportion to how fast they are traveling. MOLASSES appears as a cube in the main display and provides only three parameters. The control roll-up appears in **Figure 30**.

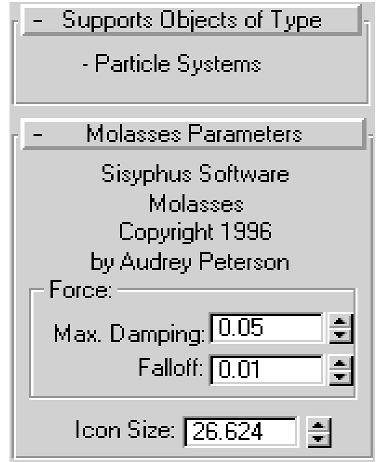

Figure 30 - MOLASSES

MAX DAMPING - This is a percentage value. A value of 100 will damp all particle velocity of bound emitters immediately within the sphere of influence's core.

FALLOFF - A factor, which determines how rapidly the effect, diminishes over distance. A value of 0 allows the Spacewarp to operate upon bound emitters everywhere regardless of distance.

Icon Size - The dimensions of the cube in the main display.

8.4.2 VORTEX

Vortex is a complex spacowarp with a number of controllable parameters. For an idea of how the settings might be used, seethe sample file using APE and VORTEX, ***'VORTEX.MAX'***.

Simply put, Vortex attempts to capture bound particles and sweep them into a swirling, falling mass. The shape of the vortex may be formed and the strength of **the various** components may be controlled over distance. The control roll-up is shown if **Figure 31**.

Axial Strength - This is a measure of how forcefully particles sweep down the center of the vortex. Helps to control vortex height.

Axial Falloff - Controls how Axial Strength and Damping vary with distance. A value of zero allows the Spacewarp to capture bound particles regardless of range. The larger this value becomes, the closer particles will get before being captured.

Axial Damping - A measure of how quickly bound particles are captured by the vortex forces. Values near 1000 produce immediate results. Smaller values allow bound particles more latitude in escaping the vortex.

Orbital Strength - How quickly particles are propelled around the vortex.

Orbital Falloff - How rapidly the orbital forces vary with distance. A value of zero captures particles immediately, and larger values tighten the vortex's effects.

Orbital Damping - Controls how quickly orbital forces affect bound particles in the direction of orbital motion. Values near 1000 produce immediate results, but smaller values give far more freedom to particles passing the vicinity of the vortex.

Radial Strength - How quickly particles are forced to approach the vortex axis.

Radial Falloff - A measure of how quickly the radial forces diminish over distance.

Radial Damping - Like the other two damping parameters, this value controls how quickly bound particles begin to fall into the vortex with a specific velocity component.

Axial Taper - This is a scaling factor which should represent the approximate height of the vortex in drawing units

Taper Coefficient - Controls the linearity of the sides of the vortex.

CW/CCW - Viewed from the top, this controls the direction of vortex rotation.

Icon Size - Controls displayed spaceward icon dimensions. Does not vary forces.

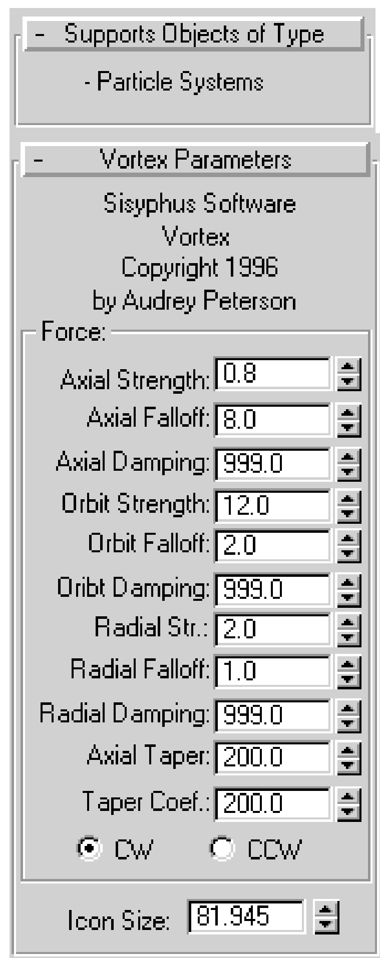

Figure 31 - Vortex