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2D and 3D information visualization

The next big Internet revolution

*Tell me and I'll forget...
... Show me and I may remember...
...Involve me and I'll understand.¹*

As a species, the human race is tremendously influenced by sensory perceptions. Visual metaphors are frequent and common in our language and culture. A picture is worth a thousand words is one such example.

The appearance of the Internet in human culture just over ten years ago has produced the capacity to graphically and visually represent ideas, problems, challenges, solutions, and results, not as one-dimensional paradigms or presentations as in previous centuries, but in two or more dimensions, allowing the human mind to radically and instantly perceive new ways of solving and representing information. In addition, the next generation has been preparing itself for a future in which virtual collaboration with others globally will be the norm instead of the exception, and the fields of secondary and higher education are well behind the curve in addressing the learning needs of the future.

The field of information visualization is very new. Since its beginnings in the 1980s, when bandwidth and server storage necessitated high-end computer workstations in order to play with advanced and real-time interactive graphics for space exploration, animation, and visual effects, 2D and 3D formats are now readily available to anyone with a standard PC platform and/or money to purchase one of the many animation and multiplayer gaming systems. 3D information visualization is poised to enter the

mainstream of Internet gaming and search engine retrieval; the market is only waiting for an affordable device or product that will capture the public's imagination and push the envelope in this area. Once that happens, the world will never be the same. Interacting online in one dimension will become passé; users will want to be able to manipulate and search and present their content in multiple dimensions.

Information organizations must quickly begin experimenting and be ready to move forward offering their information visually in 2D and 3D. With Google and other information servers already controlling much of the user interaction and information patterns online, and with the research and development money to jump when necessary, traditional information organizations such as libraries and museums will be hard-pressed to compete and maintain market share in the coming information revolution.

These sources will provide the basics of information visualization, showcase some current applications and software products that may assist information organizations to strategically use their structured metadata in new and exciting visual front-ends, and re-think how to prioritize and plan for a future 3D information user environment.

What is information visualization?

The most common definition of information visualization is: the use of computer-sup-

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ported, interactive, visual representations of abstract data to amplify cognition.²

Other definitions that may be more user-friendly include: the process of analyzing and transforming non-spatial data into an effective visual form; a highly efficient way for the mind to directly perceive data and discover knowledge and insight from it; the transformation of abstract data to a visual representation, which is rapidly understood by the user; and the visual appearance of data objects and their relationships.

While information visualization is fairly new, there are a number of subgenres within the visualization field that are much more mature, and have become fairly standardized in the last 20 years. They are:

Data visualization: the graphical representation of data, meaning the manipulation of graphical entities (like lines, images, shapes, text, etc.) and attributes (like position, size, shape, and color).

Graphic visualization: the graphical representation of spatial and geographical information. Spatial metaphors have become one of the most fundamental design models of virtual environments.

Scientific visualization: has the most extensive literature associated with it, and dates back to the 1987 National Science Foundation (NSF) report *Visualization in Scientific Computing*.

Software visualization: a branch of scientific visualization that focuses on software objects, such as programs, algorithms, and parallel processes.

There are eight dimensional data types associated with information visualization. These can be found at OLIVE, the On-line Library of Information Visualization Environments:³

- temporal
- one-dimensional (1D)
- two-dimensional (2D)
- three-dimensional (3D)
- multi-dimensional (MultiD)
- trees
- network
- workspace

When working in 2D and 3D informa-

tion visualization environments, there are a number of presentation techniques to visually illustrate the information. Explaining each one would be rather tedious, so a number of them are listed here, and more information regarding how these presentation techniques work, as well as representative Web sites, is provided in the footnote below:⁴

- benediktine space
- cityscapes
- cluster maps
- concept mapping
- sh-eye views
- graphs
- landscapes
- networks
- perspective walls
- rooms
- spheres
- topic maps
- trees

Current resources and Web sites

All information related to the area of 2D and 3D information visualization is time-sensitive. Since the Library Technology Report was published, two years have gone by, and much new information has appeared, and much more information previously cited has disappeared. Information presented here is current and accessible as of November 20, 2006.

Journals

Access to these journals is not necessarily available via their Web sites, but may be by subscription only. Check your local library for information.

Association for Computing Machinery (ACM) Transactions on Computer-Human Interaction. Since 1994, this journal has published research related to the field of human-computer interaction. *Access:* <http://www.acm.org/pubs/tochi>

ACM Interactions. A bimonthly magazine for designers of interactive products. Back issues are available for free from the Web site. *Access:* <http://www.acm.org/interactions>.

Human-Computer Interaction (HCI). Covers theoretical, methodological, and empirical issues of user science and of system design. *Access:* <http://hci-journal.com>.

IEEE Transactions on Visualization and Computer Graphics (TVCG). Originally published quarterly, this bimonthly journal focuses on user interface issues, software, hardware, and systems related to computer graphics techniques and visualization. Access to full-text of the articles is restricted to subscribers only, but anyone can review the abstract and references of any current or archived article. *Access:* <http://www.computer.org/tvcg/index.htm>.

Info@Vis: The digital magazine of InfoVis.Net. An online journal devoted to information visualization, available in both English and Spanish. *Access:* <http://www.infovis.net/index.php?lang=2>.

Information Visualization. This journal has quickly become one of the major journals in the field of information visualization since its launch in 2002. It acts as a dedicated forum for the methodologies, evaluations, theories, and techniques of information visualization and its applications. *Access:* <http://www.palgrave-journals.com/ivs>.

International Journal of Human-Computer Studies (IJHCS). Published on a monthly basis by Elsevier, this journal encompasses a wide range of topics related to virtual reality, graphic interaction, innovative designs and applications of interactive systems, and visualization, among many others. *Access:* http://www.elsevier.com/wps/nd/journaldescription.cws_home/622846/description#description.

Practical applications

The economics of exploring 2D and 3D applications in information visualization are not out of reach for most libraries. At a minimum, setting aside a certain percentage of one person's time, and providing access to a high-end personal computer or laptop with extensive memory and storage capacity, is all a library needs to do to begin to explore

the possibilities. If this computer can be set aside in a secured separate room, then other people can also participate and assist in this process. The computer should also be able to download various open-source and trial software packages, as well as various plug-ins and programs such as Flash, RealPlayer, Shockwave, etc.

There are many software products, both open-source and commercial, that allow one to explore 2D and 3D applications. Many of the commercial products come with free trial periods, so that they can be downloaded and experimented with before purchasing. This is where the dedicated computer comes in. Since there is structured metadata already available in every library's OPAC, the application of a plug-in or software product to display this information in new and exciting ways is a good first step in showing your users that your library is keeping current with futuristic applications.

See, for example, how the Lexington Public Library uses the power of their structured metadata to provide the user with a 2D topic map to their OPAC, through the use of the Aquabrowser software product.⁵ Just type a keyword in the "What are you looking for?" box on their front webpage, and see the power of the Aquabrowser software present their OPAC information in a new way to the user.

Below are some of the more useful open-source and commercial products currently available.

Open-source 2D and 3D information visualization products

3DNA. *Access:* <http://3dna.net>.

3DTop. *Access:* <http://www.3dtop.com/what.htm>.

3D virtual reality worlds. *Access:* <http://vw.indiana.edu>.

Croquet Project. *Access:* <http://croquetproject.org>.

CubicEye. *Access:* <http://www.2ce.com>.

Fedora Project. *Access:* <http://www.fedora.info>.

FSN. *Access:* http://www.sgi.com/fun/freeware/3d_navigator.html.

IHMC concept-mapping software. *Access:* <http://cmap.ihmc.us>.

OpenDX. *Access:* <http://opendx.org>.

Open Knowledge Initiative (OKI) at MIT. *Access:* <http://www.okiproject.org>.

SourceForge. *Access:* <http://sourceforge.net>.

Touchgraph products (Dynamic Graph Layout, Planet-Wissen Navigator, GoogleBrowser, Wiki Browser). *Access:* <http://www.touchgraph.com>.

Visualization Toolkit. *Access:* <http://www.vtk.org>.

Visual Understanding Environments (VUEs). *Access:* <http://vue.tccs.tufts.edu>.

Worlds.com. *Access:* <http://www.worlds.net>.

X3D (Example applications, viewers, and utilities for experimentation). *Access:* <http://www.web3d.org/x3d>.

Xcruiser. *Access:* <http://xcruiser.sourceforge.net>.

Commercial 2D and 3D information visualization products

ActiveWorlds (\$6.95 per month). *Access:* <http://www.activeworlds.com/#>.

Advanced Visual Systems (AVS). *Access:* http://www.avs.com/index_wf.html.

ADVIZOR Solutions. *Access:* <http://www.advizorsolutions.com>.

Aquabrowser. *Access:* <http://www.medialab.nl>. **Anacubis (free ten-day trial).** *Access:* <http://www.anacubis.com>.

DataDescription, Inc. *Access:* <http://www.datadesk.com>.

Grokker (free 30-day trial). *Access:* <http://www.groxis.com/service/grok>.

ILOG Discovery. *Access:* <http://www2.ilog.com/preview/Discovery>.

Inight (and other visualization tools). *Access:* <http://www.inight.com/about>.

MAYA Viz. *Access:* <http://www.mayaviz.com/web>.

Mercury Computer Systems, Inc. *Access:* <http://www.tgs.com>.

Miner3D. *Access:* <http://miner3d.com>.

Pacific Northwest National Laboratory (PNNL) Galaxies, ThemeView, Starlight, OmniViz Pro, and IN-SPIRE. *Access:* <http://www.pnl.gov/infoviz>.

Research Systems, Inc. (RSI). *Access:* <http://www.rsinc.com>.

Rooms. *Access:* <http://rooms3d.com>.

SemTalk. *Access:* <http://www.semtalk.com>.

VisuaLinks. *Access:* <http://www.visualanalytics.com/products/visuaLinks/index.cfm>.

VisualMine. *Access:* <http://www.visualmine.com>.

Visualnet. *Access:* <http://www.antarctica.net/products/visualnet.shtml>.

Visual Thesaurus and ThinkMap (free five-click demo). *Access:* <http://www.visualthesaurus.com>, <http://www.thinkmap.com>.

Vivisimo. *Access:* <http://vivisimo.com>, <http://clusty.com>

Webbook and Web Forager. *Access:* <http://www.parc.com/research/default.html>.

Webbrain 2.0. *Access:* http://www.webbrain.com/html/default_win.html.

xrefer Research Mapper (free 30-day trial). *Access:* <http://www.xrefer.com/research>.

Here are the steps a library organization can take to begin the process of becoming familiar with 2D and 3D information visualization:

Identify people in the organization to lead the experimentation and exploration.

Set aside a high-end computer or computers for these people to conduct their experimentation on, with minimal interruptions.

Begin learning about this area, and begin experimentation with a few of the open-source and trial versions of the commercial products pointed to above.

Give a presentation to the staff and administration of the library organization, providing a simple introduction to the

topic, and showcasing one to three software products by illustrating how they work and why this topic is so important within the organization.

Futures

2D and 3D information visualization is so powerful because it is:

- manipulable and interactive;
- enables perceptual inference and perceptual monitoring;
- enhances the recognition of patterns;
- reduces the time element in searching for information; and

- brings numerous resources to the user of expanded memory and perceptual processing

Some interesting applications foreseen in this area include:

- visual data mining;
- collaborative visualization;
- Web visualization;
- real-time visualization of large datasets;

- virtual reality navigation using virtual user interface technology;

- visualization on the desktop, including desktop 3D for 3D worlds, with 3D objects on a 2D display, and handheld 3D navigation devices (for use in architecture, manufacturing design, and medical fields);

- desktop 3D for novel information spaces (applied to various landscapes like cities, themes, walls, rooms, hard disk files) using various techniques;

- desktop 3D for artificial worlds, to represent information content in file cabinets, shopping malls, library shelves and catalogs, Web spaces, etc.;

- Chartjunk 3D applied to various charts such as histograms, financial data, bar charts, pie charts, icons, etc.;

- immersive virtual environments (with head-mounted gear); and

- semi-immersive environments (with special glasses and/or large projection screens).

In conclusion, information organizations are lagging far behind the curve when it

comes to what our users are experiencing and using daily in regards to learning, recreation, and social activities. 2D and 3D environments have been in the marketplace now for more than ten years, and the current generation has grown up interacting and collaborating with these technologies on a daily basis.

When they walk into our one-dimensional text environments represented by our OPACs and books, they quickly become bored and frustrated with our medieval and antiquated ways to provide access to information.

We need to step up, and become experimenters and innovators with our information resources, presenting them in new and exciting ways to our users. If we do not, we consign ourselves to the oblivion of becoming museums of knowledge that make little difference or use to the everyday human experience of life.

For more information in this area, see the author's *3D Visualization Techniques: 2D and 3D Information Visualization Resources, Applications, and Future (Library Technology Reports*, v. 41, no. 1, January/February 2005, ALA TechSource).

Notes

1. Ancient Chinese proverb. Also quoted, in paraphrase, at the beginning of Peter Cochran, "I see and I remember", in *The Internet in 3D: Information, Images and Interaction*. Ed. Rae Earnshaw and John Vince. (San Diego: Academic Press, 1997): 2.

2. *Readings in Information Visualization: Using Vision to Think*, Ed. S. Card, J. Mackinlay, and B. Shneiderman (San Francisco: Morgan Kaufmann, 1999): 6. See Table 1.1, from which this information is quoted.

3. Available at www.otal.umd.edu/Olive/. Although not updated since 1997, it has excellent definitions, links to projects, products, videos and citations.

4. See the author's *3D Visualization Techniques: 2D and 3D Information Visualization Resources, Applications and Future, Library Technology Report* (January/February 2005) (v. 41, no. 1), ALA TechSource, p. 13-14. *W*