

# VRML, the context for

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VRML (pronounced “vermel”, sounds like vernal) stands for Virtual Reality Modeling Language.

## 1.0 VRML Today

VRML stands for Virtual Reality Modeling Language. What it is depends on the limits of your imagination. Right now it is a draft specification for adding 3D data to the Web. Mark Pesce has been the VRML list moderator since it began. His vision has shaped much of VRML. Early vision (URL is <http://vrml.wired.com/concepts/visions.html>) (and is included in the course notes, 9-1).

A fairly recent talk, “VRML Equinox”, given by Mark as the Developer’s Day Keynote Address at WWW3 in Darmstadt captures the status quo as of 95.APR.15. (URL is <http://vrml.wired.com/arch/1390.html>)(notes: 8-1)

The VRML 1.0 specification comprises a subset of the ASCII Inventor File Format (IFF) with some additions to allow linking out to the Web and including other URLs. The linking out feature (WWWAnchor) provides the same feature that HREF anchors provide in HTML. The WWWIn-line feature allows scenes to be composed by referencing URLs. The IFF format was selected by the members of the www-vrml mailing list after Silicon Graphics agreed to provide a parser for it and put it in the public domain.

VRML 1.0 was agreed to be the minimal starting point for a much larger vision. There is a rich set of materials on (URL is <http://vrml.wired.com>) which should be thought of as the primary VRML site.

The specification was first presented as a draft 94.NOV.2 and was completed in early May, 1995.

Just before the VRML press announcement, Mark described VRML in a “backgrounder” (URL is <http://vrml.wired.com/arch/1010.html>) “VRML is a language for describing multi- user interactive simulations -- virtual worlds networked via the global Internet and hyperlinked within the World Wide Web.” That was an exaggeration at the time, but it was and is the goal.

On 3-APR-95, Silicon Graphics (SGI) and Template Graphics (TGS) announced their WebSpace products. This more commercial thrust adds an interesting balance to the VRML mixture. There is a lot more visibility and hype for VRML. That is both good and bad. Hopefully, the browsers coming out now (95.MAY.15) will both extend and temper the good aspects of the visibility.

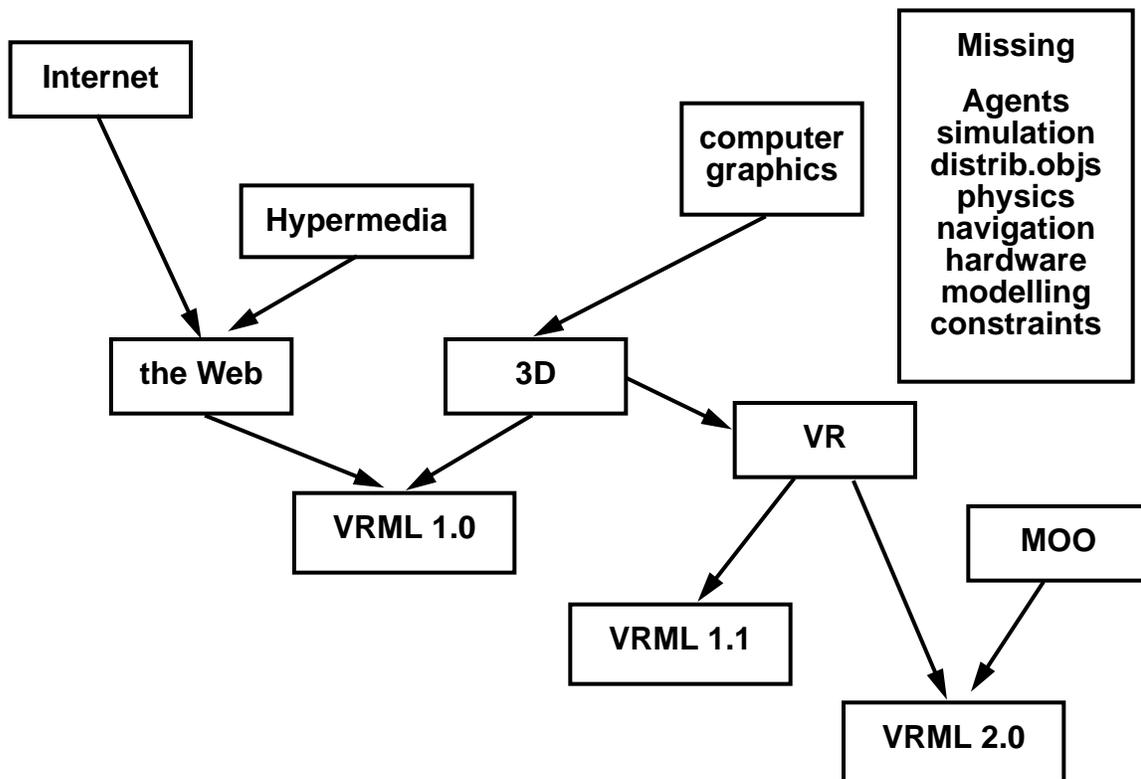
Seventeen companies and organizations also announced their support for VRML-based 3D graphics on the World Wide Web. These companies include: AccelGraphics, Inc., Brown University, CERN, Digital Equipment Corporation, Intergraph, NCD, NEC Technologies, net.Genesis Corporation, Netscape Communications, Oki Advanced Products, San Diego Supercomputer Center,

Spyglass, Tenet Networks, Viewpoint Datalabs International, Inc., the University of Darmstadt, Wavefront Technologies and 3Dlabs Inc.

There is a VRML FAQ at [http://www.oki.com/vrml/VRML\\_FAQ.html](http://www.oki.com/vrml/VRML_FAQ.html)

## 2.0 VRML tomorrow

VRML is most directly the addition of 3D graphics to the Web. However, it is really the confluence of many technologies. This figure is a simplistic family tree showing how VRML is descended from the Internet, hypermedia, the Web, computer graphics, and Virtual Reality (VR).



At this point, predicting the features and time table of VRML 1.1 and VRML 2.0 is pure speculation, but let me echo some of the ideas I've heard.

VRML 1.1 should come soon—it should be well defined at SIGGRAPH 95. It should include those things which are still vital to give VRML a good foundation, but fairly noncontroversial. The new features should be upward compatible with VRML 1.0. These have been mentioned as strong candidates: sound (ambient and point source), annotation text, I18N (internationalization), and a few more primitives with greater information density—TriStrips, QuadMesh, and perhaps the ElevationGrid, a regular quadmesh in which only Z is specified.

VRML 2.0 is currently a semantic place holder for the set of technologies and tools that will be needed to create the first heterogeneous cyberspace. It will include interactions—you will be

present and interact and behaviors—objects will move with time and in reaction to events. The notion of a VR-MOO in which multiple people are in a “room” moving and talking is the goal.

### 3.0 VRML-NG

There are many neat examples of where VRML and cyberspace may take us. Of course these are all fiction, but still quite compelling. If you have watched Star Trek - The Next Generation (ST-NG) you are familiar with the holodeck. This is the ultimate virtual reality, with no apologies. For all intents and purposes, the participant is in another world.

Perhaps a more influential work is the book *Snow Crash* written by Neal Stephenson in 1992. This book describes the “Metaverse” and especially “The Street”, the “Black Sun”, “Gargoyles” and is credited for the reassigning the word avatar to mean a representation of a person or agent in cyberspace. The Metaverse is a virtual world in which all influential people in the world participate—to conference, to socialize, to spread viruses. The degree and nature of the descriptions make it seem fairly real and technically possible. The Metaverse is a black sphere with a circumference of 64K as defined by the ACM’s Global Multimedia Protocol Group. The Street is described as the Broadway, the Champs-Elysees (The Greek Heaven, the main street of Paris). The street is “garish and brilliant, like Las Vegas freed from the constraints of physics and finance. Avatars can pass through each other on The Street, but not in the Black Sun - an exclusive club which offers a full physics based model of a bar. Gargoyles are people who are totally wired up. They have cameras, and microphones and scanning lasers for identification, they are uploading all of this data to the future merger of the CIA and the library of congress. Meanwhile they get feedback on the data they have sent. They know who is approaching them, as much about that person as their clearance allows, any on-line information, where the nearest bathroom is, etc.

I must also mention Gibson’s *Neuromancer* which launched the “cyberpunk” genre in 1984. It described “the Matrix” and Cyberspace as a mass consensual hallucination.

### 4.0 Web Hype

The Web is...

The Internet is, according to “The Internet: Complete Reference,” an 800 page guide now available in bookstores, “by far the greatest and most significant achievement in the history of mankind. \_The NY Times Week In Review - 95.MAY.30

I’ve noticed a trend to consider the Web as the Internet—for many the terms are interchangeable.

Fortune magazine (94.MAR.7 pg. 86) Declares in The Internet and your business “You should be there, too. Here’s what to expect” is a six page article in which Mosaic is mentioned twice, once as “the Internet killer application” by someone from the Internet Society, and MecklerWeb was mentioned. The article has a tone of cool technology with the Internet, but the World Wide Web itself was not named. <ftp://ftp.isoc.org/isoc/faq/what-is-internet.txt>

A year later, Fortune(95.APR.17, pg 154), an American business rag famous for the Fortune 500, runs an article about the specific steps to take to find, monitor, and make stockmarket trades using the Web, WWW, or the World Wide Web. They start at the most popular Web starting point, Yahoo. (Now moved to <http://www.yahoo.com> and commercialized, for the good).

Growth of the web has been phenomenal. There is no way to accurately measure the web at this point. In Darmstadt, the claim of 35,000 websites was bandied about. A more conservative estimate came from Sun in April - 25,000. There are better estimation for its growth when it was smaller. <http://www.netgen.com/info/growth.html>

The Boston Globe, 95.FEB.26 in an article featuring net.Genesis, estimates the Web at 12,000. This fits the pattern that it doubles every quarter of a year. The Web “is the intensely hyped Next Big Thing. If you are a technological minimalist, all you need to know is that the World Wide Web is the Internet in Technicolor.”

In March of 1995, Web packets passed ftp packets to be the most numerous type of packet on the NFSNET backbone. This was measured by port number (that :80 in the URL), so any web traffic that used a different port was not counted. The number of bytes is still higher for ftp. Since the backbone was replaced in April of 1995 with many interconnections between “super nets”, we must wait for more numbers until a new way to measure traffic evolves.

## 5.0 WebTech

The web is...

Content more than hype. Immense amounts of content that we need to navigate. Hence the need to give ourselves the visual richness and cognitive exploits of 3D. The content on the web is referenced by an “earl” or URL—Universal Resource Locator.

Check out <http://www.w3.org/hypertext/WWW/Addressing/Addressing.html> and follow the links to find the progress on URNs, (Names) and URIs (Identifiers). The idea is that the most popular web pages should be replicated and referenced by name. That will allow nameservers to direct the request to the “closest” instance of the page.

By a narrow definition, the Web is built on the Internet, the HTTP protocol, the HTML data format and some conventions. The web is tens of thousands of computers running web servers and millions of people running web browsers to view the web. A broader definition is all of the data that one can reach with a web browser. This includes the ftp (file transfer), gopher (college hockey), SMTP (mail), NNTP (USENET news), and even the telnet protocol. Browsers can also find pages on the local machine.

The mechanics of the Web can be explored at the World Wide Web Organization’s web server - <http://www.w3.org/hypertext/WWW/TheProject.html>.

The Internet Society has put together a description of the Internet that is helpful. <ftp://ftp.isoc.org/isoc/faq/what-is-internet.txt>

The FAQ (frequently asked questions) from comp.infosystems.providers contains lots and lots of pointers and answers. (URL is [http://sunsite.unc.edu/boutell/faq/www\\_faq.html](http://sunsite.unc.edu/boutell/faq/www_faq.html))

Finally, A Guide to Cyberspace <http://www.hcc.hawaii.edu/guide/www.guide.html> is getting to be out of date, but it was written when the Web was young and has lots of good descriptions.

## 5.1 HTTP & Webserver

HTTP is the HyperText Transfer Protocol, defined as an integral part of the Web. It is the protocol that Web Browsers use to talk to Web Servers. On the Internet it is layered on TCP/IP protocols, but it be layered directly on an ATM network (in theory). It uses TCP port 80 for the most part.

It is light weight, stateless and provides for negotiation of data representation. Stateless means that after fetching one web page, the protocol does not retain information about that transaction for the next time. This leads to some inefficiencies, but makes building and testing MUCH easier.

It is a client/server system. The client (Browser) makes requests and the server sends responses.

The W3O, or World Wide Web Organization, which has Tim Berners Lee (creator of HTTP/HTML) as its director, keeps a homepage devoted to a general introduction and overview of how HTTP fits into the Web. <http://www.w3.org/hypertext/WWW/Protocols/Overview.html>

The protocol specification itself is fairly readable. [http://www.w3.org/hypertext/WWW/Protocols/HTTP1.0/HTTP1.0-ID\\_1.html](http://www.w3.org/hypertext/WWW/Protocols/HTTP1.0/HTTP1.0-ID_1.html)

The IETF is the Internet Engineering Task Force. They are responsible for developing Internet standards, and hence, the formal specification and review of the HTTP 1.0 protocol in their domain. They have a homepage for HTTP. <http://www.ics.uci.edu/pub/ietf/http/>

## 5.2 HTML

HTML stands for HyperText Markup Language. It was created by Tim Berners Lee (TimBL) in 1990 as perhaps the central piece of the web. A common data file format that could reference other documents.

It is a text file with some <Markers> in it. <P>, for example means a new paragraph. It is meant to state the intention of the author and let the page layout algorithm take care of the details.

It is an SGML document type. ISO 8879:1986, Information Processing Text and Office Systems Standard Generalized Markup Language (SGML).

HTML 1.0 went out as an Internet Draft in June of 1993. <http://www.w3.org/hypertext/WWW/MarkUp/MarkUp.html> However, there were already many improvements creeping in. The focus for standardization is HTML 2.0 <http://www.ics.uci.edu/pub/ietf/html/>

The HTML 3.0 cover page. New features include tables, text flow around figures and math + equations, and a good solution to I18N (internationalization) HTML 3.0 <http://www.hpl.hp.co.uk/people/dsr/html/CoverPage.html>

A Beginner's Guide to HTML is exactly what it says. <http://www.ncsa.uiuc.edu/General/Internet/WWW/HTMLPrimer.html>

## 5.3 Browsers

Mosaic was the first widely available Web browser. It was developed at NCSA, the National Center for Supercomputer Applications, initially by Marc Andreesson. Mosaic is given credit for making the web, and hence the Internet easy to use. Marc Andreesson went on to join Jim Clark, founder of SGI, in creating Netscape—currently the most popular browser.

Browsers mostly handle the parsing and display of HTML (next section) data. However, they can also display “inline” images (usually GIF and JPEG), text files, iconic representation of ftp responses, gopher feedback. They can also server as USENET news readers. In doing all of this, a good browser can traverse the Internet giving the user the illusion that it is one integrated Web.

The best listing and of browsers is at <http://www.w3.org/hypertext/WWW/Clients.html>

### 5.3.1 A VRML viewer

You need 4 things for a simple minded VRML viewer (I use viewer to mean it views only VRML data, whereas a browser can handle a variety of formats, and client a very general term):

- VRML parser - get QvLib from [ftp://ftp.eit.com/pub/vrml/{Sun, SGI, NT, Mac }](ftp://ftp.eit.com/pub/vrml/{Sun,SGI,NT,Mac})
- URL fetching code - libWWW. As an alternative you might try "simple function to get URL" from Al Globus <http://vrml.wired.com/arch/0969.html>
- Rendering Code to plug into QvTraverse - (caution, incomplete & buggy) The sole purpose of this code was to learn enough to feel confident about giving a course at SIGGRAPH 1995. <http://vrml.wired.com/arch/1107.html>
- Communication with the browser using CCI, I think. (no code seen) As of 95.MAY the different browsers have gone different ways in terms of sharing information with the applications.

## 5.4 HelperApps & MIME

HelperApp refers to an application that the browser invokes to display content that it cannot. For example, audio and video files require much special processing and timing that would be extremely difficult to integrate into a browser. When a link to one of those files is referenced, the browser will download the file and then look up the MIME type in a file and invoke a HelperApp.

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The MIME type tells the content type and then the specific content format. Here are some examples:

|                |              |         |
|----------------|--------------|---------|
| audio/basic    | naplayer     | au, snd |
| video/mpeg     | mpegplay.exe | mpg     |
| x-world/x-vrml | WebSpace.exe | wrl     |

The MIME specification is RFC 1521 and RFC 1522. 1521 is MIME (Multipurpose Internet Mail Extensions) Part One: Mechanisms for Specifying and Describing the Format of Internet Message Bodies and can be found at <ftp://ftp.isi.edu/in-notes/rfc1521.txt>. 1522 is MIME (Multipurpose Internet Mail Extensions) Part Two: Message Header Extensions for Non-ASCII Text and can be found at <ftp://ftp.isi.edu/in-notes/rfc1522.txt>

There is a USENET news group: comp.mail.mime and a FAQ which is on the Web at (this is a good site, they have all the FAQs): <http://www.cis.ohio-state.edu/text/faq/usenet/mail/mime-faq/top.html>

MIME also provides for encoding of data. This allows for VRML files to be compressed. See the gzip encoding below.

WWW Viewer Test Page provides sample URLs for a wide variety of content. This allows you to test your browser and how it hands data off to helper applications. It also has some other MIME pointers. Check out <http://www-dsed.llnl.gov/documents/WWWtest.html>

A note of caution, VRML files have links embedded in them. It is very convenient to use relative URLs to bring in WWWInline data. However, when a browser launches a HelperApp and hands off a file that it has fetched, it must also hand off the full URL to the HelperApp in order to resolve relative pathnames.

### 5.5 [adding .wrl to server]

You need to edit the configuration file to establish the file suffix to MIME (more below) type mapping. For CERN you need to add this line to `httpd.conf`:

```
# add the VRML type.  
AddType .wrl x-world/x-vrml 8bit 1.0
```

For the EMWACS NT server, you add similar things in the Control Panel of the HTTP Server. Open that to see the list of MIME type mappings. Click on the New Mapping button and give `.wrl` & `x-world/x-vrml`

For Netsite add a type mapping from the `.wrl` extension to the correct MIME type by adding the following line to the file `/var/mc-httpd/admin/config/mime.types`:

```
type=x-world/x-vrml          exts=wrl
```

NCSA's httpd, add the following line to conf/srm.conf :

```
AddType          x-world/x-vrml      wrl
```

### 5.5.1 Compression

If you are putting up compressed VRML files on your web site you need to add a Content-Encoding line which tells the browser to uncompress it. Using the Free Software Foundation's GNU zip tools seems like the only viable cross platform option.

For Apache and NCSA's httpd, add the following line to srm.conf, and any file like \*.wrl.gz will be properly labeled with Content-encoding: x-gzip

```
AddEncoding      x-gzip              gz
```

For CERN, it is just a little different... (in httpd.conf)

```
AddEncoding      .gz                x-gzip
```

## 6.0 3D in 3 minutes

The Graphics Pipeline is a term commonly used to describe the process of turning 3D geometric data and attributes into pictures. As this process can be quite different in different systems, the term graphics pipeline does not have a precise meaning. Actual implementation of this pipeline is almost always compressed into as few steps as possible while still getting the "right" answer.

It is quite useful to isolate certain paths through the pipeline. We will take a brief look at the Geometry Pipeline and the Color Pipeline. My purpose is not to explain all of the details of the graphics pipeline, but rather, to give you a warm and fuzzy overview.

### 6.1 Coordinate Spaces

In VRML, objects are defined in "object space." You can use matrix operations to position them in a scene. These matrices are sometimes referred to as modeling matrices, as they allow for the creation of a model. They transform geometry from object space, where they are defined, to "world coordinates", where different pieces of the scene are placed together in one global coordinate space. Since nothing in VRML is defined in world coordinates, this is just a conceptual crutch for us. In the second step of the geometry pipeline, the geometry is transformed by the camera (also implemented as matrices internally) into "pixel space," "window coordinates," "device space," etc. Cameras allow the user to look at the model from any angle.

The geometry pipeline is also called the *transformation* pipeline.

Render culling takes place when an object is not “in camera” after being transformed to view space. This is tested by transforming the bounding box of the object.

## 6.2 Color Pipeline

Lighting is the process of calculating how much and what color light is striking the surface. In addition, the reflective properties of the surface must be used to determine how much light bounces back off the surface. An object may also emit light (emissive color—ignored for now)

This is controlled by the ambient, diffuse, and specular colors of both the light source and the Material applied to the object. Light sources may be Point lights (naked light bulb), Directional lights (sunlight) or Spot lights (as in dog? :-)

Shading involves taking the color values calculated for the lit corners of a triangle or polygon and then interpolating the color values between them. This produces a smooth gradation of shades between the calculated colors. In VRML, you will get smooth (Gouraud) shading if you have normals or colors bound to vertices. Otherwise, you will get flat shading—each facet will be a single color.

Texture mapping, by common usage, is the process of mapping the colors from an image onto a surface. The surface can have explicit or implicit texture coordinates (either u,v or s,t). In VRML, textures can be specified directly or by referencing an URL. (SFImage)

Transparency refers to “alpha blending” the color newly generated source pixel with the color of the destination pixel, which serves as the background. This would be more aptly named translucency. It should be possible for things to be lit, textured and blended simultaneously—in theory.

Stereoscopic displays use two images of the same scene to give depth perception. The two images are rendered from slightly different viewpoints. There are several ways to display these images: color filter glasses, shutter glasses or for head mounted displays, simply have two displays.

Open Inventor was selected as the starting point for VRML 1.0 (URL <http://www.sgi.com/Technology/Inventor>) The Inventor Mentor [Inventor Mentor, Josie Wernecke, Addison Wesley (1994), ISBN 0-201-62495-8] is a good reference.

Foley, van Dam, Feiner and Hughes [FVDH90] is a great reference. ISBN 0-201-12110-7

The Graphics Gems books (I-V) are rich in explanations, I happen to have III, David Kirk, handy, It's ISBN is 0-12-064480-0.

## 7.0 VR virtually

*Virtual Reality - An immersive, interactive simulation of realistic or imaginary environments.*  
(Jaron Lanier, credited with coining the term, creator of the “data glove”)

Virtual Reality (VR) is an oxymoron used to describe one’s presence in a virtual world. In VRML 1.0, there is nothing specifically for VR, except that VR is built upon 3D graphics for the most part. VR is the motivation and the future of VRML.

At the most basic level, viewing a scene in VRML is “Desktop” VR, or Window on World (WoW) VR. The alternative would be an immersive VR experience, in which one had a Head Mounted Display (HMD) and “gloves” for catching the richness the hands can articulate. Of course, sound would be included. Sound will be the next major feature added to VRML—before behaviors and interactions.

The CAVE is similar to an immersive experience, but with just light weight shutter glasses instead of a full headmounted display. There are three projection systems which project onto the walls and ceiling of a small room. This gives the feeling of being in a “cave.” <http://www.ncsa.uiuc.edu/EVL/docs/html/CAVE.html>

Another form of VR, in some cases called telepresence, is when the operator sits in a driver’s seat of some sort and drives a machine in cyberspace, or perhaps on another planet. I am eager for the day when I can ride a virtual bicycle through the VRML worlds.

In addition to sight, sound and motion, one’s sense of realism is dramatically affected by “haptic” feedback. This is also called force-feedback. It is the steering wheel in the arcade game that has resistance when you turn to hard or twists when you rub the wall.

Augmented Reality refers to the mixing of sensory input from the “real world” and VR. Similar to a “heads up display” where information is superimposed on a visor or windshield. Augmented Reality does not block it out, but adds information.

Virtual Reality is now earning its keep in the CAD world, the medical world, and the scientific world. An effective use is creating “electronic mock-ups” where designers and manufacturers can visualize the design, try sticking an arm into service areas and check for collisions. Saving one iteration of a physical prototype saves literally millions of dollars. One of the neat medical applications to catch the media this year was treating acrophobia. People could get the sensory input that caused them to panic in a situation they knew was safe.

<ftp://sunee.uwaterloo.ca/pub/vr/documents/whatisvr.txt>

<http://alex-immersion.army.mil/vr.html>

<http://www.cs.umd.edu/projects/eve/eve-articles/IV.Definitions.html>

<http://nemo.ncsl.nist.gov/~sressler/OVRThome.html>

## 8.0 MOO musings

The term VRMUD or VRMOO is often used to describe the next step in the evolution of VRML. Check out <http://www.kaworld.com> has jumped in with a 3D chat system.

MOO is best understood as standing for Multiuser Object Orientations, descended from MUDS Multi-User Dungeons. MUDs were created to play Dungeons and Dragons remotely in England in the 1970's. They have evolved into a more serious environment for researchers to collaborate. For example, Media MOO at the MIT Media lab is used as a way for people to leave show & tell items for others.

MOOs allow programming new objects in the environment and usually consist of many rooms or spaces connected together. The metaphor is a room. MOOs are similar to IRC chat "channels" or chat rooms on the on-line services, except that there are objects and actions instead of disembodied speakers.

Lambda MOO is probably the most famous MOO (or MUD). It was developed by Pavel Curtis of Xerox PARC. While these are currently text only interfaces, the realness of the social contact can be very strong. LambaMOO was the scene of the infamous "rape in cyberspace" which was originally published in the Village Voice and can be found off of this page. <http://vesta.physics.ucla.edu:7777/lambda/lambda.html>

<http://wwwsc.library.unh.edu/Systems/mudmoo.htm>

<http://www.ccs.neu.edu/home/nop/mudwww.html>

[http://www.hhcl.com/ProgrammersManual.texinfo\\_1.html](http://www.hhcl.com/ProgrammersManual.texinfo_1.html)

Also check out [rec.games.mud](http://rec.games.mud) (for tiny MUD, a very popular system)

## 9.0 Navigation

There are two aspects of navigation: within a given environment and between environments. The first problem is a user interface and metaphor problem. The second, navigating between parts of cyberspace is a conceptual and philosophical issue, at least at this time. Successful navigation means you get where you want and you are still oriented correctly.

For navigation in a single space there seem to be three metaphors:

- steering
- props
- some combination of the two.

Some of the natural steering metaphors are bicycles, flying, walking, and even the motorcycle chase from Snowcrash. Each of these has varying degrees of control of one's own movement. Walking give you freedom on a surface, a bicycle add speed to the equation. Flying give almost

total control. However, with more control there is more of a chance to get disoriented. Many of these contain the ability to follow a given surface. I'd love to see that in viewers.

A simple example of props is a map or touch pad approach. This was in the Labyrinth & Paragraph demonstrations I saw.

Higher technology props for navigation usually involves objects with 6D sensors (3 for position and 3 for orientation) on them. An interesting example is the World In Miniature metaphor or WIM, (NOT do What I Mean) but do what I do, or "programming by example" This is a "You are here" sign that you can pick up and take with you. You can move objects using the WIM and move one's self.

<http://uvacs.cs.virginia.edu/~rws2v/wim/wim-paper.html>

What about vocal commands, or textual command line interpreter. These are certainly the forms of navigation in MOOs & MUDs.

Why not just scale your self up? Scale the world down.

The problems of moving between spaces in the Web where hyperlinks (anchors) are the main metaphor may prove too disorienting in VR. Touch this box and transport to another world.

The topology of Cyberspace itself is a question. Most likely all possible topologies and methods of navigation will be explored and used to some degree or another. The Snowcrash Street metaphor in which space was uniformly scaled and everyone registered for a give part of the consistent street metaphor is one. It is too orderly for the Internet. Dr Who's Tardis is a space that is "little on the outside and big on the inside" the interior space is much larger than the enclosing volume.

Will there be any consistent metaphors for getting from place to place? What about getting back?

## 10.0 Timeline

In 1965, Ivan Sutherland laid out a research program for computer graphics in a paper called "The Ultimate Display" that has driven the field for the past nearly thirty years.

<ftp://sune.uwaterloo.ca/pub/vr/documents/whatisvr.txt>

"One must look at a display screen, as a window through which one beholds a virtual world. The challenge to computer graphics is to make the picture in the window look real, sound real and the objects act real." [quoted from Computer Graphics V26#3]

Q2 1963 SKETCHPAD paper published, Ivan Sutherland  
XXX-1963 Engelbart publishes "A Conceptual Framework for the Augmentation of Man's Intellect"  
XXX-1969 ARPANET connects 4 western U.S. scientist (becomes internet)  
Oct 1971 GINO paper published, P.A. Woodsford.  
XXX-1979 MUD1 Richard Bartle Richard Bartle and Roy Trubshaw (MUD FAQ)  
XXX-1984 Gibson publishes Neuromancer  
XXX-1986 SGML - standard ISO 8879:1986 Standard Generalized Markup Language  
XXX-1987 Jeff Conklin publishes "A Survey of Hypertext".  
XXX-1988 IRC Internet Relay Chat written by Jarkko Oikarinen  
MAR-1989 First Project Proposal - Tim Berners Lee  
<http://www.w3.org/hypertext/WWW/History.html>  
NOV-1990 First World Wide Web Prototype  
NOV-1990 LambdaMOO starts up  
AUG-1991 Web announced in alt.hypertext, comp.text.sgml, comp.mail.multi-media  
XXX-1991 Neal Stephenson publishes Snow Crash.  
AUG-1992 SIGGRAPH92 Inventor announced?  
XXX-1992 ISO 10744 Hypermedia/Time-based Structuring Language (HyTime)  
JAN-1993 XMosaic alpha released, 50 HTTP servers  
SEP-1993 Mosaic for Mac, PC, in addition to X machines.(Web traffic 1% of NSF backbone)  
XXX-1993 ISO 10646 - Universal Multiple-Octet Coded Character Set  
JAN-1994 Labyrinth application started Mark Pesce & Tony Parisi  
APR-1994 VRML term coined. <http://vrml.wired.com/concepts/raggett.html>  
MAY-1994 1st Web Conference VRML BOF, Mark Pesce presents Cyberspace Protocol  
JUN-1994 www-vrml mailing list started - Brian Behlendorf & Mark Pesce  
AUG-1994 SIGGRAPH94 - Discussion group for selecting basis of VRML  
OCT-1994 2nd Web Conference - VRML Draft announced, NetScape beta.  
NOV-1994 VRML 1.0 Draft - Gavin Bell, Tony Parisi and Mark Pesce.  
DEC-1994 W3C - World Wide Web Consortium first meeting at MIT-LCS TimBL  
JAN-1995 QvLib - VRML parser released Paul Strauss & Gavin Bell  
MAR-1995 Ubuque Ltd. virtual trade show - interaction on the web <http://www.ubique.com/>  
MAR-1995 Web packets (port 80) pass FTP traffic to be leading Internet protocol  
APR-1995 SGI, TGS announce WebSpace and 17 others endorse VRML.  
<http://www.sgi.com/Headlines/1995/April/vrml-webspace.html>  
APR-1995 WWW3 Darmstadt.de Mark Pesce presents VRML Equinox at Developer's day  
APR-1995 Web packets pass ftp packets as most common. NSF backbone comes to an end  
MAY-1995 SGI & TGS start shipping WebSpace beta, Intervista follows soon  
MAY-1995 VRML 1.0 Specification is complete

### ACK

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