

Readme

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Chapter 1

Readme

1.1 Readme.guide

REAL 3D V.3

Thank you for purchasing Real 3D, the fastest and most impressive ray tracing, modelling and animation software in the Amiga market.

This file contains information not included in the manual and descriptions of changed features.

CONTENTS

=====

WHAT IS NEW IN REAL 3D V.3

FEATURES NOT DESCRIBED IN THE MANUAL

- JPEG support
- Autoconfig feature
- Custom menus
- Creation method
- Shrink wrapping
- Lens flares
- Post effects and memory usage

COMPATIBILITY ISSUES

MISCELLANEOUS TOPICS

1.2 summary

WHAT IS NEW IN REAL 3D V.3

=====

Version 3 introduces hundreds of new features and improvements. This document

lists and describes briefly the most outstanding new features.

- Modelling
- Rendering
- Animation
- Materials
- RPL
- Other

1.3 modelling

MODELLING

- Surface coordinate system allows you to enter 3d points just by clicking points from object surfaces. When this function is used, mouse actually moves along surfaces of underlying objects, instead of the planar input plane. For example, to create a motion path for a snake wriggling over a mountain, just draw a curve along a surface representing the mountain.
 - The 'Reflect' function allows you, for example, to position a light by defining where you want a highlight to be on an object.
 - Fast background image blitting allows accurate perspective matching, rotoscoping, etc. The project file 'projects\backdrop.prj' demonstrates this feature.
 - A new rounding function allows you to easily round objects by selecting points and defining rounding radius for them. This also works for solid objects, such as pyramids and polyhedrons.
 - Active Camera View feature interactively updates camera view windows while the user is moving a camera object.
 - The new 'View Tool' window allows you to activate easily most commonly needed functions during creation and modification functions. For example, depth, angles, rotations, 3d coordinates, centering etc. can all be activated through this window. The window adapts according to the selected function giving instant feedback of what is possible during the currently activated function.
 - Settings for fractal trees and landscapes can now be saved and loaded.
 - Primitive depth can now be defined numerically or with the mouse during object creation.
 - It is now possible to view and modify the geometry of all objects through a numerical interface.
 - 'Dump Object Tree' function prints a diagram of object hierarchy and all object attributes. This is very handy when examining very complex scenes.
 - All objects can now be converted to polygonal models (trisets). This allows you to export models consisting of B-Spline and quadric objects to programs which can only handle polygonal models.
-

- Triset meshes allow colorization of individual faces -> better support for converted triangle objects.
- New normal orientation feature to fix phong shading problems of converted objects (Modify/freeform/Surface type).
- Settings/attributes allows definition of default depth and name of objects.
- Automatic 'subdivide freeform object to sub-groups' function.
- 'Deselect points which are already included in one of the selected sub-groups' function. This makes it easy to sub-divide very complex objects to sub-groups and make sure sub-groups don't overlap.
- Hot key for repeating the last action.
- New 'bounding box' drawing attribute for objects.
- Extrude tool contains new 'Hierarchy' option which can be used for controlling whether all selected curves should be extruded to one single object or whether the function should duplicate the hierarchy of the parameter curves.

1.4 rendering

RENDERING

- 2 ... 10 times faster B-Spline rendering.
The project file 'projects\autobox.prj' contains a typical 3d logo object. The new version renders this project 6 times faster than the previous version 2.
 - Lens flares.
For an example, see projects\lensfla1.prj and lensfla2.prj. Note that these projects contain several render settings creating different flares; you can use Load button of the render settings to select and render them.
 - Glow effects for simulating fire, atmospheric effects, laser beams etc.
 - New 'Fade' object attribute for fading objects in and out and for quickly rendered transparent layers.
 - Auto box rendering.
This feature saves memory and speeds up rendering of complex scenes. The feature makes it possible to render efficiently large images.
 - Automatic field interlacing.
 - Rendering settings can now be named, saved and reloaded.
 - Distance antialiasing.
 - 8 bit alpha channel output in IFF file rendering.
-

- Non-adaptive supersampling for creating very high quality images.
- Open 3rd party interface for post processing effects.
- Render settings loading and saving.

1.5 animation

ANIMATION

- Easy to use higher level interface for most commonly needed animation effects.

- New 'Surface' animation method.

This animation method uses Real 3D's collision detection system to automatically derive motion for objects based on the friction between the objects and the ground. The user just has to define some 'friction points' from the object to be animated, an object which defines in which direction the gravity affects and an object representing the ground.

For an example, see 'Projects\girlwalk.prj'.

- New 'Shrink Wrapping' animation method.

This is also based on the collision detection system of Real 3D. It allows you to apply collision detection between freeform objects. For example, to wrap a skirt around an walking human character. The collision between the body and the skirt makes sure the skirt fits all the time.

The project 'Projects\skirt.prj' contains a walking b-spline character wearing a skirt. One 'Surface' method causes b-spline girl to walk and one 'Shrink Wrap' method is used for making sure the skirt follows the body of the girl.

- Several improvements to skeletal control:

- Skeletons can now contain 'sub-skeletons' which allows tree-structured skeleton systems. For example, a hand contain five sub skeletons ie. fingers.

- Constraints can be used for defining minimum and maximum angles for bones.

- There is no need to subdivide freeforms to sub-groups any longer. A skeleton can be attached to freeform objects directly.

- 'Fidelity' attribute can also be defined for individual points of freeforms.

- Easy to use interface for attaching skeletons to objects. Just select freeform objects and define a skeleton for them.

- Improved Inverse Kinematics:

- Motion curves are now automatically snapped to the nearest joints of a skeleton which makes it very easy to create 'motion capture' animations.
-

Just create a skeleton and load in motions curves for desired joints. Real 3D takes care of the rest.

- Improvements to morphing:
- The user has now control over what properties of the target object the morphing method affects, such as geometry, color and material.
- Morphing no longer stretches skeletons if bone lengths are equal. Morphing also handles angle constraints.
- Morphing can be applied to objects with different number of points.
- New 'Discrete' interpolation type added. This allows for example camera cut effects.
- 'Keyframing' method allows you to create keyframe animations by a traditional keyframe interface.
- The envelope editor allows the user to view and define motions, rotations, scaling etc. for objects through envelope curves.
- Easy to use interface for the procedural creation method. The user just defines attributes, such as life time, randomness, velocity, spin etc. and Real 3D creates the correct hierarchy for the effect.
- Now the user has control over the time distribution for motion curves. In other words, it is possible to define time/frame values for each knot point on a curve.
- A new animation method attribute to turn off inheritance of time modifications.

1.6 materials

MATERIALS

- The material purge function scans the scene and deletes such a materials which are not mapped to any objects.
 - Glow size and brightness attributes.
 - New material color handler for defining a constant material color which replaces object's original color
 - New 'Roughness' mathematical bump map, with density and bump height control.
 - New 'Dither' mathematical color map, with density and intensity control.
 - Additional Edge X/Y gradient control for texture gradients allows sharp texture map edges with interpolated texture map interior.
 - Infinite tiling is now possible also when applying FreqX/Y feature to make texture denser - this fixes the 'seam' problem in spherical mapping.
-

- Much faster clip mapping

1.7 rpl

REAL 3D PROGRAMMING LANGUAGE

- Local variables
- Function parameters.
- Faster compilation/linking.
- Built-in vector operations.
- Extended GUI programming support. Functions for creating windows, sliders, buttons, etc. are now available. For example, all the tools in the 'Custom' menu have been created by using these new RPL functions.
- Functions for writing and reading raw files implemented.
- User menu system allows you to write custom tools and bind them to menus.
- The new RPL auto-configure feature provides the user with an easy to use standard for expanding and customizing the user interface using RPL. It is possible to integrate new macros and tools to the program by copying the RPL program files to the 'startup' directory of Real 3D.

1.8 other

IMPORT/EXPORT

- 3D Studio import/export. 3DS objects can be read directly and Real 3D objects can be saved in 3DS format.
- Full JPEG support: it is possible to render directly to a JPEG file and use JPEG images as textures.
- PPM images can now be used as textures as well.
- Improved FLI/FLC support

OTHER IMPROVEMENTS

There are numerous smaller improvements which are not listed here. For more information, see the manual. In addition to new features, many existing features have been optimized or otherwise improved.

PLATFORMS

V3 works under Amiga, Windows 3.1/Win32s, Windows NT and Windows 95.

1.9 jpeg

1. Full JPEG support.

Real 3D can read JPEG files. Display can display them.

1.10 autoconfig

2. Autoconfig feature.

All rpl files which are placed in 'startup' directory will be executed automatically when the program is started.

The purpose of this is to provide an easy to use standard method for customizing and expanding the program.

1.11 custommenus

3. Custom Menus and Tools.

Number of useful tools can be found from the menus Custom/Modelling and Custom/Animation.

For more information, select the function and click 'Help' button.

1.12 creation

4. Creation Method

Creation Method is now executed only once per frame, not once per animation sample. The following new tags can be attached to the Creation method:

FLIF - Life time in seconds.
IICN - Initial number of particles. This many particles will be created in the first frame.
FVRN - Random factor for velocity
FSRN - random factor for spin
FLRN - random factor for life time

The custom function 'Custom/Animation/Creation' allows you to easily define these through a graphical interface.

1.13 shrinkwrap

5. Shrink wrapping animation method recognizes two attributes which are not described in the manual:

Samples - Shrink wrapping takes more than just one sample/point to detect a new position for the point to be mapped. This eliminates jagged edges, but unfortunately slows down shrink wrapping. The tag which defines this attribute is 'ISWS'.

Displacement - Wrapped points are displaced this much from the target object's surface. The attribute is defined by 'FDIS' tag.

1.14 lensflare

6. Lens flare post effects

The post effect module 'Lensflare' generates lighting effects which simulate camera lens flares created by light sources.

To include a lens flare effect to an image or an animation, do the following:

- Create some light sources into your scene. Naturally, the light sources need to be visible from the camera position. Light sources obscured by other objects or behind the camera don't create any flares. Spot and beam lights do not create flares unless the camera is inside the area illuminated by them.

- Open the render settings dialog. Set the rendering mode either to 'Shadowless' or to 'Normal'.

- Click the Post Effects button of the render settings dialog. Select 'Lensflare' from the effect list at the left and press the 'Create' button. Click OK to close the post effect editor, then OK to close the render settings dialog. Render.

The lens flare effect is defined by the following attributes, which can be changed by using the post effect editor.

Name:

You can define a suitable name to this edit box.

Static:

If this gadget is set, the light source brightness does not affect the size or brightness of flares. The flare effect becomes easier to control, but may appear too static in animations where light sources are animated.

Center size:

Defines the size of the flares centered around the light sources.

Sub flares:

The number of circular lens flares. Set this to zero to switch off circular sub flares.

Sub flare size:

Defines the maximum size of the circular sub flares.

Sub flare brightness:

Defines the maximum visibility of the circular sub flares.

Flare set:

Selects a sub set from the computed circular sub flares. The flare effect computes internally 200 sub flares, from which you can pick a suitable sub set using 'Sub flares' and 'Flare set' sliders.

Stars:

If set, the star like flares centered around light sources are generated. These stars can be controlled using the three settings below.

Size:

Length of the star flare streaks.

Thickness:

Thickness of the star flare streaks at the center of the star.

Streaks:

Number of streaks.

Random streaks:

If set, randomly directed streaks from light sources are generated. These streaks can be controlled using the three settings below.

Size:

Length of random streaks.

Thickness:

Thickness of random streaks.

Streaks:

Number of random streaks.

Rings:

If set, circular red flares centered around light sources are generated. Ring flare controls are:

Size:

The radius of the rings.

Thickness:

Defines thickness of the rings.

Brightness:

Brightness of the rings.

The color of the central glow is defined by the color of the light source. In normal mode rendering, the color of the central glow changes if the light coming from a light source passes through a colored material.

Modify/Properties/Lighting attributes/No flares button can be used to switch flares from a particular light source on and off.

When using a lens flare effect with static option switched off, the auto exposure feature of render settings may affect the flare effect very much under certain conditions. Namely, if auto exposure is on and you place all light sources near the space origin, the program scales the brightness so that objects near the origin where the brightness is measured get suitable illumination. The lens flare effect is created in the lens system of the camera. If the camera is quite far away from the origin, the light falls on it with a low intensity, and the flare effect becomes very faint.

If necessary, this side effect of auto-exposure can be compensated by using 'No fading' option of Modify/Properties/Light sources or by moving light sources further away from the origin or by adding other light sources which are far enough.

1.15 posteffects

7. Post effects and memory usage

Some of the post effect modules, especially glow and lens flare, require large internal memory buffers to compute the effect. If the image resolution is high and/or amount of available memory is low, the program may not be able to compute the image. If this happens, the following actions probably help:

- Set Render Settings/memory usage to 'Fixed' and define the memory amount to be about 70-80 % of the total amount of memory.
- Switch Render Settings/Auto box rendering on.

1.16 compatibility

COMPATIBILITY ISSUES =====

The IFF hunk format of many data types of Real 3D has been changed, but the program can convert modified data items automatically.

The menu modifications mean that old RPL startup files are not fully compatible. If you have customized the RPL startup, take the modifications from the old file and add them to the file supplied with the new version. After that, verify that MENU word parameters match the new menu system.

The rendering engine algorithms have been modified, mainly for speed optimization reasons. This affects the image output. Therefore, do not render consecutive animation frames using different program versions, because even tiny changes may spoil the animation.

1.17 miscellaneous

MISCELLANEOUS TOPICS

```
@{ " Environment Saving          " LINK "Environment_Save"}
@{ " Tool Types                  " LINK "Tool Types"}
@{ " Color Problems              " LINK "Color Problems"}
@{ " RPL Stack Problems          " LINK "RPL Stack Problems"}
@{ " Menu List, Menu Numbers and Hotkeys " LINK "Menu List"}
```

1.18 environment_save

Environment/Save

The 'Environment' saving has changed. Now Project/Environment functions load and save all project information which is related to working environment itself. This information includes all data sections except objects and materials, which are clearly project specific.

In earlier versions, the Environment concept included only Window and Screen data sections.

The first thing many users attempt when they start Real 3D for the first time is to configure the environment. For most, the default HiRes-Non-interlaced screen is simply not desirable. The manual provides a thorough explanation of the Open Screen requester features; unfortunately, it never relates a clear step-by-step example of opening a new environment. The following example demonstrates how to open a new screen and close the default one. The screen type, depth, name, etc. may be modified accordingly.

To open a new environment screen:

- 1) Select Project/Environment/Open Screen from the pull-down menus. Choose a HiRes-Interlaced screen with a depth of four and click on OK to accept the settings.

When a new screen opens, it is totally blank except for the title bar and a Real 3D Screen window. The Screen window provides several gadgets for manipulating AmigaDOS screens, including 'Hi-jack' and 'Close' gadgets. The features of this window are fully explained on page REFERENCE 1.16. For now, the most important feature of this window is that it delivers access to Real 3D's pull-down menus from any screen.

- 2) While the Screen window is selected (the default when a new screen opens), select Project/Windows/View to open a Real 3D View window on the new screen.

Actually, the type of window chosen is irrelevant. A Select or Tool window works just as well. There merely needs to be a Real 3D window open to claim this new screen as a Real 3D environment.

3) Once there is a window open, the Screen window is closed using the top-left window close gadget (NOT the button labelled 'Close'). Or, to close the old environment screen, the 'Jump' button is used to transfer the Screen window to the next screen. When the Screen window lands on the old environment screen, the 'Close' button will close the current environment and the Screen window.

NOTE: Each time the 'Jump' button is clicked, the Left-Amiga-M key combination will cycle through the AmigaDOS screens until the Screen window is found on the next screen.

4) Open any other windows that are desired (i.e. Select, Tool, other Views, etc.).

View windows are fully configurable to help new users get a feel for the Real 3D universe. For instance, an X-Y-Z axis and coordinates give real-time feedback as well as a representation of the current view angle. An added virtual ground can enhance the sense of perspective views. Both of these functions are located in the View/Drawing Set requester (Right-Amiga-D) as Coordinates and Abs Grid, respectively.

In addition, icons are added to a Tool window by selecting the desired sets from the Tools/Icons... pull-down menu.

5) Specify a new environment as the default by saving it to the startup directory of Real.

Save the project to the "R3D2:Environments/" directory as a file called "real-startup" using the Project/Environment/Save menu function. Then copy this file to the "R3D2:s" directory using a directory utility program, or from the AmigaDOS shell type:

```
copy R3D2:Environments/real-startup R3D2:s
```

You may also save the environment directly to the "R3D2:s" directory, but this has a side effect of setting the default environment directory path to "R3D2:s" instead of "R3D2:Environments", which is a more appropriate alternative.

1.19 tool types

Tool Types

Real 3D v.2.4x main program supports the following icon tool types:

LACED=TRUE/FALSE	(default false)
SCREEN=HAM/WORKBENCH/HIRES	(default hires)
DEPTH=2/3/4/5/6/7/8	(default 3)
PROJECT=R3D2:S/REAL-STARTUP	(default R3D2:S/REAL-STARTUP)
TEXTURES=R3D2:Textures;R3D2:Bumpmaps	(default R3D2:Textures)

The first three define the default screen type, which is used, if no real-startup is found or if it does not include any screens.

PROJECT definition specifies the name of the startup file.

TEXTURES definition can be used to set default paths for texture map files.

1.20 color problems

Color Problems

On page TUTORIAL 1.11 at the bottom of the first column, the manual describes how to change the color of the table object. Some users click on the brown color, the third row down on the left of the Palette window. This makes the wireframe of the object a very dark gray, almost the color of the background. Others click on the first color (color register #0) and then move the sliders to the desired color. This will produce an invisible object on the environment screen.

The reason for this is that each color register in the Palette window corresponds directly to the color registers in a 16 color environment screen. The wireframe display colors are taken from these registers. For instance, if the first color register (#0) in the Palette window is selected and then changed to 255 0 0 (red) using the sliders, the object's rendered color would be red but its wireframe color would be the same as the environment's background color - effectively making the object invisible. This is because the background color of the environment is also defined by color register #0. If color register #2 (white) is selected and then changed to red, the object is still rendered as red, but its wireframe is now white because color register #2 on the environment screen is also white.

For a visual comparison of the color registers, select Project/Windows/Palette and then Project/Environment/Screen Palette. The Screen Palette on the environment screen will show the corresponding wireframe colors to the registers in the Palette window.

1.21 rpl stack problems

RPL Stack Problems

If you encounter an error message 'Stack Full' when loading large RPL files (or when executing them using Macro system), do the following:

- 1). Replace the current environment with your 'real-startup' file using Project/Environments/Replace, if your current working environment requires cleaning before saving it as a new real-startup. If you are not sure what this means, just exit the program and re-start it.

- 2) Select Settings/RPL and double all the values displayed in the RPL setting requester. Then select OK.
- 3) Save the modified environment as specified in the Miscellaneous/Environments guide section.
- 4) Exit the program and restart it. This guarantees that the modified settings will be used by all RPL related functions.
- 5) If the problem does not disappear, repeat the steps until the stack is large enough.

1.22 menu list

MENU ITEM	RPL Menu word	Hotkey

* = Toggle		
Project		
Objects		
Insert	0 0 0	
Save	0 0 1	
Replace	0 0 2	

Font Loader	0 0 4	
Project		
New	0 1 0	

Insert	0 1 2	
Save	0 1 3	
Replace	0 1 4	

Insert Sections	0 1 6	
Save Sections	0 1 7	
Replace Sections	0 1 8	
Materials		
Window	0 2 0	<RAM>M

Delete	0 2 2	
Delete All	0 2 3	

Insert	0 2 5	
Save	0 2 6	
Replace	0 2 7	

Purge	0 2 9	
Macros		
* Record	0 3 0	

Execute Current	0 3 2	

	Execute Named	0 3 3	
	Repeat Current	0 3 4	
	Spread Current	0 3 5	

	Current to Named	0 3 7	
	Named to Current	0 3 8	
Named Colors			
	Select	0 4 0	
	Create	0 4 1	
	Modify	0 4 2	
	Delete	0 4 3	

	Insert	0 4 5	
	Save	0 4 6	
	Replace	0 4 7	
Windows			
	Select	0 5 0	
	View	0 5 1	
	View Superbitmap	0 5 2	
	View Borderless	0 5 3	
	View DBuffered	0 5 4	
	RPL	0 5 5	
	Tool	0 5 6	
	Animation	0 5 7	<RAM>A
	Palette	0 5 8	<RAM>P
	Measuring	0 5 9	
	Screen	0 5 10	
	Color Wheel	0 5 11	
	External Classes	0 5 12	

	Close	0 5 14	
	* No Gadgets	0 5 15	
	Window Name	0 5 16	
	View Tool	0 5 17	
Environment			
	Open Screen	0 6 0	
	Make Def.Pub	0 6 1	
	Close Screen	0 6 2	
	Close Current	0 6 3	

	Insert	0 6 5	
	Save	0 6 6	
	Replace	0 6 7	

	Save Screen	0 6 9	
	Screen Palette	0 6 10	
External Screen			
	Open	0 7 0	
	Close	0 7 1	
	Set Modes	0 7 2	
	Settings	0 7 3	
	Save	0 7 4	

Exit Real	0 8 0
-----------	-------

Create

Visibles

Polygon	1 0 0
Polyhedron	1 0 1
Polymid	1 0 2
Cut polymid	1 0 3

Rectangle	1 0 5
Cube	1 0 6
Pyramid	1 0 7
Cut pyramid	1 0 8

Reg.polygon	1 0 10
Reg.polyhedr.	1 0 11
Reg.polymid	1 0 12
Reg.cut.plmd	1 0 13

Circle	1 0 15
3P Circle	1 0 16
Cylinder	1 0 17
Cone	1 0 18
Cutcone	1 0 19

Sphere	1 0 21
Ellipsoid	1 0 22
Ellipsegment	1 0 23
Cut ellipseg	1 0 24

Hyperbol	1 0 26
Cut hyperb.	1 0 27

Sectors

Circle	1 1 0
Cylinder	1 1 1
Cone	1 1 2
Cut cone	1 1 3

Ellipsegment	1 1 5
Cut ellipseg.	1 1 6

Hyperbol	1 1 8
Cut hyperbol	1 1 9

Structure

Level	1 2 0
Link	1 2 1
Group	1 2 2
Method	1 2 3

Light-sources

Point	1 3 0
Line	1 3 1
Wall	1 3 2

	Spot	1 3 3
	Beam	1 3 4
Controls		
	Attribute	1 4 0
	Offset	1 4 1
	Axis	1 4 2
	Coordsys	1 4 3

	Open Line	1 4 5
	Closed Line	1 4 6
	Circular Line	1 4 7

	B-Spline Ctrlp	1 4 9
	B-Spline Knot	1 4 10
	B-Spline Curve	1 4 11
	B-Spline Closed	1 4 12
	B-Spline Cir.	1 4 13
	B-Spline Helix	1 4 14

	Skeleton	1 4 16
Mapping		
	Default	1 5 0
	Parallel	1 5 1
	Cylinder	1 5 2
	Sphere	1 5 3
	Disk	1 5 4
Compound Tools		
	Lathe	1 6 0

	Circular Subdivided	1 6 2
	Rounded Circ. Subd.	1 6 3
	Sharp Circular	1 6 4
	Rounded Circular	1 6 5

	Conical	1 6 7
	Conical Subdivided	1 6 8

	Rectangular	1 6 10
	Rectangular Subdiv.	1 6 11
	Rectangular Conical	1 6 12
	Rect.Conical Subd.	1 6 13

	Rounded Polygon	1 6 15
	Rounded Polyhedron	1 6 16
	Ellipsed Polygon	1 6 17
	Ellipsed Polyhedron	1 6 18

	Join Primitives	1 6 20
	Object-Pixel Tool	1 6 21
Freeform		
	Mesh	1 7 0
	Torus	1 7 1

	Coplanar	1 7 3
	Orthogonal	1 7 4
	Rotate	1 7 5
	Swing/Move	1 7 6
	Swing/Size	1 7 7
	Build from Curves	1 7 8
	Mesh-Pixel Tool	1 7 9
	Skin Curve	1 7 10
	Parallel C/S	1 7 11
	Extrude	1 7 12
	Triset from Mesh	1 7 14
Fractals		
	Landscape	1 8 0
	Tree	1 8 1
Boolean		
	OR	1 9 0
	AND	1 9 1
	AND NOT	1 9 2
	AND with Paint	1 9 3
	AND NOT with Paint	1 9 4

	Rethink	1 9 6
	Rethink All	1 9 7
	Unthink	1 9 8
	Unthink All	1 9 9
Particles		
	Skeleton	1 10 0
	Volume	1 10 1
Modify		
Linear		
	Move	2 0 0
	Move COG	2 0 1
	Size 2D	2 0 2
	Size 3D	2 0 3
	Stretch	2 0 4
	Extend	2 0 5
	Rotate	2 0 6
	Mirror	2 0 7
	Shear	2 0 8
	Rot&Ext	2 0 9
	Deform	2 0 10
Structure		
	Cut	2 1 0
	Copy	2 1 1
	Paste	2 1 2
	Delete	2 1 3
	Duplicate	2 1 4
	Swap	2 1 5
Properties		

	Color	2 2 0
	Name	2 2 1
	Attributes	2 2 2
	Alpha Channel	2 2 3
	Tags	2 2 4
	Animation	2 2 5
	Replace Tags	2 2 6
	COG	2 2 7
	Direction	2 2 8
	Velocity	2 2 9
	Spin	2 2 10
	Size	2 2 11
	Physical Attr.	2 2 12
	Lighting Attr.	2 2 13
	Geom Attr	2 2 14
	Fade	2 2 15
Bend Local		
	Move 2D	2 3 0
	Move 3D	2 3 1
	Move Radial	2 3 2

	Size 2D	2 3 4
	Size 3D	2 3 5
	Size Radial	2 3 6
Bend Global		
	Move 2D	2 4 0
	Move 3D	2 4 1
	Move Radial	2 4 2

	Size 2D	2 4 4
	Size 3D	2 4 5
	Size Radial	2 4 6
Bend Endp.		
	Move 2D	2 5 0
	Move 3D	2 5 1
	Move Radial	2 5 2

	Size 2D	2 5 4
	Size 3D	2 5 5
	Size Radial	2 5 6
Bend Linear		
	Move 2D	2 6 0
	Move 3D	2 6 1
	Move Radial	2 6 2

	Size 2D	2 6 4
	Size 3D	2 6 5
	Size Radial	2 6 6
Bend Circular		
	Move 2D	2 7 0
	Move 3D	2 7 1
	Move Radial	2 7 2

Non-linear

Move	2 8 0
Size	2 8 1
Stretch	2 8 2
Rotate	2 8 3
Twist	2 8 4

Parabola	2 8 6
* Linear	2 8 7
Circle	2 8 8
Sine	2 8 9
Curve	2 8 10

Set Tool	2 8 12

Special

Inverse Kinematic	2 9 0

Parallel Shrink	2 9 2
Cylindrical Shrink	2 9 3
Spherical Shrink	2 9 4
Normal Shrink	2 9 5
Reflect	2 9 6

COGs

Size 2D	2 10 0
Size 3D	2 10 1
Stretch	2 10 2
Extend	2 10 3
Rotate	2 10 4
Mirror	2 10 5
Shear	2 10 6
Rot&Ext	2 10 7

About COGs

Size 2D	2 11 0
Size 3D	2 11 1
Stretch	2 11 2
Extend	2 11 3
Rotate	2 11 4
Mirror	2 11 5
Shear	2 11 6
Rot&Ext	2 11 7

Freeform

Reparametrize	2 12 0	<RAM>K
Move Knotpoint	2 12 1	
Concatenate	2 12 2	
Swap Direction	2 12 3	
Open/Close	2 12 4	
Type	2 12 5	
Invert	2 12 6	
Remap	2 12 7	
Surf.to curves	2 12 8	
Distribute	2 12 9	
Assign	2 12 10	
Exchange u & v	2 12 11	
Snap to	2 12 12	

Delete	2 12 13
Insert	2 12 14
Break	2 12 15
Set start	2 12 16
Triple ends	2 12 17
Round	2 12 18
Convert to Triset	2 12 19
Surface to Groups	2 12 20
Fidelity	2 12 21

Draw Mode

* Accurate	2 14 0
Bounding box	2 14 1

View

Type

* Parallel	3 0 0	
Perspective	3 0 1	

* Separate IO	3 0 3	
* ViewCam Motion	3 0 4	<RAM>L
ViewCam Pos.	3 0 5	<RAM> ,
Surface	3 0 6	

Input Plane

Set XY	3 1 0	<RAM>1
Set YZ	3 1 1	<RAM>2
Set XZ	3 1 2	<RAM>3
Object->IPlane	3 1 3	<RAM>N
ViewCam->IPlane	3 1 4	<RAM>Q
Roll XYZ	3 1 5	<RAM>4
* Horiz. Lock	3 1 6	<RAM>5
* Vert. Lock	3 1 7	<RAM>6
Reset Hot Point	3 1 8	<RAM>7
Hot Point Forwards	3 1 9	<RAM>8
Hot Point Backwards	3 1 10	<RAM>9

ViewCam

Reset all	3 2 0	<RAM>E
Reset Scale	3 2 1	<RAM>0
Position	3 2 2	<RAM> `
Pos&Zoom In	3 2 3	<RAM>I
Pos&Zoom Out	3 2 4	<RAM>O
Center	3 2 5	<RAM>>
Auto Focus	3 2 6	<RAM><
Set XY	3 2 7	<RAM>X
Set YZ	3 2 8	<RAM>Y
Set XZ	3 2 9	<RAM>Z
Set Custom	3 2 10	<RAM>C
Define X	3 2 11	<RAM>F
Define Y	3 2 12	<RAM>B
Camera->ViewCam	3 2 13	<RAM>W
IPlane->ViewCam	3 2 14	<RAM>J
ViewCam Control	3 2 15	

Camera	ViewCam->Camera	3 3 0	<RAM>V
	Create Camera	3 3 1	
	Define Camera	3 3 2	

	* Camera View	3 3 4	
Grid	Select	3 4 0	
	Create	3 4 1	
	Modify	3 4 2	
	Reposition	3 4 3	
	Delete	3 4 4	

	* Visible	3 4 6	
	* Snap to Grid	3 4 7	
Render	Window	3 5 0	<RAM>R
	Boxes	3 5 1	<RAM>T

	Greyscale	3 5 3	<RAM>G
	HAM	3 5 4	<RAM>H

	Selected	3 5 6	
	Settings	3 5 7	<RAM>S

	Export RPL	3 5 9	

	Render Hierarchy	3 5 11	
	Export DXF	3 5 12	
Drawing Set		3 6 0	<RAM>D
Boxes	Define	3 7 0	
	Modify	3 7 1	
	Delete	3 7 2	
	Delete All	3 7 3	
	Show All	3 7 4	
Window Size		3 8 0	
Control Window		3 9 0	
ate			
Create	Path	4 0 0	
	Direction	4 0 1	
	Rotation	4 0 2	
	Sweep	4 0 3	
	Stretch	4 0 4	
	Size	4 0 5	
	Morphing	4 0 6	
	Inverse Kinematic	4 0 7	
	Skeleton	4 0 8	
	Shrink wrapping	4 0 9	

Forces

Radial	4 1 0
Directed	4 1 1
Tangential	4 1 2
Friction	4 1 3
Noise	4 1 4

Control

Play Forwards	4 3 0
Play Backwards	4 3 1
Go to Beginning	4 3 2
Go to End	4 3 3
Go to ?	4 3 4
Step Forwards	4 3 5
Step Backwards	4 3 6
Refresh	4 3 8

Time Line

4 4 0

Edit

4 5 0

Extras

Vectors

Push	5 0 0	
Pull	5 0 1	<RAM>.
Enter	5 0 2	
Clear	5 0 3	
Subtract	5 0 5	
Average	5 0 6	
Average All	5 0 7	
Cross Product	5 0 8	
Eval. Current	5 0 10	
Define & Eval.	5 0 11	
Length evaluate	5 0 12	
Lasso Select	5 0 14	<RAM>[
Lasso Deselect	5 0 15	<RAM>]
Push Selected	5 0 16	<RAM>*
Pull All	5 0 17	<RAM>/

Undo

5 1 0 <RAM>U

Statistics

5 2 0

Refresh All

Wire-frame	5 3 0
Ray Trace	5 3 1

Cancel All

5 4 0

Evaluate			
	Curve Length	5 5 0	
	Parameter	5 5 1	
Select Objects		5 6 0	<RAM>space
Free Images		5 7 0	
Repeat Last		5 8 0	5

Settings

Clip Boxes		
	Active	6 0 0

	Select	6 0 2
	Deselect	6 0 3
General		6 1 0
Refresh		
	None	6 2 0
	Current	6 2 1
	* All	6 2 2
Oper.Level		
	* Active	6 3 0

	Depth	6 3 2
Creation		
	* Qry. Level Name	6 4 0
	* Qry. Prim. Name	6 4 1
	* Auto Current	6 4 2
	* Auto Selected	6 4 3
	* Auto Index	6 4 4
Paths		6 5 0
Alpha Channel		6 6 0
Attributes		6 7 0
RPL		6 8 0
View Resolutions		
	Rotation	6 9 0
	Position	6 9 1
	Zoom	6 9 2
Undo		
	* Active	6 10 0
	Set depth	6 10 1
	Clear	6 10 2
File Icons		6 11 0

Tool

Icons	7	0	0
Create Icon	7	1	0
Delete Icon	7	2	0

Custom