

INTERNATIONAL SOCIETY FOR DIGITAL EARTH

**PROCEEDINGS OF THE
SECOND INTERNATIONAL DIGITAL EARTH
3-D GEOBROWSER WORKSHOP**

Convened

SANTA BARBARA, CALIFORNIA, USA

28-29 MARCH 2003

The Jeffrey Star Memorial Laboratory
Department of Geography
University of California, Santa Barbara

THE SECRETARIAT OF THE INTERNATIONAL SOCIETY FOR DIGITAL EARTH
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ORIGIN

The International Digital Earth Geobrowser Working Group (IDEGWG) prepared this document for the International Digital Earth Workshop of the International Society for Digital Earth, which consist of

Timothy W. Foresman, ICRSE, Workshop Co-Chair
Michael Goodchild, NCGIA, UCSB, Workshop Co-Chair
Samuel P. Walker, USC, Workshop Rapporteur
Daniel A. Zimble, ESRI
Nickolas Faust, GTRI
Jim Fournier, Planetnetwork, Inc.
Chuck Stein, Geofusion, Inc.
Joe Skopek, Chromatrobe, Inc
Andrew Frith, Chromatrobe, Inc.
George Percivall, NASA/GST
Jeannette T. Candau, USGS-Western Geographic Science Center.
Dave Lorenzini

Locations

ESRI – Environmental Systems Research Institute
GTCI – Georgia Tech Research Institute
ICRSE – International Center for Remote Sensing Education
IRSA – Institute of Remote Sensing Applications, Chinese Academy of Sciences
NCGIA, UCSB – National Center for Geographic Information and Analysis, UC. Santa Barbara
USC – University of South Carolina

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IDEGWG thanks Professor Mike Goodchild and his staff for his promotion of the program and contributions towards the design, structure and substance of the workshop. Additionally, the staff of the ICRSE, under the direction of Dr. Tim Foresman provided extensive logistic, technical and material support to the completion of the workshop and documentation. In preparation of the document, we are especially indebted to the support provided by Mr. Sam Walker for the arduous task of Rapporteur and report drafter. We are also indebted for the support provided by ESRI, NASA, and the United Nations Environment Programme (UNEP).

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ADL	Alexandria Digital Library
AEIN	African Environmental Information Network
ARP	Academic Resource Planning
ASP	Application Service Provider
CAS	Chinese Academy of Sciences
CAVE	Collaborative Automated Virtual Environment
CNIC	Computer Network Information Center
COTS	Commercial Off the Shelf
DB	Database
DBM	Database Management
DE	Digital Earth
DEPS	Digital Earth Prototype System
DERM	Digital Earth Reference Model
DWG	Design Working Group
ESRI	Environmental Systems Research Institute
GIS	Geographic Information Systems
GML	Geography Mark-up Language
GTRI	Georgia Tech Research Institute, Georgia Institute of Technology, USA
ICRSE	International Center for Remote Sensing Education
IDEWG	International Digital Earth Working Group
IRSA	Institute for Remote Sensing Applications
ISDE	International Society for Digital Earth
KIP	Knowledge Innovation Program
LDES	Laboratory for Digital Earth Sciences
NCGIA	National Center for Geographic Information and Analysis
NCSA	National Center for Supercomputing Applications
NGO	Non-Governmental Organization
OGC	Open GIS Consortium
PWG	Programming Working Group
R&D	Research and Development
RFD	Request for Demonstration
RS	Remote Sensing
SDK	Software Development Kit
SOK	State of Knowledge
SQL	Structured Query Language
3D	Three Dimensional
TIN	Triangulated Irregular Network
USC	University of South Carolina,
UCSB	University of California, Santa Barbara
UN	United Nations
UNEP	United Nations Environment Programme
UWG	User Working Group
VDL	View Description language

VGIS	Virtual Geographic Information System
WG	Working Group
XML	Tensible Markup Language

NOTE: In keeping with the principles of the ISDE, the official language for the workshop was English. However, all major United Nations (UN) languages will be promoted by the ISDE for the widest distribution of Digital Earth information.

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EXECUTIVE SUMMARY

The International Society for Digital Earth convened the Second International Digital Earth Workshop, from 28 to 29 March 2003 at the University of California, Santa Barbara. The workshop, which was attended by over 20 participants, provided a forum for reviewing the status of Digital Earth development and implementation around the world. The participants included representatives from academic, governmental, industrial, and non-profit sectors. A key feature of the workshop was the continuation of the Digital Earth Geobrowser functional user documentation that was initiated during the First Digital Earth Workshop (Beijing, China, December 2002). The workshop also served as a developmental component for the Geobrowser-3 Workshop, to be held 17/18 July 2003 in Washington, D.C, and the Third International Symposium on Digital Earth, to be held in September 2003 in Brno, Czech Republic.

The International Society for Digital Earth (ISDE) is a non-political, non-governmental and not-for-profit international organization, principally for promotion of academic exchange, science and technology innovation, education, and international collaboration. The primary purpose of the Society is to promote international cooperation on the Digital Earth vision, and enable the Digital Earth technology to play key roles *inter alia*, in economic and social sustainable development, environmental protection, disaster mitigation, natural resources conservation and improvement of human beings' living standard.

The first day of the workshop was devoted to a review of the state of knowledge and a series of technical presentations that highlighted the growing number of Digital Earth applications and technologies across the world. Specific foci including three-dimensional (3D) effects, file compression, programming elements, and high performance networks were presented. Numerous, existing applications were reviewed in addition to some prototype demonstrations. The spectrum of application scales became evident as presentations were made addressing, global, national, regional, and local issues. One key difference between this workshop and the previous one that was held in Beijing was the strong representation by the private sector software development community. There were eight current geobrowser developers present at the workshop, and their input was invaluable, providing critical perspectives from a key stakeholder in the Digital Earth community.

The final day of the workshop was dominated by the working group session discussions, including design, programming, and user requirements. The working group addressed the growing need to develop a mandate to promote harmonized development of geobrowsers, the key delivery mechanism for Digital Earth applications to citizens and scientists. Participants were united in seeking practical and transferable solutions, through the Digital Earth Vision, to meet the challenges expressed through sustainable development.

The workshop culminated with an executive summary session wherein the Secretariat members outlined the final documents that would serve as the permanent record for the workshop, and discussed ideas for future opportunities to promote and sustain the Digital Earth vision including the

development of a schedule of objectives and milestones to be completed before the Third International Digital Earth Workshop (planned for 17/18 July 2003 in Washington, DC).

INTERNATIONAL SOCIETY FOR DIGITAL EARTH

SECOND INTERNATIONAL DIGITAL EARTH 3-D GEOBROWSER WORKSHOP

Santa Barbara, California, 28-29 March 2003

PROCEEDINGS

DAY 1

28 March 2003

Introduction

[1] An assembly of international experts was convened in Santa Barbara as a continuation of the process to maintain international communications regarding the underlying technologies and application advances within the international Digital Earth community. This assembly also continued to work on the effort initiated during the first international workshop on Digital Earth geobrowsers, held in Beijing, China in December 2002.

[2] This plenary style workshop brought together experts from academic, industrial, governmental and the non-governmental sectors to address the status and requirements for documenting the functional user needs for three-dimensional (3-D) graphic user interfaces, or geobrowsers. The objectives targeted defining the process for identifying key stakeholders and their range of applications for the Digital Earth vision. In addition, preliminary definitions of the basic functions and components of 3-D geobrowsers were developed and reviewed. Technical presentations were made in an effort to establish the state of 3-D geobrowser technology.

[3] This document records the primary material and discussion points from the two-day session. Results from this workshop will be combined with the documents from the first (Beijing, December 2002) and third (Washington, July 2003) geobrowser workshops.

Opening and Orientation

[4] The two-day International Digital Earth Workshop 2, organized by the International Center for Remote Sensing Education (ICRSE), hosted by the ISDE Secretariat and the National Center for Geographic Information and Analysis (NCGIA) at the University of California, Santa Barbara (UCSB) began with welcoming remarks by workshop co-chairs Dr. Timothy Foresman

(ICRSE) and Dr. Michael Goodchild (UCSB). The 20-plus participants were welcomed to Santa Barbara, specifically to the Jeffrey Star Memorial Laboratory within the Department of Geography at UCSB. Dr. Goodchild formally convened the session and outlined the objectives for the workshop, and reviewed the proposed agenda.

[5] The participants provided self-introductions, and Dr. Foresman distributed the formal proceedings from the Beijing workshop to all present. He also provided a brief summary of the outcomes from the Beijing workshop in an effort to structure the discussion. Dr. Foresman highlighted the key milestones in the evolution of the DE concept, and underscored the utility of implementing the DE vision in mainstream social, scientific, and operational activities.

Opening Perspectives

[6] Dr. Foresman began a series of presentations by offering an historical perspective on the evolution of Digital Earth and the subsequent development of 3-D geobrowsers as a mechanism for realizing the vision. Dr. Foresman's presentation was entitled "3-D Geobrowsers – Gateway to a Digital Earth."

[7] Dr. Foresman provided a chronology of technology highlights (germane to the Digital Earth), specifically noting the creation of the United Nations Environment Programme (UNEP), the Landsat program, and Earthwatch. Similarly, he noted the rapid development of the personal computer and subsequent citizen access to environmental data, and the convening of global conferences, such as those in Rio and Kyoto, and the documents (i.e., Agenda 21 and the Earth Charter) that evolved from those and similar efforts. He concluded that the 2002 World Sustainability Summit demonstrated the value of "type-2" partnerships, and suggested that the global network being created through these relationships would prove critical in sustaining the Digital Earth vision.

[8] Dr. Foresman highlighted the true international nature of the recent Digital Earth related conferences that have met in Washington, Nairobi, Cartagena, Johannesburg, Beijing to validate the vision that was first articulated by Vice President Albert Gore, Jr. in 1998. Dr. Foresman continued by mentioning the planned Third International Digital Earth 3D Geobrowser Workshop in Washington, DC (July 2003) and the upcoming Third International Symposium on Digital Earth in Brno, Czech Republic (September, 2003).

[9] Dr. Foresman continued by suggesting that the citizens of the world were undergoing a transition in terms of self-educating themselves about the environment in which they live, and that 3-D geobrowsers could enhance this data and information sharing at a fundamental level. The potential for a "global vision" is emerging and growing, as witnessed by Agenda 21 and other consensus documents, such as the Aarhus Convention that established an open policy for worldwide environmental data sharing. Dr. Foresman mentioned several specific instances and institutions where publicly available and accessible environmental data are implementing the Aarhus Convention doctrines, such as the African Environmental Information Network (AEIN).

[10] Dr. Foresman concluded his presentation by reaffirming the key objective of the workshop (i.e., developing community-wide collaboration for 3-D geobrowser development) and defining the key workshop goal of establishing a comprehensive benchmark for functional user requirements. He outlined other goals of the workshop also, including the review and modification of the technical requirements matrix and the refinement of the Geobrowser Mandate document, both of which were drafted in Beijing. Dr. Foreman highlighted some of the fundamental benefits of the workshop efforts, including better informed citizens, enhanced influence of science in policymaking, and a practical contribution to sustainable development.

[11] Following Dr. Foresman's presentation, a question was posed regarding the integration of social and physical sciences – and what has been the experience of the DE community in dealing with these aspects? A key problem was specifically identified, that of rendering of social data in spatially explicit, 3-D visualization environments.

[12] Dr. Goodchild followed with a presentation on the history and evolution of tessellation technology and methods, the Global Grid, Alexandria Digital Library, and related 3-D visualization efforts. The purpose of the presentation was to provide the participants with a common technical base for the ensuing discussion and to outline the state of knowledge (SOK) regarding tessellation development.

[13] Dr. Goodchild's comments included a review of the relative benefits and detriments of using grids in a variety of forms (triangles, squares, or hexagons) in the context of analyzing environmental data. He also noted the critical nature of compression capability, the importance of "stacking" grids for model analysis, and the particular elements associated with the representation of continuous data values. Dr. Goodchild also made a clear distinction between the strict representation of features and the indexing of these same objects in three dimensions.

[14] Dr. Goodchild continued his presentation by highlighting the fundamental issue facing those who are attempting to develop 3-D geobrowsers, that is representing the curved surface of the Earth with squares (or some other geometric shape) in an environment (i.e., computer screen) that is inherently two dimensional. He proceeded by showing a number of very explicit examples, all of which included conversion of a latitude/longitude-based reference to a cellular scheme (i.e., a grid) and possess specific merits and assumptions (e.g., assumption of differences in shape/size), and all of which contribute to an increasing body of academic knowledge on the numbering schemes required to develop spatial models.

[15] The presentation continued with Dr. Goodchild mentioning the International Conference on Discrete Global Grids, the Alexandria Digital Library, and providing some general comments on "geolibraries" – digital catalogs that are searchable by geographic parameters. He noted the value of these emerging geolibraries as a major data discovery tool that permits users to avoid the complexities associated with map projections and similar data conversion issues. Dr.

Goodchild also noted the importance of having a command line interface that enables the user to establish a search based on the relationship between a place and a name (i.e., “gazetteer”), and highlighted the distinction between the discovery and actual rendering of data (i.e., georeference vs. geospatial data).

[16] Dr. Goodchild concluded by suggesting that DE technology is perhaps part of a “class” of visions/efforts that he termed “Digital X” that might include such foci as: Digital Earth, Virtual Human, Digital Cosmos, Human Genome, Virtual Cities. The common link between and among these efforts is a spatio-temporal framework that can be addressed in part by a comprehensive data model that can accommodate diverse information sources. Such a model, Goodchild argued, is represented by 3-D geobrowser technology. He argued that geospatial data and 3-D geobrowsers may help to enable a shift in education by providing a renewed focus on how the world (and its systems) function, as opposed to how these same components look.

[17] Following Dr. Goodchild’s presentation, a brief discussion took place relating to 2-D, 2.5-D, 3-D definitions and the importance of defining these different approaches clearly in the Mandate for Geobrowser document and any subsequent literature. A question was posed about the specifics of the 3-D perspective and why this 2-D view is referred to as “3-D.” The consensus among those gathered was that the 3-D aspect was a conceptual one for the human(s) interacting with the geobrowser.

[18] Dr. Goodchild was followed by Professor Nick Faust from the Georgia Institute of Technology (Georgia Tech) who delivered a comprehensive presentation on the evolution of 3-D visualization entitled “Terrain Visualization: Basics and Challenges.” Professor Faust’s comments were designed to provide a summary of the “how and why” of the current visualization technologies, to highlight the fact that key considerations need to be made to accommodate a diverse set of users, and to identify the key distinctions between user groups in order to design the most effective visualization environments.

[19] Professor Faust presented several practical examples of 3-D visualization technologies, including the 3-D data views that were part of the City of Atlanta’s successful bid for the 1996 Summer Olympics. He noted that the ASPEN project provided the basis for the presentation to the International Olympic Committee. Professor Faust also mentioned the JASON Project that integrates unmanned submersible craft and 3-D visualization for science education purposes.

[20] Throughout the presentation the common theme was the evolution of visualization technology, and this focus provided the framework for a discussion of the integration of visual elements and associated attributes into a Virtual Geographic Information System (VGIS). Professor Faust noted the specifics of a time-dependent volumetric data structure, and provided some suggestions on how the technology community can best articulate the limitations of that architecture while still highlighting its utility.

[21] Professor Faust also suggested that one of the key “transitions” in the 3-D visualization arena is the switch from dumping “pre-cooked” (i.e., previously synthesized and packaged) data from a GIS into the geobrowser to true real-time rendering based on a user query. He also noted that another key issue is the need to resolve the integration of wireless telecommunication technologies.

[22] Professor Faust continued by suggesting the raster (grid) data is key to the development of 3-D geobrowser applications, but the existing investment in vector data is substantial and needs to be accommodated as well. He noted the development of Collaborative Automated Virtual Environment (CAVE) projects and the value and significance of making these environments mobile. Professor Faust highlighted some practical examples, including flood modeling, weather prediction, plume dispersion modeling, and habitat analysis of applications that benefit from virtual environment display and observation.

[23] Professor Faust concluded his remarks by noting the importance of linking the visual outcomes and products with decision makers in a policy-setting situation. He focused on the value of “augmented reality” which allows true interaction between the user and the underlying database. Finally, he made a specific point of acknowledging the need to understand and maintain awareness of both functional and detailed user requirements.

Break

Facilitated Discussion

[24] The morning session continued with a facilitated discussion, led by Professor Nick Faust, that focused on the purpose and content of the functional requirements “matrix” that was first drafted at the Beijing workshop. Professor Faust provided an introduction on the thought process behind creating the matrix, and then facilitated a discussion that involved all the attendees.

[25] Professor Faust provided a synopsis of the Beijing matrix development, and noted that the initial goal was to develop a framework for industry-wide functional requirements without infringing on the proprietary nature of software development (transparent access or data democratization). The discussion also focused on the private intellectual property issues vs. practical contribution to the user community dilemma.

[26] Professor Faust provided an excellent summary of the rationale for including the current matrix elements and making clear that additions and edits are potentially required and are welcomed. A brief discussion regarding the distinction between *viewing* the data and *actually accessing* the data ensued. A comment was made to suggest that data access might be a demand driven issue, not a supply side issue (i.e., data holders will finally relinquish the resources if demand is high enough – as driven by applications).

Open Discussion

[27] An open discussion relating to the status of, concerns about, and suggestions for the matrix elements ensued. Some of the key comments, and suggestions about which “elements” to include in the matrix are provided, below:

- **Platform/Server Hardware** – the hardware requirements for the server side software operating in conjunction with processors, memory, and other systems components.
- **Operating System** – the operating systems that the software must run on.
- **3-D Rendering** – the methods and algorithms applied to the graphic presentation of three-dimensional objects determining the performance and hence functional limits.
- **Tessellation** – the method used to enable dynamic, local to global, seamless display of framework data.
- **Client/Server** – the architectural strategy for hardware and operating systems performance across a network.
- **Data Type** – the capacity to handle different types/formats of data.
- **Volumetric Rendering** – the methods and flexibility for addressing three-dimensional displays and models for volumetric applications.
- **Time Series** – the strategy and algorithms for integrating time series data link to the user domain.
- **Internet** – the performance characteristics for operating on multiple and distributed databases.
- **Client Hardware** – the assumptions for the user’s system.
- **Multi-Layer Capability** – the methods for handling multiple layers of raster and vector data formats with flexibility for transparency and defining display priorities.
- **GIS Identification** – the identification of appropriate and priority databases with all associated attributes.
- **Entity Selection** – the ability to address any entity identified and manage the use of the entity for additional operations, such as query, search, access, and download.
- **Multiple Connections** – the ability to link simultaneously with distributed data resources.

- **Data Compression** – the methods applied to manage data compression in accordance with web standards.
- **Command Line Option** – the ability to initiate a search via a “gazetteer” style text search.
- **Interface Usability** – multiple level capabilities and the ability to publish the results from a session are key aspects of the usefulness of a geobrowser.
- **Data Subset Delivery** – user publication and post-session use of results by the user.
- **Data Discovery Component** – ability to explore beyond a user’s own resident datasets through the interface; searching vs. browsing; display of results.
- **Collaboration Capability** – this is a high level aspect but it will emerge. Personalization, publication, interaction. View sharing and real-time shared search and rendering capability.
- **Credibility/Validity** – needs to be integrated into the *search* mode (for the creator) and the *presentation* mode (for the end user).

[28] The comment regarding data credibility launched a separate discussion that revolved around the concept of having a “certified” network of geobrowsers. Who would be part of this network and how would it be administered? By the community and its users? Comments were also made on the developing “virtual signature” technologies for digital data and information exchange.

[29] Another free-flowing discussion ensued that led to a variety of comments, suggestions, and hypothetically posed questions, which are summarized below:

- Comment: Some key areas to consider are, functional requirements, geobrowser elements, and existing GIS obstacles.
- Comment: Regarding the distinction between the weights of the different elements being considered as potential “functional requirements” for geobrowsers.
- Comment: Regarding the specific concerns with the tessellation scheme issues and how this influences the interoperability of geobrowsers and the potential outputs (that might be shared) (“meta view description file”?).
- Comment: Enabling a fundamental level of communication among geobrowsers (GML?)

- GML – has advanced vector ID/transfer capability (in use by OGC vendors)
 - e.g., Virtual Terrain Project (does not yet have Web-transfer capability)
- Comment: Regarding the usefulness of the geobrowser (i.e., how will the geobrowser community “sell” this concept to the user community in *their* terms?)
 - Comment: Very simply, the ability to “describe” a view of the Earth with anecdotal capabilities (e.g., Keyhole’s publication option).
 - Comment: Another key discussion point emerged, which was the concept of a “view description language” or VDL (i.e., something fundamental that will remain regardless of the discrete geobrowser development/adoption efforts).
 - Comment: Regarding the structure of existing geobrowsers (TIN vs. grid and the point at which/method used transition takes place). This point included a discussion that made reference to the issue of real-time rendering vs. real-time data, and also how to address the caching of data within the client/server realm.
 - Comment: The scale of the applications is generally not global – more often local or regional. Therefore the users will not always need to have access or ability to render a DB of the entire Earth.
 - Comment: There is a concern that intellectual property rights need to be addressed as a foundation element of a geobrowser, open-source code vs. proprietary code.
 - Comment: Capability to “align” disparate data sets (is this a client side solution issue?) is a key consideration. Conflation aspects need to be addressed within any functional requirements. This was acknowledged as separate and distinct from the metadata issue.
 - Question: Is there a need for a base image that is shipped with a geobrowser to “seed” the user-defined applications?

Lunch Break:

Technical Demonstrations

[30]

ManyOne (Joe Firmage)

Highlights: “The Digital Universe”

Addressing some unmet needs of the web:

1. Reusable portal infrastructure based upon open source standards
2. Rich-media content experiences regardless of bandwidth
3. Simpler and more powerful navigation of the Internet (overcome the overwhelming nature)
4. Medium in which quality of information can be ascertained (critical for education and policy)
5. Viable financial model that allows for eventual self-support

Wants to transition from Pages&Links to Spaces&Objects

“Table of Contents” for the Internet (not so much a search engine)

Click-less navigation (as defined by user) of the “taxonomy”

Built-in auto update in the caching/media manager

Inform (news), discover (education), trade (commerce), communication modes

Software uses a very graphic interface (i.e., schematic)

Architecture is tied to the financial plan of ManyOne, which will support an international foundation

Syndication is possible, still a 56K compatible application

Stewardship Partners are responsible for link selection in specific sectors

[31]

Alexandria Project at UCSB (Dan Ancona)

Attempting a very simple interface for a spatial data search within the ADL

Scalability is essential (for the search, the display/rendering, and the publishing)

Open source project (generic terrain model) with continuous display update

Concept of a “data landscape” (e.g., 3-D charts and graphs for sales figures, etc.)

Providing “context” for the place that you are in a given database (i.e., what is it connected to, adjacent to, related to, magnitude)

Discovery systems with collection-level metadata are being developed at ADL project

[32]

BFI / EARTHscope (Joseph Skopek)

Educating the public about *Design Science*

spaceship EARTH project was launched in 2001

EARTHscope is a web-based geo storytelling tool

Work from a global to local perspective

Neutral Ground does not exist (every action or inaction is a choice with impacts on the future)

Incorporates human component into the design and focus

EARTHscope Demo 1.0 (built in Flash)

Addressing the business as usual vs. sustainability models and how to influence a change in trend

The Fuller Projection (good for global viewing)
The foundations for a “fork in the road” decision-making suite of tools
Component system architecture (each element loads separately into an integrated framework)
Floating framework (not rigid) so that the interface can be customized for different users of uses
Very lightweight, modular client (maps, text, graphs)

[33]

ESRI (Dennis Smith)

ArcGlobe demonstration (still under development) – COTS product
3-D visualization within GIS environments; graphics card dependent
Will be part of the 3-D Analyst extension and ship with ArcGIS
Globe-based visualization tools for the GIS environment
Utilizes GeoFusion software and comes with pre-packaged base data
Multi-resolution, continuous data model with standard GIS functionality
Extracted and extruded spatial elements (using compression utilities)
Showed demonstration of data transparency from globe to city level to built objects
Incorporates 3-D symbols and annotation; “target-setting”; on-the-fly data conversion
Data subscription services can be linked with web services to integrate with ArcGlobe
Eventually will be stored behind ArcIMS

Break

[34]

Keyhole Corporation (Noah Doyle)

“Keyhole: Perspective is Everything”

Visualization/Simulation elements are primary with *performance the key metric*
Product offered as an ASP service (via the web) or Enterprise solution (deployed on-site)
Internet streamed 3-D earth visualization (used w/ 3-D HW acceleration and broadband connectivity)
Mobile capability has been designed into the future architecture
In the context of the geobrowser discussion this product highlights the value-added side of things and vertical applications sacrificing “extras” for performance.
Screen has dynamic compass, visual direction controls, user-defined preference interface, gazetteer
View share capability (two modes) – collaboration site for sharing views
(www.bbs.earthviewer.com)

[35]

GeoFusion (Chuck Stein)

“Digital Earth Visualization”

Geo Matrix Digital Earth System (requires geographic projection for rendering)
Marketing a toolkit for building applications; platform independent; sphere-based rendering
Portable, OpenGL, demand based system for rendering, continuous level-of-detail
Blending of data layers (even those at different resolutions), custom animation over time
Output arbitrary resolution images or frames for movies
Dynamic citation of data on-screen; compression is a key programming focus

Demonstrated the “creation” of a DE environment within GeoFusion
Above-globe applications (aeronautics) showing trail and elevation for an aircraft
Immediate mode rendering (“waits” for tile to arrive); *deferred mode* (will use fuzzy data to save time)

[36]

VTP – Virtual Terrain Project Suite (Rob Hranac – The Open Planning Project)

Data democratization for DE through peer-to-peer applications, all open source code

Manage the DigitalEarth.org domain

Focus on urban planning issues and public participation; also want to plug into web geoservers

Integration of terrain and infrastructure data

Interest in improving core open source tools

Written in C++ and Java

Facilitated Discussion

[37] Dr. Goodchild provided some culminating remarks in closing the Day 1 session, and then provided a few suggestions on what topics the Day 2 discussion would focus. The basic suggestion was to focus on the need to collectively build interest and support within the geobrowser community to begin identifying and adopting key functional requirements. Dr. Goodchild proposed several other potential discussion points for the Day 2 session, including:

- Segmentation of the user community
- Prediction of future user needs
- Cross-support within the community
- Can and/or should the community make available a certain default set of data as a?
- How can these suggestions be realized within the community?
- Development of a paradigm where company financial models are not compromised
- Suggestion to begin with the public education system (free distribution and then build up)
- Heightened visibility might increase the marketability of the proprietary applications
- Revisiting the functional requirement matrix that was drafted at the Beijing workshop
- Ponder the potential gravitation toward lightweight client (server-centric) systems

Adjournment

[38] Workshop Co-Chairs, Drs. Goodchild and Foresman, provided some culminating remarks, acknowledged the valuable contributions of the attendees and then formally adjourned the Day 1 session, calling for the participants to reconvene for Day 2, at 0900 on 29 March 2003.

DAY 2

29 March 2003

Review of Objectives

[39] Dr. Goodchild began the Day 2 discussion with a brief review of the suggestions that were made at the close of the previous day and suggested that the discussion initially focus on distinctions within the user community, then revisit the functional requirement matrix, continue with a discussion of fundamental data set elements, and culminate with comments on the potential for the gravitation toward lightweight client (server-centric) systems.

[40] Comments were made that began defining the list of Representative User Levels to be Considered, these included:

- Scientists
- Professionals
- Education
- Citizens
- Media

[41] A specific comment was made about the potential disparity in the level of detail required and inherent ability to manipulate the interface as key distinctions among the user groups. As the discussion continued, the needs of the user groups were more explicitly defined. Several needs, such as view sharing and presentation/output options, were identified as being fundamental across all of the user groups. Some of the key needs are provided below:

- Scientists: integration capability, comprehensive discovery tool
- Professionals: data discovery
- Education: simulation, server-level functions, content authoring
- Citizens: pre-defined applications,
- Media: high compression, annotation

[42] A specific comment was made that addressed the issue of specific individuals that might fit the “profile” of more than one user category. This led to a discussion of how the interface itself could be developed to provide varying levels of interaction, perhaps through the selection and activation of specific toolbars.

[43] The ensuing discussion led to a variety of comments, suggestions, and hypothetically posed questions, which are summarized below:

- Question: Under what circumstances would you choose a geobrowser?
 - Stand-alone application
 - Plug-in to a traditional browser
 - Permit traditional browser plug-in

- Question: Can there be auto recognition of data sets by the geobrowser?
- Comment: A great value of this technology is in integrating science and policy.
- Question: Would a universal tessellation scheme benefit the community?
- Question: Is there potential for the adoption of data translation tools for the 3-D visualization community? Does this create a middleware requirement?
- Comment: Regarding the importance of the tessellation scheme, the interface of the client/server, and the location of caching in developing a practical and efficient geobrowser.
- Comment: There is a distinction between the absolute “base data” need of a geobrowser vs. traditional base data selection within a GIS.
- Comment: The issue of texture compression issues for the developers (already consistently used in the game industry) will need to be addressed in the context of geobrowsers.
- Question: Should geobrowsers accommodate time as a true dimension, not simply an attribute?
- Comment: The *roles* of the communities vary. System modes can perhaps address the differences in the user community.
- Comment: An important aspect is the distinction between time series data vs. discrete data views (does this require “precooking” of the data for each time interval?).
- Suggestion: Geobrowsers could provide a “swipe” tool (only) if time series data is present in the geobrowser view. This would provide the user with an excellent conceptual tool for understanding temporal data.
- Suggestion: A query tool could set the temporal mode (i.e., if time series data is loaded).
- Comment: Geobrowsers could use automated techniques to detect differences in iterative data to reduce the volume of rendered data when there is an update transfer occurring. This would increase the dependence on the server side of the architecture and perhaps require middleware.
- Discussion: How are requests for tiles in a global tessellation made by Geobrowsers to remote servers? Several approaches were briefly discussed including an approach of an

http request for each tile, where the request includes the tessellation index. One Geobrowser developer indicated that they would make their methods publicly known in order to allow concurrent developments. Another developer indicated that they would keep their scheme proprietary, but they are interested in access OpenGIS Web Services as additional layers.

[44] This far-reaching discussion concluded with a consensus that real time viewing of the Earth system data is of critical importance. There was also a suggestion that the requirements should be defined as either functional, data, or hardware elements.

[45] The following agenda was developed as the result of a fairly detailed discussion of where this DE effort should be directed over the coming months.

Ongoing Agenda:

1. Organize Materials
 - a. Mandate document
 - b. List of requirements
 - i. Functional
 - ii. Data (includes View Description Language)
 - iii. Hardware
 - iv. Deployment (View Description Language used here)
 - v. Architecture
 - c. User community elements

2. Define the Steps to Proceed
 - a. Planning for Geobrowser Workshop 3 (July 2003, DC)
 - b. Request for community demonstrations
 - i. Must meet criteria for performance in order to demonstrate
 - ii. Based on web-mapping test bed model
 - iii. Develop criteria in RFD format (G. Percivall to draft)
 - c. Web presence and content (minimal overhead here)
 - i. Bibliography
 - ii. Existing documents/graphics
 - iii. Links to vendor/user community examples
 - iv. Proceedings
 - v. Calendar of events
 - vi. Link to mailing list(s) and/or discussion lists

3. Define Roles and Tasks
 - a. Establish web presence (NCGIA, Goodchild)

- b. Workshop 2 Proceedings and additional documents (Walker, Stein)
- c. Workshop 3 Planning (Goodchild, Foresman, Percivall)
- d. *DEFINING THE GEOBROWSER CHALLENGE (tentative title)*
 - i. Day 1: Demonstration by “alpha” vendors in morning, executive session in afternoon where policy responses can be formulated for R&D, education, etc.
 - ii. Day 2: Other demonstrations in morning; DE Workshop 3 committee meeting to document the event and plan future efforts in afternoon.

Open Discussion

[46] Mr. Sam Walker provided a brief overview of the document that is tentatively titled “Mandate for Digital Earth Geobrowsers: Status and Recommendations.” This document was originally drafted during the Beijing workshop (December 2002) and is designed to serve as a foundation for the effort being undertaken. The document formally articulates the argument for community wide adoption of functional requirements for 3-D geobrowsers, and provides

[47] The discussion led to a review of the document’s outline structure, and several key modifications were made to the text of the Mandate. Key comments included:

- The observation that the Mandate document (to date) is “heavy” on the reasons why, and “lighter” on the specifics (this is what the workshop information/resolutions provide).
- The suggestion to include a series of sidebars (or vignettes) within the text to highlight key user groups and applications.
- The suggestion to more thoroughly use the metaphor of the Earth’s surface as a representation of geographic data, in order to provide a more intuitive user framework.

[48] The participants agreed to provide additional input and comments as time permitted more detailed examination of the document. Professor Nick Faust provided the Secretariat with a draft bibliography that will serve as the basis for a growing list of literature references that address the 3-D visualization, geobrowser technology, and user community issues that were discussed.

[49] A presentation of the WMS Global Mosaic was made by George Percivall (NASA Geospatial Interoperability Office and GST). This presentation was requested by several of the Geobrowser developers. The WMS Global Mosaic provides Landsat imagery from 2000 in full resolution through an OpenGIS Web Map Service. Mr. Percivall presented a discussion of the WMS architecture including use of the NASAS Web Map Viewer.

Lunch Break

Adjournment

[50] Workshop Co-Chairs, Drs. Goodchild and Foresman, provided some culminating remarks, acknowledged the valuable contributions of the attendees and then formally adjourned

CONCLUSION

[51] The Day 2 afternoon session began with the development of a draft schedule that noted key milestones and associated dates of completion for workshop documents, future workshop planning, and the establishment of a web presence for the series of workshops. Of particular concern was the timing of the Third International Digital Earth 3-D Geobrowser Workshop, which will be held in Washington, DC in July 2003. Appendix 3 provides a graphic representation of the draft schedule that was developed.

[52] A tentative set of dates was established for the joint “Geobrowser Challenge” and Third International Digital earth Workshop: 17-18 July 2003. A suggestion was made to begin identifying a specific venue for the event and several suggested facilities were noted. The need to establish a web presence for the effort was acknowledged, and the representatives from The Open Planning Project (Rob Hranac) and the NCGIA (Ben Sprague) both volunteered to help host (or provide a link to) the web site that will be adopted for the workshop documents and supporting materials, to be maintained on the NCGIA web site.

[53] It was agreed to work from the draft bibliography, provided by Professor Nick Faust, to develop a comprehensive, on-line reference list. A final discussion point was the acknowledgement of as-yet uninvolved stakeholders. Specific mention of CEOS, Microsoft, and NCAR, were made, and there was a suggestion to begin exploring the potential contributions of these groups.

Appendix 1- Workshop Agenda

Friday 28 March 2003

- 0900 Mike Goodchild welcomes participants to UCSB
- 0910 All participants introduce themselves
- 0920 Tim Foresman introduces the history and progress to date of the geobrowser series
- 0935 Mike Goodchild lectures on the history of the tessellation, Global Grid conference, and linkages to Alexandria Project from 3-D efforts
- 1000 Nick Faust lectures on 3-D visualization, where we have come from, what are the big issues
- 1030 Break
- 1100 Nick Faust introduces the thought process behind creating the matrix of Functional Requirements
- 1130 Open discussion on the categories, concerns, and status related to matrix elements (Mike Goodchild and Nick Faust moderators)
- 1300 Lunch (catered)
- 1400 Technical demonstrations
(Exact order to be determined: ManyOne, Keyhole, Geofusion, ESRI, BFI, s scheduled to present)
- 1530 Break
- 1600 Continuation with Tech Demos
- 1630 Open discussion on matrix definitions and refinement (Goodchild and Faust moderators)
- 1715 Discussion on 3-D interface specifications or functional desirability, IP, and balance of technical/performance issues for matrix fill in.
- 1800 Adjourn for Group Dinner (Sea Side Café (to be confirmed))

Saturday 29 March 2003

- 0900 Review newly drafted Technical Matrix, with upgrades (Goodchild and Faust moderators)
- 1015 Break
- 1045 Chart road map activities that can be aligned, development activities that can be cooperatively worked on, and define a schedule for remainder of 2003 drafting and reviews
- 1300 Lunch and plenary adjournment
- 1400 Documentation of workshop results (volunteers welcomed)
- 1800 Workshop adjournment

Appendix 2 – List of Participants

Participants in GeoBrowser 2 Workshop (28-29 March 2003)		
Dan Ancona	UCSB – ADEPT	da@alexandria.ucsb.edu
Krist Bender	National Council for Science & the Environment	krist@ncseonline.org
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Appendix 3 – Draft Schedule for Completion of Key Milestones

