

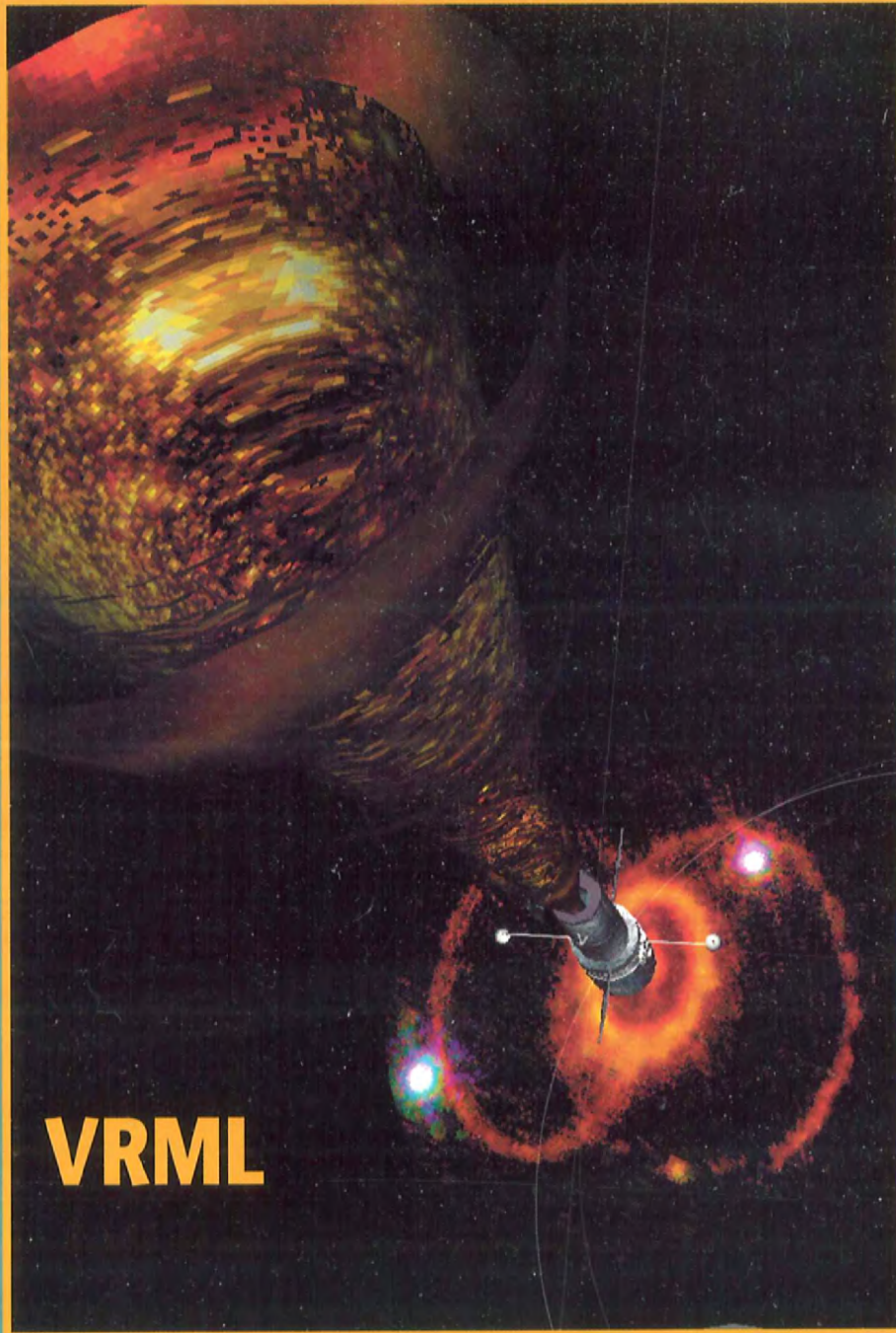
DEX

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VRML

- Public Speaking in VR
- Glassner on string Crossings

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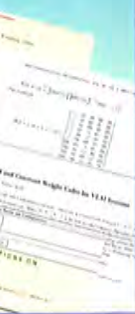
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IEEE Computer Graphics

AND APPLICATIONS

Articles

March/April 1999

Volume 19 Number 2

Published by the IEEE Computer Society

VRML

17 Guest Editor's Introduction:
Virtual Reality Modeling Language
Maureen Stone

18 Tutorial: Building Virtual Worlds
with VRML
David R. Nadeau

VRML makes it easy to create virtual worlds. This tutorial reviews VRML's syntax and features as well as its world construction and animation abilities.

30 TerraVision II: Visualizing Massive
Terrain Databases in VRML
*Martin Reddy, Yvan Leclerc, Lee Iverson,
and Nat Bletter*

To disseminate 3D maps and spatial data over the Web, the authors designed massive terrain data sets accessible through either a VRML browser or the customized TerraVision II browser.

39 Large-Scale Mine Visualization
Using VRML
Keith Russ and Andrew Wetherelt

Traditionally, mine plans and sections in 2D stored 3D information. This article shows that using VRML to model this information leads to new, interactive methods of data visualization.

45 "Bottom, Thou Art Translated":
The Making of VRML Dream
Stephen N. Matsuba and Bernie Roehl
Bringing virtual theater to the Web requires 3D graphics, efficient networking, and strong content. The authors discuss the VRML Dream Project, a real-time Internet performance.

52 Developing the VRML 97
International Standard
*George S. Carson, Richard F. Puk, and
Rikk Carey*

VRML 97 arose from a cooperative effort between the standards and VRML communities. The methodology employed applies equally well to development of future standards.

59 VRML Testing: Making VRML Worlds
Look the Same Everywhere
*Mary Brady, Alden Dima, Len Gebase,
Michael Kass, Carmelo Montanez-Rivera,
and Lynne Rosenthal*

NIST tools address problems posed by testing 3D graphics. This article explains the test development strategy and design issues in developing and delivering these testing tools.

68 A Framework for Streaming Geometry
in VRML
*André Guézic, Gabriel Taubin, Bill Horn,
and Francis Lazarus*

The authors introduce a framework for streaming geometry in VRML that eliminates the need to perform complete downloads of geometric models before starting to display them.

79 Dynamics Modeling and Culling
*Stephen Cheney, Jeffrey Ichnowski, and
David Forsyth*

The tools described permit including large numbers of complex dynamic models in a VRML world easily and efficiently while maintaining high frame rates.

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Departments

4 About the Cover

Advancing 3D through VRML
on the Web

6 Projects in VR

Public Speaking in Virtual
Reality: Facing an Audience
of Avatars

10 Applications

VizSim Technology Helps
Find Oil Faster

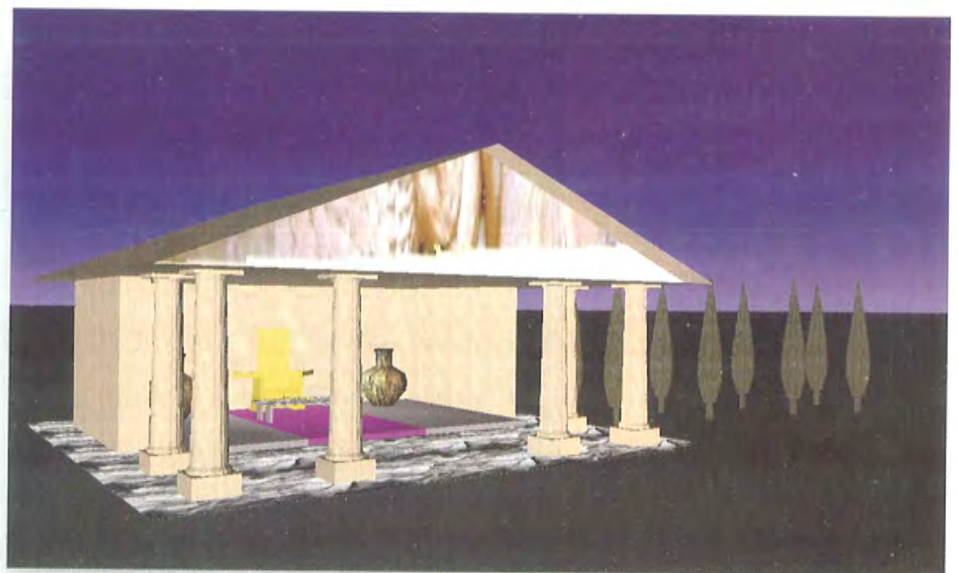
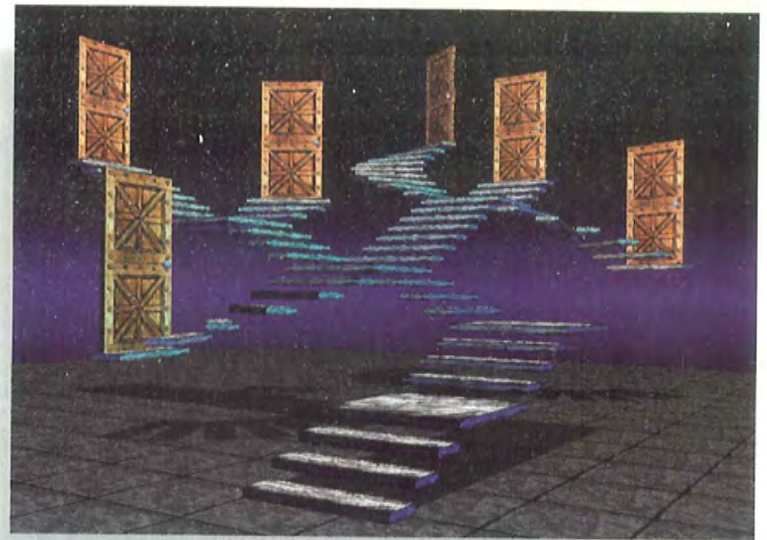
88 Andrew Glassner's Notebook

String Crossings

96 New Products

100 Advertiser/Product Index

Computer Society Information, C3
Change of Address form, p. 1



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TerraVision II: Visualizing Massive Terrain Databases in VRML

To disseminate 3D maps and spatial data over the Web, we designed massive terrain data sets accessible through either a VRML browser or the customized TerraVision II browser.

Researchers have increasingly turned to Virtual Reality Modeling Language (VRML) to represent geographic information. In VRML's early days, the result was a few toy examples that did not scale well, such as coarse, single-resolution elevation grids. Today, VRML is drawing more serious interest from researchers across the spectrum, including geographers, cartographers, geologists, and computer scientists, as the sidebar "Related Work" describes. As Theresa-Marie Rhyne noted, geographic information system (GIS) and scientific visualization tools have begun to expand into each other's

domains,¹ and VRML offers cartographers and geographers the potential to disseminate 3D maps and spatial data over the World Wide Web. However, to date we have not seen useful large-scale VRML geographic databases.

Martin Reddy, Yvan Leclerc, Lee Iverson,
and Nat Bletter
SRI International

We aim to enable visualization of near photorealistic 3D models of terrain that can be on the order of hundreds of gigabytes. This might include different types of terrain imagery for particular regions, as well as site models and auxiliary information for ground features.

The following scenario indicates the capabilities required. Say a user wants to find a particular building in a particular city. Her journey begins with a 3D model of the earth viewed from space. This model is texture-mapped with satellite imagery of 100 kilometers resolution—that is, each pixel in the texture map represents a region on the planet's surface covering 100 km². To find the city, the user first rotates the earth to view the

target region in the region, higher resolution imagery, are produced until she is "flying" to one-meter resolution rain, alternative photographs; the top of the terrain up area, 3D models the user clicks on played in a separate method, the user out the navigation an active map into landscape being v

In setting out to define four principal

- **Scalability.** Our sets. Common many millions imagery.
- **Composability.** the introduction data, including natural features, a user switch betw
- **Efficiency.** Users structures easily VRML browser increases brows
- **Data interchange.** representations for will let other geo using the same n

Related Work

Currently, interesting and significant work addresses the problem of representing geographic data in VRML. In the earth sciences, Kate Moore described the work of the Virtual Field Course (VFC) project,¹ which is developing software tools to familiarize students with fieldwork locations and aid data collection and analysis. The VFC project uses VRML and Java to provide interactive 2D and 3D views of geo-referenced data to enhance students' cognition of the real environment.

The US Naval Postgraduate School is currently working on a project to develop a 3D model of the Monterey Bay National Marine Sanctuary. They aim to create a VRML representation of the sanctuary based on raw bathymetry (below sea level) data for a 2.5 × 2.5 degree region of the bay. Their representation uses multiresolution techniques to deliver these large data amounts over a 28K modem connection.

Michael Abernathy and Sam Shaw described their work using VRML to visualize the course for a 197-mile relay race through the San Francisco Bay Area.² They did this using standard US Geological Survey (USGS) 7.5 arc min digital elevation models (DEMs) for the terrain geometry with geo-referenced satellite imagery draped over the terrain. Their system also used Global Positioning System (GPS) input to create a line segment showing the race's course over the VRML terrain.

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1. K. Moore, "Interactive Virtual Environments for Fieldwork," *British Cartographic Society Annual Symp.*, 1997; available at <http://www.geog.le.ac.uk/mek/VirtEnv.htm>.
2. M. Abernathy and S. Shaw, "Integrating Geographic Information in VRML Models," *Proc. Third Symp. VRML*, ACM New York, 1998, pp. 107-114.

Guided by these functionality in a loading data over toped a custom TerraVision II that features. Although n TerraVision II lets th level optimizations seamless interaction We designed our maintenance and to lar sets of geo-refer Java scripting to ex the External Authori fic management of To help develop s graphical represent Lee Iverson formed group, an official We mium (<http://www.a>) the VRML communit made freely available all of the tools we dev data sets. This includ om VRML nodes an generate the VRML c

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