

The Lost World

Macintosh and VRML (Virtual Reality Modeling Language)

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Abstract

The Virtual Reality Modeling Language (VRML) is a file format used to describe interactive 3D objects and worlds. VRML is designed to be used on the Internet, intranets, and local client systems. VRML is also intended to be a universal interchange format for integrated 3D graphics and multimedia. VRML may be used in a variety of application areas such as engineering and scientific visualization, interactive multimedia presentations, simulations, entertainment and educational titles, web pages, and shared virtual worlds.

This paper serves as a starting point for Mac Users new to VRML. We will cover the history of VRML, provide a brief introduction to the language, and then present Mac VRML tools and resources.

Introduction

VRML is an ISO/IEC standard language. Like HTML it is an open standard. Responsibility for the standard falls on the Web 3-D Consortium. Its charter members include Apple, Microsoft, Silicon Graphics, Oracle, Platinum, Sony and others. 42 corporations comprise the consortium. They and many other content, 3-D, and internet firms currently support the ongoing process of bringing 3-D content to the world wide web. Additionally, the MPEG 4 specification names VRML as it's 3-D component.

Interoperability between the many different programming languages was a major goal of VRML specification. It uses JavaScript as its internal scripting language, and can even exchange data with an HTML page. Java is

commonly used as external authoring interface or EAI. Any type of software application, tool, game, and multi-user chat environment can be created. X3D, the next generation of the VRML spec., is focused on integrating with XML and DOM.

VRML content can be created by a software package designed specially for VRML world building, exported from a 3-D modeling tool (usually via a plug-in), or it can be created in any text editing software package like BBEdit, SimpleText or MS Word. Furthermore, you can also generate VRML on-the-fly, using Script nodes, the Java EAI, or by using a CGI script to generate VRML, and return the result to the VRML viewer via a Web browser. The code is ASCII text and is designed to be read and edited by hand. In looking at actual code, we see that VRML uses vector-based representations to build its worlds. Objects and their properties are defined by elements called nodes and rendered in real-time. VRML representations are fully three dimensional. Users can move anywhere, view from any angle, and interact (and be interacted upon) in such environments.

Mac users currently have the tools and software to build worlds on a par with the PC community. Mac users can create advertising banners, educational sites, on-line training, art projects and, of course, on-line gaming. Even on-line multi-user Java / VRML worlds that are being developed by groups such as VNET and DeepMatrix are Mac compatible. It may further surprise many in the Mac community that there are worlds built 100% on the Mac OS that are considered among the best, most creative examples of VRML 97 on the net today.

History

Originally based on a subset of the Open Inventor file format developed at Silicon Graphics, VRML first appeared in 1994 thanks largely to the efforts of Mark Pesce and Tony Parsi. The engineering was led by Rikk Carey (the developer of Open Inventor), Paul Strass, and Gavin Bell. VRML 1.0 was first drafted in November of 1994. The VRML 1.0 spec would be submitted in May of 1995 and clarified in January of 1996. During those two years a great deal of interest in VRML was generated. Major corporations, small companies and individual developers, took interest in the emerging standard. Apple's involvement began in 1995; it was a charter member of the VRML Consortium. Fabio Pettinati, Director of 3-D Media Technologies was appointed to the Consortium's Board of Directors. In August 1996, Apple partnered with IBM to produce a compressed binary format for the language. In December of 1996, Apple announced that it would bundle SGI's CosmoPlayer browser for the Mac OS with its Internet Access Kit. Neither the binary format nor the Apple & SGI "co-developed" CosmoPlayer plugin were completed. There were many reasons for this.

VRML 2.0, the next version of the language, came in March 1996. It was selected from a number of proposals. The winning proposal was called "Moving Worlds" and was led by SGI. Losing proposals included ones by Microsoft and Apple. Additionally, the binary format project was doing poorly. These failures marked a turning point. Despite early promise, VRML content failed to gain traction in the mainstream. Apple was facing mounting financial losses as Microsoft tightened its grip on the PC market. At that time, Apple's VRML development efforts were cut. Although Apple remains a charter member of the Consortium, its efforts are directed toward QuickTime and QTVR. VRML is not currently embraced by Apple. OpenGL is now supported by the Mac OS through Apple's purchase of Conix's extension. Just prior to purchase Conix released version 1.5. It is 25% faster overall and up to 400% faster with textures. Once Apple decides to release this version, VRML performance will increase dramatically.

Browser/plugin development for Macintosh came in small bursts. Early on Netscape created Live 3D, a VRML 1.0 plugin. They would create a version 1.1 and stop. RealVR Traveler, a VRML 2.0 QTVR hybrid, was introduced in 1996, but the Mac still lacked tools and widespread support for its underlying technology never developed. It exists today as the Live Picture Viewer, and it is capable of viewing VRML worlds, however it does not support the full VRML 97 spec. In the summer of 1997 Intervista released their WorldView plugin for Netscape. Mac users could now view animated VRML 2.0 worlds. The plugin supported about 75% of the VRML 2.0 spec. The main problem was that it handled color and lighting differently from the leading plugin: CosmoPlayer.

The CosmoPlayer plugin was created by CosmoSoftware. Which was SGI's VRML division. Although it and Worldview were evenly matched, Cosmo was (and is) viewed as the industry standard. In March 1998 SGI CosmoSoftware released CosmoPlayer 2.1 Alpha for the Macintosh. During the summer of 1998 and with little fanfare, CosmoPlayer 2.1 beta was released. Most in the Mac community never even knew of its release. A fast stable VRML 97 compatible plugin is available. One undocumented feature of this plugin is its support of MPEG and QuickTime movies within the VR world. There are issues that remain: the memory leak is fixable as mentioned and navigation can still be awkward (mice were not meant to fly in VR worlds). Cosmo's solution of "Click","Drag"(in a direction you wish to move) and "Hold" (to continue moving) is a fair one. Speed is controlled via the distance between where you "Click" and how far you "Drag". Pressing the "Shift Key" increases speed dramatically.

Platinum bought CosmoSoftware soon after SGI and Sony's talks collapsed. Earlier Platinum had bought Intervista's WorldView. In fact not only did the company own VRML's best plugins, it purchased the very best tools as well. (None of which are available for Macintosh.) On February 23rd, 1999, Platinum announced they were going to open the source code to the development community. Also Java 3D supports VRML 97 and the port to Mac OS / JDK 1.2 is underway. It is being handled by

the same developers who recently presented Java 3D on Linux at the Linux expo. In late May, Platinum is scheduled to sign the agreements to open the source code to developers. A late breaking twist is that Computer Associates Inc. has announced that it will buy Platinum.

At present a group of developers (including some current, many former employees) of Apple, SGI, CosmoSoftware and Platinum have united with Mac VRML content developers and Mac media representatives to fill gap between VRML and Macintosh. This paper is a part of that effort.

The VRML Language

VRML 97 is the latest version of the VRML specification. It defines VRML as an object-oriented, hierarchical language. The data within the file itself is referred to as the Scene Graph. Individual elements within the Scene Graph are called nodes. Nodes are the building blocks of the code. A node consists of the node type (VRML 97 supports 54 node types) and data fields that further define the node. These nodes represent all physical aspects of the 3-D content within the file. Furthermore these nodes are grouped along parent and child relationships. Multiple levels of parent and child grouping allow the VRML hierarchy to take shape.

The spec also allows for custom nodes to be created by the VRML author. These custom nodes are called PROTOs. PROTOs can be defined by other VRML nodes and or a browser specific mechanism. Some VRML nodes generate events in response to user interaction, user position, or simply by a time based mechanism. Event routing steps outside of VRML's Scene Graph structure, allowing events of parent/child structures to effect another. For example: Several nodes can be grouped in a parent/child structure to describe a button. That button when pressed could activate the animation of a separate parent/child structure. The code examples that follow can be automatically generated by a variety of VRML tools.

In glancing over a piece of VRML code you might see words like: ProximitySensor, DirectionalLight or Cylinder. A ProximitySensor generates an event as mentioned above by sensing user proximity. A DirectionalLight is a light that shines in one direction. A Cylinder is, you guessed it, a cylinder shape. These elements are also called nodes. Each type of node is further defined by information grouped after it by a pair of {}'s This information is called a field. Each node has fields of information specific to its type. Perhaps a better definition is to say that fields represent distinct properties of a node.

On the next several pages that we will introduce some basic code. Starting with a cylinder shape and then adding color, these examples will progress to an example of a simple animated blue "can".

Into the Code

The fields for a Cylinder node are: radius, height, side, top and bottom. Below is an example of a Cylinder node. Note: Default values are used for all properties not specified in the file. A Cylinder node could be written simply as `Cylinder {}`.

```
Cylinder {
  radius      1
  height      2
  side        TRUE
  bottom      TRUE
}
```

The numbers following radius and height represent meters. The TRUE values after side and bottom indicate the cylinder has sides and a bottom. To turn this node into a VRML file we place the cylinder within a Shape node, add the VRML header (`#VRML V2.0 utf8`), and save the file as text with the VRML `.wrl` extension. Try typing up the file and save it as “can.wrl” NOTE: The indentation is just for readability. The positioning of {}s is flexible so long as the correct information is inside them.

```
#VRML V2.0 utf8

Shape {
  geometry
  Cylinder {
    radius      1
    height      1
    side        TRUE
    bottom      TRUE
  }
}
```

If you have a plugin for VRML installed and open this file in your browser you will see a white cylinder centered in a black background.

Defining Color

To change the appearance of our cylinder from white to blue we add three lines of code between Shape and geometry. Color is expressed in terms of R G B and as decimal values between 0 and 1. In this case the value for blue will be set to 1.0.

```
#VRML V2.0 utf8
Shape {
  appearance Appearance {
    material Material {
      diffuseColor 0.0 0.0 1.0
    }
  }
  geometry
  Cylinder {
    radius 1
    height 1
    side TRUE
    bottom TRUE
  }
}
```

Note: the brackets “{“ and “}”. Some nodes can enclose their own fields and other node within their set of brackets. VRML relies heavily on parent/child relationships. These relationships are defined by enclosing nodes in {}'s. Multiple nodes are grouped by declaring them as children and placing them within a set of []'s. This grouping usually implies that the group is going to be modified or used in way. If only one node is being used or modified, the []'s are unnecessary, but not illegal.

Positioning Objects

We have created a blue cylinder, but where is it in our world? Without a position defined it is placed at the coordinate 0 0 0, which is the center of the world. By adding a Transform node to the hierarchy we can use a translation field to change the cylinder's location. With this new node added below, our cylinder is now over to the right, a bit lower and a bit further away. A coordinate represents values of the X axis, the Y axis, and Z axis.

```
#VRML V2.0 utf8
Transform {
  translation 8 -2 6
  children [
    Shape {
      appearance Appearance {
        material Material {
          diffuseColor 0.0 0.0 1.0
        }
      }
      geometry
      Cylinder {
        radius      1
        height      1
        side         TRUE
        bottom      TRUE
      }
    ]
  ]
}
```

Defining Objects

Once a particular node is defined it can be reused or animated. To animate our cylinder we must change the value of the field that defines its' position. This is found in the Transform node. We do this by adding DEF in front of the Transform node. In the example line below the node is named OUR_CAN.

```
DEF OUR_CAN Transform {
```

ANIMATING AN OBJECT

Adding movement to the cylinder requires three more steps. First we must define the positions we wish the object to move to in a PositionInterpolator node we'll name POSITION_IS. VRML uses keyframe animation, and in the key field we'll enter two values: 0.00 and 1.00, representing the two key frames we will create. Zero thru one is the range of values used in many VRML instances. The X,Y,Z coordinates for the two key frames are entered in the keyValue field. When we animate the object VRML will move the cylinder from one keyValue to the other.

```
DEF POSITION_IS PositionInterpolator {
  key      [ 0.00, 1.00 ]
  keyValue [ 10 0 0, -10 0 0 ]
}
```

Because animations occur over time, a TimeSensor must also be defined. We'll call ours THE_TIME. The field cycleInterval indicates the amount of time needed to count from 0 to 1, which is the length of a cycle. TRUE in the loop field means the cycle will repeat indefinitely.

```
DEF THE_TIME TimeSensor {
  cycleInterval 20
  loop          TRUE
}
```

The third step is to link the timer, keyframes and cylinder together. First we link the TimeSensor to the positions array. As the TimeSensor THE_TIME changes it chooses different values from the array of possible positions in POSITION_IS. We then link the POSITION_IS value to the position of the OUR_CAN object.

```
ROUTE THE_TIME.fraction_changed TO POSITION_IS.set_fraction
ROUTE POSITION_IS.value_changed TO OUR_CAN.set_translation
```

The Final File:

```
#VRML V2.0 utf8

DEF OUR_CAN Transform {
  children [

  Shape {
    appearance Appearance {
      material Material {
        diffuseColor 0.0 0.0 1.0 }
    }
    geometry
    Cylinder {}
  }
  ]
}

DEF POSITION_IS PositionInterpolator {
  key          [ 0.00, 1.00 ]
  keyValue     [ -10 0 0, 10 0 0 ]
}

DEF THE_TIME TimeSensor {
  stopTime -1
  cycleTime 20
  loop      TRUE
}

ROUTE THE_TIME.fraction_changed TO POSITION_IS.set_fraction
ROUTE POSITION_IS.value_changed TO OUR_CAN.set_translation
```

To gain more insight, try experimenting with the values in the key, keyValue and cycleInterval.

Macintosh VRML Tools

Good VRML tools for the Mac do exist, however Mac developers still must learn some VRML code to build some types of interactivity into their worlds. While several VRML specific authoring tools have been released on the PC, no such tool is available for Macintosh developers. Like the PC, several existing 3D modeling tools have been updated (usually through a plugin or extension) to export to the VRML file format. Often these programs won't open VRML files, or don't support all the features found in VRML 97. Still it is possible to create some great worlds with even those limitations. Another possibility is to use PC emulator software to run some of the PC software. In nearly all the tools mentioned VRML documentation is minimal or not even mentioned. Finding help can be frustrating as the tool maker's customer service representatives often know nothing about VRML. Contacting other VRML developers is your best bet for getting assistance.

At present there are many VRML tools that use Java. These will usually run fine on the Mac OS, however a few extra steps are needed at first. Download Apple's latest Java SDK and look for the JBindery application. It creates Macintosh compatible Java apps from non-compatible PC .exe files. Generally all one has to do is drag the Java application on to JBindery and in the window that appears, type in the correct command line. Check the "save as application" dialogue box and the PC executable will be converted to a Macintosh application with all the standard features such as drag and drop functionality.
<http://developer.apple.com/java/>

Full 3-D Modelers

Recommended: Inspire 3-D
(tools listed alphabetically, by developer)

ARTIFICE, Design Workshop
<http://www.artifice.com/>

Artifice has created a tool called Design Workshop aimed at architectural development. Three versions (Pro / Classic / Lite) are available and they range from a professional version to entry level (\$495-\$20) Each has the same VRML capabilities: basic VRML 97 code, no animation or DEF / USE.

AUTO-DES-SYS FormZ
<http://www.formz.com/>

FormZ is a high-end 3-D modeling package with good basic VRML 2.0 capabilities. It doesn't export animations.

MACROMEDIA, Extreme 3-D
<http://www.macromedia.com/>

Macromedia's 3-D modeling product, Extreme 3-D exports basic VRML 2.0 code much like Strata Studio Pro. Extreme 3-D does list the aspects of VRML 2.0 it supports and a few other useful facts in its help index. Macromedia as a company is squarely focused on the Internet. In spite of this, plans for future VRML development haven't been made.

MAXON Computer GmbH CINEMA 4D
<http://www.maxon.de/>

Cinema 4D comes in three versions. GO the entry level tool, SE the mid range, and XL the professional version. All tools export VRML 2.0, but do not export animation.

METACREATIONS, Ray Dream Studio /
Ray Dream / Bryce 4
<http://www.metacreations.com/>

MetaCreations Ray Dream Studio is a professional level modeling and animation product, while Ray Dream 3-D supports only modeling. Both export basic VRML 2.0, lacking the ability to export animation. The export does feature an option to remove the blank spaces found in the code. MetaCreations is continuing to develop Ray Dreams VRML 2.0 export features. Bryce 4 released in February 1999 now has VRML export capabilities.

This high end environment generator is a good tool for the serious world builder. Additionally Poser 3 is not VRML enabled but it is also a useful tool for creating human forms.

NEWTEK, Lightwave / Inspire 3-D

<http://www.newtek.com/>

Lightwave by NewTek is the best VRML tool on the Macintosh platform. Lightwave has had VRML export capabilities since late 1996 and NewTek has consistently updated the tool. It's principle drawback for new VR developers: a retail price of 1,800.00. NewTek has realized this and released Inspire 3-D, which is essentially a mid-priced, mid-level dongle-free version of Lightwave available at a price beginners can afford.

This full featured 3-D modeler supports VRML animation, DEF / USE, SphereSensors, TouchSensors and Fog nodes. This is in addition to the basic VRML features such as lights, viewpoints, index face sets, textures, etc. Both Inspire 3D and Lightwave share the same plugin. A greatly improved plugin "Version 22" can be downloaded from NewTek's "Outpost" site (the new plugin is not on the CD, Version 16 is). New VRML developers should know the following: The plugin is available under the Options Menu, Generic Plugins. Use "Scene Save", uncheck PROTO's & EXTERNAL OBJECTS, set navigation to ANY. Do not save to the desktop (the plugin names files in part by location. Therefore the space between "Desktop" and "Folder" will cause an error.). The other features can be fully used as your VRML skills develop.

Inspire 3-D's interface is based on Lightwave which does not follow many of the conventions of the Macintosh interface. Yet it's features make it worth spending the time to learn. A detailed tutorial is included on a separate CD. Like the other tools covered here, the packaged documentation lacks any help for those new to VRML, in fact VRML doesn't even appear in the manuals. Online the specs and the new plugin can be found at: lightwave-outpost.com

PLAY INC, Amorphium

<http://www.electricimage.com>

Amorphium a great entry level modeling tool. It has no animation features. It too exports VRML 97 code.

STRATA, Strata Studio Pro

<http://www.strata.com/>

Strata Studio Pro is an intuitive high end 3-D design tool with basic VRML 2.0 export features. It supports the basic VRML 2.0 nodes such as: geometric primitives (Box, Cone, and Cylinder), index face sets, textures, anchors, viewpoints, and lights. It does not export animation or any sensor nodes. Code adheres to the VRML 2.0 spec, though the files it creates tend to be large.

Geometry Generators

These tools create "pieces" of VRML

DAVID HARVEY, Rotor

<http://web.ftch.net/~honeyg/rotor.htm>

This is a Java applet that can be used to interactively create VRML source for extrusion shapes by drawing 2D cross-sections.

Gregory Seidman's Extrusion Creator

cs.brown.edu/~gss/vrml/drawpoly.html

A very cool and very easy to use online extrusion tool. Builds shapes in the window and then copy the code.

IRONY GAMES MapMagical Terrain Editor

<http://www.irony.com/igmmte/>

MapMagical is an online terrain editor Java applet by Irony Games. This applet requires a Java 1.1 enabled browser with full AWT 1.1 support.

RICK BONO, Dome

www.cris.com/~rjbono/html/domes.html

Dome is a tool for creating a geodesic dome or sphere. The Mac version is a straight port from DOS, and therefore has a primitive interface, but it works. Unfortunately it generates VRML 1.0 code, but it can also generate code in other formats such as DXF.

RICK BONO / TRAPEZIUM / M LOUKA,

JavaDome

<http://home.telia.no/mlouka/>

JavaDome is a tool for creating a geodesic dome or sphere. This is an experimental port to Java of the original Dome (see above). This version has a graphical user interface and exports VRML 2.0 (sometimes).

LandSculptor 3D

macware.com/free/landsculptor.sit.hqx

This is a great piece of freeware for making terrain models by painting them. It exports DXF.

BSOLUTIONS, BSmooth

kagi.com/busse/BSmooth/BSmooth.html

This is a shareware terrain-modeling tool that exports DXF and Bryce files. Amongst other formats, it imports GTOPO30 and 1 degree ASCII formatted Digital Elevation Maps. GTOPO30 DEMs are available for free on the Net from the EROS Data Center

CARL WEST, Prism

<http://www.inmet.com/~eisen/prism.html>

This is an online prism building tool by Carl West. Requires Shockwave.

DEVELOPMENT TOOLS AND UTILITIES

Recommended: Chisel / Easy-GZ

(tools below vary greatly in function)

ARNO SCHAEFER, VRML Java Script TG

<http://www.igd.fhg.de/CP/scriptgen/>

This is an VRML Java Script Template Generator applet by Arno Schaefer that generates Java code templates for VRML Script nodes. It takes as input a Script node from a VRML file and outputs one or two ready-to-compile Java classes that can then be filled with code. This is a really useful utility for Java Script programmers.

CINDY REED BALLREICH, Find Me

werple.net.au/~miriam/CindysFindme.txt

A bit of code for finding ones location. Very useful for making viewpoints, and placing last minute additions to a world.

CREDO INTERACTIVE, Liforms Studio

<http://fas.sfu.ca/liforms.html>

Credo Interactive's Liforms described as character movement software. This it does very well. It has no modeling features. You import and animate objects created in other tools. Liforms imports VRML 1.0 and 2.0, as well many other formats such as Infini-D files and native Strata Studio Pro files. Animations created in Liforms can be exported to VRML 97. A demo of Liforms is available for free on-line and is useful as a VRML translator. Additionally the demo, though save/disabled, allows for export of five key frames of animation.

GARY ENNIS, Abacus VRML Tools 98

iris.abacus.strath.ac.uk/glasgow/vp.htm

Gary Ennis of the ABACUS project group at Strathclyde University has put two online tools onto this Web page. You simply enter the URL to your virtual world and then choose whether you want to create viewpoints or animations, and then click on the 'Continue...' button. Very useful.

ERIC HAINES, Pellucid

[http://www.acm.org/tog/resources/apple
ts/vrml/pellucid.html](http://www.acm.org/tog/resources/apple
ts/vrml/pellucid.html)

This is a Java-based tool that simulates the VRML illumination model. It is primarily intended for browser developers to check conformance but it is an interesting tool for the rest of us too. Use JBindery to run it (drag the Jar file onto JBindery and then type in the class name, as described in the Pellucid instructions)

HARTMUT PALM, VRML Perl Modules

dc.gfz.potsdam.de/~palm/vrmlperl/

These VRML Perl Modules by Hartmut Palm are useful for generating VRML on-the-fly from a Web-site, as well as for building offline code generators and converters. They work fine under MacPerl. Just copy 'VRML.pm' and the files in the 'VRML' folder (after you've unpacked the distribution archive) to MacPerl:lib and the files in the 't' folder to MacPerl:t and then you can test the examples to make sure that you have installed everything correctly.

HELMUT DERSCH, Panorama Tools

[http://www.fh-furtwangen.de/~dersch//
VRMLCubes/VRML_Cubes.html](http://www.fh-furtwangen.de/~dersch//
VRMLCubes/VRML_Cubes.html)

Helmut Dersch has written a useful set of tools for Photoshop and GraphicConverter that can be used to generate, edit and transform many kinds of panoramic images. For VRML developers, these are useful for working with Background node images, and they are freeware.

JOHN STILES, Easy-GZ

komkon.org/~stiles/easy-gz/index.html

Gzip is a binary compression scheme common on the net. Given how big VRML files can be, we strongly recommend gzipping them. There are a number of tools for gzipping and gunzipping text files. Easy-GZ is a favourite because it is fast and very easy to use (simply

drag and drop files to compress or decompress them), and it's freeware.

JUSTIN COUCH, JVerge

<http://www.vlc.com.au/JVerge/>

JVerge by Justin Couch is a Java class library that many VRML developers swear by. However, the future of JVerge is uncertain.

LIVE PICTURE, Photo Vista

<http://www.livepicture.com/>

Live Picture has created a number of VR products including a proprietary hybrid QTVR / VRML plugin called Live Picture Viewer. To support this product they offer several tools, one of which, Photo Vista is used to distort images to be viewed as panoramic backgrounds. The free demo will not export QTVR but, it will export an image that can be used for the six sides of a VRML background node.

MATTHEW LEWIS, Sanbaso

<http://www.cgrg.ohio>

state.edu/~mlewis/VRML/Sanbaso/

This is a Java-based online keyframe animation system for h-anim compliant humanoids that uses the VRML EAI. You can move body parts, set keyframes, and generate VRML code containing the resulting animation (which is output as VRML 2.0 to the Java console). Seems pretty stable for an EAI-based tool too.

NOVAFEX, Flamingo Optimizer

<http://www.novafex.com/>

Novafex's Flamingo Optimizer is a Java based product. It has an attractive Swing-based user interface and has editing functionality that enables you to easily create new VRML nodes, change field values, and rearrange VRML scene graphs. Optimizer provides a graphical representation of the scene graph. In fact, the only thing that it is missing to make it a full-featured VRML code editor is full editing support for Script nodes and ROUTES. Optimizer has strong geometry optimizer features and plugin technology to load any 3D

file format. The product is currently in Beta. It should be released shortly.

TRAPEZIUM, Chisel / Vorlon

<http://www.trapezium.com>

Chisel, by Trapezium is a VRML 97 optimizer, code validator and file compressor is 49.95. It is considered the industry standard. A scaled down version is called Vorlon and is free. These tools are written in Java and can run on any platform with a Java engine. Mac so you should use the JBindery program that comes with the MRJ SDK to run these tools. Easy to follow instructions aimed at Mac users have been added to their website in February of 1999. Though both Chisel and Novafex's Flamingo Optimizer do similar functions, there are different enough to call them complimentary rather than competitive products - for now.

PAUL THIESSEN / M LOUKA, vrm12pov

A quick and simple port of Paul Thiessen's nifty VRML to POV scene converter. You can use it to create beautiful ray-traced images of your VRML worlds. It cannot cope with everything that you throw at it, but it can be fun to experiment with and it can produce very nice results.

All the tools listed above can help you produce cutting edge VRML worlds. VRML needs creative developers, it needs Mac developers. The tools do exist and the supporting information is available. If you wish to build new worlds, all you have to do is try.

NODE REFERENCE

The following is list of VRML nodes grouped by general function. Complete definitions and supporting field information is a part of the VRML 97 spec. The specs URL is listed in the reference section of this paper. Note that no math or scripting functions are mentioned. This is because those features are handled by JavaScript placed with the "{}"s of a Script node.

LINKING TO A URL

Anchor {} Inline {}

GENERAL WORLD INFO

Background {} Collision {}
Fog {} NavigationInfo {}
Viewpoint {} WorldInfo {}

GEOMETRY DEFINITIONS

Box {} Cone {}
Coordinate {} Cylinder {}
ElevationGrid {} Extrusion {}
FontStyle {} IndexedFaceSet {}
IndexedLineSet {} Normal {}
PointSet {} Shape {}
Sphere {} Text {}

MATERIAL SURFACES

Appearance {} Color {}
ImageTexture {} Material {}
TextureCoordinate {} PixelTexture {}
TextureTransform {} MovieTexture {}

GROUPING AND TRANSFORMING

Group {} Switch {}

Transform {}

SOUND

AudioClip {}
Sound {}

ANIMATION FUNCTIONS

ColorInterpolator {}
CoordinateInterpolator {}
NormalInterpolator {}
OrientationInterpolator {}
PositionInterpolator {}
ScalarInterpolator {}

USER INPUT SENSORS

Billboard {} CylinderSensor {}
LOD {} PlaneSensor {}
SphereSensor {} ProximitySensor {}
TimeSensor {} TouchSensor {}
VisibilitySensor {}

LIGHTING

DirectionalLight {}
PointLight {}
SpotLight {}

SCRIPTING

Script {}

Each of the above nodes are further defined by fields and event types. Individual or groups of nodes can be reused through DEF and USE statements. New nodes can be created by the use of PROTO and EXTERNALPROTO functions.

Books

For those looking for more about the basics and advanced concepts there are many on-line tutorials. There are also several good books on the market. I would recommend one that is dedicated to VRML 97 or 2.0. 2.0 books are fine as VRML 97 was only an update. Check for a Macintosh compatible CD with example of code. Learning code is much easier when you have ready-made pieces to blend into your own worlds. Many books make the mistake of dedicating chapter after chapter to large uninspired projects. Small projects that are easy to learn and modify are better.

Recommended as a first book is Chris Marrin's "Teach Yourself VRML 2.0 in 21 Days." Its coverage is complete and easy to read. Another good book is the "VRML 2.0 Sourcebook" produced by the San Diego Supercomputer Center. At 654 pages, it explains in great detail the inner workings of VRML 2.0. The VRML 2.0 Handbook is fair. It has no CD nor easy node references but, it does offer some good explanations of the language. Late Night VRML with Java is good if you already know some Java. Other books such as VRML Clearly Explained are not recommended

Those seeking tutoring might try an online VRML Language class like ones offered by Ziff Davis zdu.com. Its currently taught by VRML stalwart Sandy Ressler.

Resources to help you start building worlds are available on-line.

Mac VRML Plugins:

Cosmo Player, Web 3-D Consortium
<http://www.CosmoSoftware.com>

Live Picture Viewer, Live Picture
<http://www.livepicture.com>
408-371-4455

Live Picture 910 East Hamilton Ave, Suite 300
Campbell, CA 95008

Express VR, Brad Anderson

<http://www.andrew.cmu.edu/user/anderson/vrml/>

Mac Vrml Tool Contact List:

Extreme 3-D, Macromedia

<http://www.macromedia.com/>
415.252.2000

Macromedia, Inc., 600 Townsend St., San Francisco, CA 94103 USA.

Ray Dream Studio, MetaCreations

Ray Dream 3-D, MetaCreations

Bryce 4, MetaCreations

<http://www.metacreations.com/>
805.566.6200

MetaCreations Corporation 6303 Carpinteria Avenue Carpinteria, CA 93013

Novafex Software Limited

6009 Quinpool Road, Suite 804

Halifax, Nova Scotia B3K 5J6 Canada

info@novafex.com

Tel 1-902-492-9206 / Fax 1-902-492-4407
outside North America.

<http://www.novafex.com/>
1-800-528-6585

Lightwave, NewTek

Inspire 3-D, NewTek

<http://www.newtek.com/>

Plugin / FAQ

<http://www.lightwave-outpost.com>

210-370-8000

NewTek, 8200 IH-10 West, Suite 900 San Antonio, TX 78230

Gareth Ennis

online "Viewpoint Creation" tool

<http://iris.abacus.strath.ac.uk/glasgow/vp.htm>

Studio Pro, Strata

<http://www.strata.com/>

1-800-678-7282

2 West St George Blvd., St George, UT 84770

Lifeforms Studio, Credo Interactive Inc.

Lifeforms, Credo Interactive Inc.

<http://fas.sfu.ca/lifeforms.html>

Credo Interactive Inc. Suite #270, 8900 Nelson Way Burnaby, B.C. Canada V5A 4W9

Vorlon, Trapezium

Chisel, Trapezium

<http://www.trapezium.com>

General Information:

(This is a small portion of what is online)

MacWeb3D

<http://www.MacWeb3D.org>

This site has been recently been set up by a number of long suffering Mac VRML developers. If you wish to build VRML worlds on a Mac, bookmark this page and join their list.

VRML on the Macintosh

<http://home.telia.no/mlouka/vr/mac/>

A Mac VRML site with tips and advice, and a comprehensive list of tools and utilities. There is also an introduction to VR, which contains a very simple VRML tutorial for beginners, at <http://home.telia.no/mlouka/vr/vrhiof98/>

The Leper Colony

www.leper.to

A Mac VRML site dedicated to art and philosophy. Also features product reviews, links, and other information

VRML.ART

<http://www.vrml-art.org>

Some 40 "art" sites accepted by VRML.ART for exhibition at the 1999 VRML Conference

The Mining Co./ Focus on VRML

<http://vrml.miningco.com/mbody.htm>

A great place to find new information and new VRML sites. Managed by Sandy Ressler

VRML WORKS

<http://hiwaay.net/~crispen/vrml/>

Managed by VRML Review Board Member Bob Crispen. Site features a great deal of VR information.

The Web 3-D Consortium

www.vrml.org

Fosters VRML development. Frequently updated VRML FAQ and official specs. Go here for detailed descriptions of the VRML 97 language and the development of X3D

The VRML Respository

sdsc.edu/vrml_repository/repository.html

Features the most complete listing of VRML tools and browsers to be found on the internet.

VNet

<http://ariadne.iz.net/>

Online 3-D multiuser VRML / Java environments; PC, Iris and Mac compatible.

Mac users require only Cosmo Player to view.

Deep Matrix

Similar to VNet, more active development but currently less useable for Macintosh.

<http://fas.sfu.ca/lifeforms.html>

Tutorials

Introduction to VRML 2.0

www.sdsc.edu/siggraph96/vrml

An online tutorial, with examples of code

Introduction to VRML 97

<http://ece.uwaterloo.ca/vrml98/cdrom/courses/nadeau/>

A downloadable reference library, written by Dave Nadeau

Sources for the information given in this paper are listed in the above general information section. (Bob Crispin's VRMLWORKS especially). Portions of the sections on "How to Code" and "Mac Tools" are derived from Mr. Guynup's Oct 98 coverstory in NetProfessional Magazine <http://NetProLive.com> (Edited by Raines Cohen and Michael Murie) Both sections have been substantially updated. Additionally we'd like to thank the VRML community, for their openness and helpfulness

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