Evolution of Digital Libraries, Problems and Prospects

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The focus this paper is on evolution of digital libraries in Nigeria. The paper explores the origin and concepts digital library, its potentials, components and technological tools needed for its implementation. The evolutionary development of the library in Nigeria is traced, and possible factors that inhibit successful implementation of the library in Nigeria is presented. The paper also discusses the prospects of digital libraries in Nigeria and offers recommendations on the way forward.

Keywords: Evolution, Digital libraries, Technology, Problems and Prospects

Introduction

We are living in the age of information explosion. This is made possible by the Internet and World Wide Web technologies. These technologies provide opportunity for cost, effective access to broad range of information resources and enhance communication and collaboration. The network of information support search and display of information from organized collections distributed all over the word. It enables libraries to participate in cooperative venture with other libraries and information centers.

Libraries in developed countries have exploited the benefits of these technologies through the use of digital libraries, also called virtual libraries. The importance of digital library lies in the fact that it is a tool for documenting, preserving and dissemination of historical, cultural and intellectual heritage of a nation and a means of enhancing information provision and learning .It is therefore a veritable instrument of sustainable national development. However, in a developing services of providing current information for learning and research due to non-utilization or under-utilization of digital libraries.

University libraries in many Nigerian universities face difficult times with staffing difficulties and provision of local resources. Most university libraries are in a deplorable condition due to inadequate funding (Ogunsola and Okusaga, 2006). In addition, there is increasing student population without corresponding support facilities such as classroom and other physical facilities . There is also dearth of information resources and lack of proper interaction between librarians and library users (Etim, 2006).This has great implications for learning, teaching, research and development.

To address these challenges, The Federal Government of Nigeria in collaboration with the ministry of education embarked on the digital library project- an electronic library project in 13 universities in Nigeria with the intent of overhauling institutional libraries and empowering the student (Fabunmi, 2009).

The introduction of digital library in Nigerian university libraries has rekindled great interest from both library users and librarians, When compared to physical libraries, digital libraries have higher storage capacity and require less physical space for the storage of digital contents. The cost of setting up and maintaining a digital library is less than that of a traditional library on account of the fact that lot of money is involved in erecting building, buying books and paying for staff (Raghunath and velayudhan, 2011). Digital libraries improve the quality of teaching and learning in academic institutions in Nigeria through the provision of online bibliographic information of library collections. The library enhances scholarship, research and lifelong learning through the establishment of permanent access to shared digital archival collections and advance the use and usability of a globally – distributed network of library resources.

However, creating and maintaining digital libraries in   Nigeria is challenging but inevitable. Despite the challenges to realizing the potential of digital library in Nigeria, digital library technologies and practices have developed enough so they are within the reach of educational institutions. To that end ,this paper is intended to provide information managers with a vision of what the digital library should be, the components of the library and technologies needed for its realization. The paper discusses the problems that may inhibit the development and use of the library in Nigeria as well as its prospects. It also offers recommendations for solving these problems and efforts needed to realize the global digital library vision of the future.

2. Digital library: Origin and Conceptual Frameworks

The idea of digital library was put forward by wells in 1737. Wells promoted the idea of 'world brain'. He observed that "both the assembling and distribution of knowledge in the world at present are extremely ineffective….most hopeful line for the development of our racial intelligence lies rather in the direction of creating a new world organ for collection, indexing, summarizing and release of knowledge…. These innovators, who may be dreamers today, but who hope to become very active organizers tomorrow, project a unified, if not a centralized world organ to pull the mind of the world together …"(Wells ,1937). Licklider (1960) also envisioned that human brains and computing machines would be tightly coupled together and supported by a network of 'thinking centers' that will incorporate the function of present day libraries together with anticipated advances in information storage and retrieval. Presenting a similar concept of a digital library, Bush (1945) urged researchers to "consider a future system in which an individual storage all his books, records and communication and which is mechanized so that it may be consulted with exceeding speed

and flexibility". Borges (1964), in his book The Library of Babel describes a magnificent endless library whose shelves register all possible collections.

Well ,Licklider, Bush and Borges were advocating a system very close to what we might call a digital library. Digital library means different things to different people from an information retrieval point of view, it is a large database ; for people who work on hypertext technology , it is one particular application of hypertext technology; for those working in wide –area information delivery, it is an application of the web; and for librarian it is another step in the continuing automation of libraries (Cleveland, 1998).

Digital library has many names associated with it. It is called digital library, electronic library, community network ,library without walls or library of the future. Candela etal, (2007)   define a digital library as "an organization which might be virtual, that comprehensively collects , manages and preserves for the long –term rich digital content and offers to its user communities specialized functionality of the content of measurable quality and according to codified policies".

Daniel (2002) posits that it is called 'virtual' because , in a good electronic wide, area networked library, the user enjoys the euphoria of being in distant libraries and yet has not physically moved. Green (2005) sees a virtual library as an organized set of links to items (documents, software, images, databases, etc.) on a network . Riccio (2001) asserts that a digital library is a technological way that brings together the resources of various libraries and information services, both internal and external, in one place, so that users can find what they need quickly and easily.

Bradley (2002) argues that whatever digital libraries may be called , they are collaborative ventures in which information professionals and other experts in specify subject areas pools their knowledge and experience to collate information on a specific subject.

Common to all these definitions, according to salawu (2010a), is the fact that it is a' library   without walls', where information resources can be accessed by remote user without their physical presence in the library.

3. Components of a Digital Library

Digital libraries are slightly different in content and organization. As a result, it is not possible to give a complete list of all the elements that may be found in a digital library. However , there are basic elements which any digital library should contain. These include the following:

- Name: A digital library should have a unique name.

- Site logo: A logo is a printed symbol designed for and used by an organization or company as its special sign. A logo is an essential element that identifies a digital library.
- Links: A digital library contains links to other websites and resources. The library contain databases of resources listed at a library and links to external databases and resources.
- Subject Guides: A digital library contains documents which may be full text, list of meeting, conferences and exhibitions, etc.
- Documents: A digital library contains documents which may be full text, list of meeting, conferences and exhibitions, etc.
- An e-mail front-end that allows users to initiate interlibrary loan and document.
- Delivery requests suggest purchases or ask reference question from within the OPAC (Magnussen, 2003)
- Mailing lists: A mailing list is a group of users with a shared interest whose e-mail addresses are collected together in electronic list that can be used to send e-mail to each member of the list (Greenlaw and Hepp, 2000).
- Newsgroup: A newsgroup is a discussion group, in which computer users throughout the world participate.
- Report and papers.
- Electronic books, journals and multimedia matereals.
- Bibliographies.
- Link to E-learning: Digital libraries should involve initiatives to unify the information technology structures of the university and to transform the learning process through innovative technology.

4. Digital Library Technology Enablers

Computer and network technology continues to evolve over the years. Nowhere is this more evident than in the evolving world of digital library implementation and practice. The digital library, in order of function effectively, makes uses of those technologies to bring together the information contained in the library and the user of the information. These consist of hardware and software.

4.1 Hardware Requirements

Digital library does not exist in the air but rather "depends on mundane earthbound elements…" (tebbetts, 1999). The digital library basically a network system and therefore makes use of existing network technology. Digital library requires a computer acting ,as a server and a network , as a basic hardware requirement. Along with computer system, cables are essential connectors of the library's infrastructure. The are the critical elements without which the digital library could not function. Electrical wiring and telecommunication

cables are fundamental components necessary to connect the user computer (which have no wireless facilities) in the local network.

The digital library also require printers, digital cameras or system with webcam facility for capturing images as well as scanners and digitizing equipment for conversion of content from physical to digital form.

4.2 Software Requirements

For a digital library to function effectively, it require a collection of software for running the system, for storage, management and access to the library resources. These suite of software are presented below:

Developing a digital library requires a high capacity operating system with the capability of installing and operating different software needed. The operating system considered suitable for the server and windows and linux and so on. Linux is more suitable and more reliable but it is more difficult to operate. Window is therefore more commonly used and it has the capability for establishing network and security connections as well as being suitable for users control, resources management and a working flexibility with different software.

Digital libraries require web servers for serving files. Common web servers are Microsoft SQL server, wampserver, SQL server 2000, OpenDlip, etc. for connecting the user to the server and the services of the digital library, different services such as FPT and HTTP are used.

The contents of a digital library are stored in a storage system which is basically a database. Mysql, Oracle, Access, etc. are commonly used database systems. The contents are only useful when they are meaningfully organized to facilitate identification and access. The is done by describing the materials appropriate metadata and indexing schemes. Many metadata schemes for describing digital library information exist such as MARC, Dublin Core and FRBR. Dublin core is more generally are not limited to textual materials but include multimedia material such as videos, audios and to represent textual materials. Access to multimedia materials is made using multimedia presenter.

Users navigate through the library collection to obtain information. Access to information is achieved using a browser. When specific information is sought and requires a search through the local the external resources of the library, a search engine responds to user by searching the lists and displaying search results. There is also a link engine , the part of the search engine that connect different information ,and query optimizer which contain tools that increase the efficiency of the queries passed to the digital library search engine.

Access to digital library is not always free. To ensure that, only authorized users access the library, and authentication software is used to control access to the library.

5. Evolution of Digital Library

In 1989, the World Bank provided funds to 30 federal universities in Nigeria for the acquisition of books, journals, and equipment (including computers) to encourage. Those universities to open their doors to information and communication technology (NOK,2006). The computers were used then as stand-alone system for cataloguing bibliographic information of library holding and for processing documents. With the emergence of digital libraries in the 1990s coupled with the takeoff of the www (Foo and Theng, 2004), NUC introduced projects aimed at computerizing university library services across the country. The early stage of digital library development was document collection-oriented and designed only to automate traditional library functions by helping librarians to manage physical books and perform other function such as acquisitions , loans recalls and library planning . library software such as Tinlib, x-lib, Liplus, Alice, CD ISIS were used then to perform these functions.

Later ,NUC initiated management information system (MIS) and started the Nigerian Universities Network (NUNET) project. NUNET was aimed at developing a viable local and Wide Area Network(WAN) in each institution. This was followed by the national virtual (digital) library. The idea was to extend the notion of the library forward into the emerging digital information context.

Digital libraries began with a rather simple assumption: the attributes, information, and practices of the library could be translated relatively unscathed to the online environment. The prevailing belief was that the library would benefit from and be enhanced by the new technical developments, and the user of those libraries would in turn benefit from these 'libraries without walls'. The mission was "to provide , in an equitable and cost-effective manner, enhanced access to national and international library and information resources and for sharing locally-available resources with libraries all over the world using digital technology"(Nok, 2006). To achieve these objective , local Area Nerwork(LAN) and Internet connectivity were set up in some university libraries along with university portals and library websites which serve as gateway to library information access in university libraries. With these new technologies on ground , library functions shifted from stand-alone operations that characterized early library computerization, focusing instead on fully integrating digital material into the library's collection. As a result of technological advancement , by 1995, WINDOWS, CD-ROMs, power point, DVD came into use(jayaprakash and venkataramana,2006). Library resources such as journals from popular publishers were made available via CD-ROMs. These system were used locally , while most external resources were through in CD-Rom electronic format. Which were made accessible on servers through library intranets, while access to resources on the Internet was made through library website. At that time, www was in a nascent stage, and netscape, and mosaic were among the popular browsers. This early digital library was primarily technical

system- a set of protocols and standards that enable browsing over a network of document, and handled by computer scientists, while librarians were almost uninvolved.

The next stage of digital library focused on digitization of library resources, metadata schemes- finding ways of describing library materials to facilitate their access, data management techniques and digital preservation. At this time, most university libraries online in portable document format (pdf). Library software also shifted to network-based versions to adapt to the changing internet environment. As open source software become readily available, most university libraries took advantage of the situation and opted to the use of open source software such as Koha, Dspace, Greenstone and other. It has become commonplace for libraries in Nigeria to provide access to full text journal issues and articles by subscribing to the journals on behalf of the users. Digital libraries in Nigeria now provides links to e-books, e-journals and other free resource through academic digital libraries.

6. Problems of Digital Library

In spite of the enthusiasm generated by the new thrust in digital libraries and a myriad of information technologies available , overall problems that may impede proper implementation of digital in Nigeria abound. These problem incluse:

6.1 Inadequate Founding

The success of any project is dependent on the involvement of the stakeholders and sponsorship of funding agencies, such as the government, NUC and so on. The creation and maintenance of digital libraries is very expensive. Costs are incurred for production, for ongoing provision of access, and for preservation of the digital information. Adequate funding, planning and management expertise coupled with good maintenance culture are imperative towards the successful implementation and operation of the digital library in Nigeria.

6.2 Network Connectivity

Digital libraries run on network. To a large extent, the existence of a university WAN, LAN and Internet connection within the library determines the success of digital library services. This is a major challenge to many university libraries in Nigeria. There is no reliable WAN/LAN and Internet connection in most universities. This makes internal and external information access and sharing difficult.

6.3 Power Supply

The success of digital library cannot be assured without the use of communication and technological tools which cannot function without electricity. Regular power generation remains a problem in Nigeria. Most libraries experience epileptic power supply and the cost

of running generation plants is prohibitive. This hampers effective functioning of digital libraries.

6.4 Lack of Technological Infrastructure

Building and sustaining a virtual library requires the proper technological infrastructure which include telecommunication, servers, application platforms and software applications (Gbaje, 2007).

Sophisticated information and communication technology is essential to make information resources accessible globally. The requires provision of virtual library service, which require extensive computerization, networking and digitization (Salawu, 2010b). this adversely limits creating and running a digital library.

6.5 Digitization of Analog Materials

In order to build a comprehensive resource, library materials in analog form (e.g. books, journals, sound recording, manuscripts, photographs) must be converted. The technology for digital conversion is, at best, emergent and often forces a library to choose between risking damage to precious originals or producing the highest quality reproduction. The quality of digital materials is often reduced after digitization. There is a need for more sophisticated support equipment for capturing exact quality of materials.

6.6 Ineffective Search Interfaces

Multiple interfaces to information resources make searching in digital libraries difficult. Core administrative service like naming convention and access control can simplify integration by reducing and standardizing the interfaces between disparate information repositories, but can themselves be difficult to build and control.

6.7 Interoperability

Libraries distributed across the country are supposed to be assembled into a virtual unity. This will enable information to be shared. For this to be achieved, standards and protocols are required. The type of standards need to be determined , for example, whether to use Z39.50 , that is, distributed search, or indexing search, the approach used in search engine. Also, the metadata schemes need to be determined.

6.8 Copyright Issue/Access Restriction

Copyright is a major issue in digital libraries. Information placed on the digital libraries is not considered to be public simply because it is available worldwide; so it is not free for anyone to download, copy or use. There are restrictions, which vary from vendor to vendor, on how the information can be used. This constraints accessibility to information in digital libraries.

6.9 Information Security

Digital library as an Internet based system is faced with the problems of information insecurity . Internet-based system are characterized by "openness, dynamism, connectivity and hostility" (jacobsson, 2008). Virus attacks are a common occurrence in digital libraries. Most licensed antivirus are expensive and most libraries cannot afford them while free antivirus are not powerful enough to guard digital library system effectively.

6.10 Lack of Suitable Personnel/Technical Support

Running a digital library requires the knowledge, skills, and abilities of people well versed in difference disciplines. Building a successful library require first and foremost a librarian for selecting , organizing and managing information in the library. In setting up a virtual library, a network expert or computer engineer is needed to set up the network.

In text conversion, low-level personnel is required for typing and scanning materials. A computer scientist is required to undertake quality assurance and may double as web master to update the content to web pages according to management guidelines. These personnel are hard to come by.

Also the more computers and technology tools that are used in the digital library , the greater the need for good technical support. Such technical support is not readily available. There have been many cases of system being donated to libraries without a follow-up care or support. The first time the systems break down could be the end of their usage because there is no well-trained personnel to repair them.

7. Digital Library Prospects in Nigeria

The main prospects of digital libraries are to provide resources and services beyond the library's physical boundaries and ensuring that users can readily take advantage of the library services from anywhere and at any time. The digital library provides the following prospects for libraries in Nigeria.

7.1   E-Learning Services

Online education and electronic reference service are the important ingredients of digital library. Some universities provide distance learning opportunity to their students. The student who study or conduct research within or why away from physical campuses can use the library facility and resources anywhere, anytime as required (Sarwat, 2006).

Digital libraries provide help services such as electronic helpdesk that enable users interact with librarians and obtain answers to their question and also obtain help on how to use or access resources. The digital library can also offer electronic document delivery of scanned item from print collection (Brophy et al. 2002).

7.2 Subject- Specific User Support Center

Digital library offers the library opportunity to create user support center in specific disciplines. The center consists of sections manned by librarians in specific subject areas. Each expert supports a user group. User phone in or send e-mail with problems they encounter. Each call or mail gets routed to an appropriate expert. Each expert librarian keeps logs of all actions taken. These logs are collected in a database available to all librarian in the library and other support librarians world-wide, who may be consulted for expert advice in case of any difficulty that cannot be handled internally. Digital libraries also provide Selective Dissemination of Information(SDI) and Online bibliographic Service(OBS) to users anywhere and at any time.

7.3 Storage Conservation

Digital libraries store much more information on account of the fact that it requires very little space to store the digital content. From the economic perspective, the cost of maintaining a digital library is much lower, thereby decreasing the library budget. The cost of paying for staff , buying books, erecting a library building or renting one makes the cost of running a traditional library very high.

7.4 Enhanced Library Cooperation

Digital library enables group of university libraries to come under an agreement and permit access to their subscribed e-books or e-journals to other members of the group. In this way ,they can save a lot of money and get benefit of the library cooperation. The library also permits information sharing among cooperating libraries.

7.5 Global Access to Library Materials

With a digital library, access to information is no longer restricted to local contents of individual libraries. A digital library provides global access to information and to many users at a time-independent of their location.

7.6 Enhanced Searching for the user

Digital library offer improved access to information resources by using search and retrieval facilities (Chowdhury and Chowdhary, 2004). One –step search interface is being provide, where user can search many information repositories from a single search interface. This reduces the time and effort users spend in searching for information using conventional search engines.

Conclusion and Recommendations

The pace of change in digital library development and use in Nigeria has accelerated tremendously. Nigeria digital libraries have shifted from delivering digital contents in CD ROMs to delivering contents online and then to delivering external online resources such as e-books, e-journals and providing access to open access e-resources.

Digital libraries still face significant challenges such as insufficient funding, poor power supply. Inadequate technological infrastructure, poor network connectivity, digitization problems, copyright restrictions and inefficient search interface.

It is recommended that the government should see the need for digital libraries in Nigeria and give adequate sponsorship for the development and use of the library power supply should be addressed as a matter of urgency, Digital library interfaces should be designed to provide ease of access to information in digital libraries. The library should subscribe for fee-based resources on behalf users so as to offer unrestricted access to digital library information.

Digital information offer great prospect in Nigeria. The digital library can be integrated into the learning environment to provide academic community seamless access to local and global information giving the user one-step access to information. Digital libraries conserve storage space and enhance cooperation in online environment.

The library discipline is highly collaborative and has a need for sharing resources. This has not been possible in Nigeria due to data inconsistency of differences in data format which makes sharing difficult. It is recommended that the next generation of digital development and deployment should focus on standardization, providing greater usability for library users, and increased interoperability among digital collections, and more cost-effective choices for institutions just beginning digitization programs.

Course management system providers, textbook publishers and library management should work together as more texts are published electronically. In future, digital libraries should not only provide information resources for teaching and learning, but should support e-learning by creating and managing e-resources and be embedded into "campus e-learning and administrative system to provide a one-stop virtual campus "(pasquinelli, 2002).

References

1. Borges J L (1964), "The library of Babel, Selected Stories and Other Writing" , New Direction, pp. 51-58, New York.
2. Bradley Phil (2002), " What is a Virtual Library" , Internet Power Searching The Advanced Manual, p. 118, Neal-Schuman Publishers, Inc., New York.
3. Brophy p, Fisher S and Clarke Z (Eds.) (2002), Libraries Without Walls; The Delivery of Library Services to Distant Users, Facet Publishing, London.

4. Bush V (1945). "As We May Think", Atlantic Monthly , July, pp. 101-108.

5. Candela L, Castelli D, Ferro N et al. (2007), "The DELOS Digital library Reference Model, Foundation for Digital Libraries, Version 0.98", available at http://www.delos.info/files/pdf/Reference Model/DELOS_DLReferenceModel_0.98.pdf

6. Chowdhury G G and Chowdhury S (2004), Introduction to digital Libraries,p. 307, Facet Publishing London.

7. Cleveland Gary (1998), "Digital Libraries: Definition , Issues and Challenges", UDT Core Programme #8,,available at http://ifla.queenslibrary.org/V1/5/op/udtop8/udt.op8.pdf

8. Daniel J O (2002), "virtual Libraries for Nigerian Libraries", Nigeria Magazine, vol, 36, No. 2, p.56.

9. Etim F E (2006), "Resource Sharing in the Digital Age: Prospects and Problems in African Universities", Library Philosophy and Practice, Vol. 9, No. 1.

10. Fabunmi B A (2009), "Challenges and Prospects of Virtual Libraries in Universities in Nigeria", European Journal of Scientific Research, available at http://www.eurojounals.com/ejsr.htm

11. Foo S and Theng Y L (Eds.) (2004), " A Snapshot of Digital Library Development: the Way Forward in the Asia Pacific, Design", available at http://www/ntu.edu.sg/home/assfoo/publications/2004/2004chap20-foo-theng fmt.pdf pl

12. Gbaje E S (2007). "Challenges of Implementing Virtual Library for Higher Institutions in Nigeria ", in Nigerian Libraries for the Future: Progress Development and Partnership: Compendium of Papers Presented at the 45th Annual National Conference and AGM of the Nigeria Library Association at Uyo, September 9-14,pp .52-58.

13. Green David (2005), " Proposed Operations of a Virtual Library", Environmental and Information Science, Charles Stuart University. Albury NSW 2460, Australia.

14. Greenlaw Raymond and Hepp Ellen (2000). "Newsgroups and mailing Lists", In-Line/On-Line: Fundamentals of the Internet and the Word Wide Web, p, 350, McGraw-Hill, Boston.

15. Jacobsson Andreas (2008), " Privacy and Security in Internet-Based Information System", Blekinge Institute of Technology, Doctoral Dissertation Series No. 2008:02.

16. Jayaprakash A and Venkatramana R (2006), "The Role of Digital Libraries in E-Learning, DRTC Conference on ICT for Digital Learning Environment" january 11-13, DRTC Bangalore.

17. Licklider J C R (1960)," Man-Computer Symbiosis", IRE Trans. Human Factors in Electronics, HPE, Vol. 1 pp.4-11.

18. Magnussen Amanda (2003)," Creating Digital Libraries. A Model for Digital Libraries Development", 10th Asia Pacific Special Health and Law Librarians Conference, Angust 24-27, Adelaide.

19. Nok G (2006)," The Challenges of Computerising a University Library in Nigeria: The Case of Kashim Ibrahim Library, Ahmadu Bello University, Zaria", Library Philosophy and Practice, Vol. 8, No. 2.

20. Ogunsola L A and Okusaga T O (2006)," Development Countries and the Need for Virtual Libraries: Problems and Prospects ", journal of social Sciences , Vol. 13. No. 3, pp. 221-229.

21. Pasquinelli Art (2002)," Future Directions ", Library Technology Trends, Sun Microsystem Inc., p.35, available at http://www.ncsi.iisc.ernet.in/raja/is214/is214-2005-01-04/digital_library_trends_020923.pdf

22. Raghunath pandey and M N Velayudhan Pillai (2011), Digital Library: Trends and Prospects , Jnanada Prakashan (Ed.) available at http://www.bagchee.com/en/book/view/66354/digital_library_trends_prospects.htm

23. Riccio Holly M (2001), "Problems and Prospects of Digital Library : Past , Present and Future", available at http://www.llrx.com/features/virtuallibrary.htm

24. Sarwat M R (2006),"Problem and Prospects of Digital Library and Library Digitization in Bangladesh ', Institute of Higher Education 4th Convention PLANNER 2006, November 9-10. P. 106, Mizoram Univ. Aizawal.

25. Salawu B A (2010a) ,"the Virtual Library ; Considerations for its Implementation in Nigerian Libraries ", Continental j. Information Technology, Vol. 4, pp. 65-77 available at http://www.wiloludjournal.com

26. Salawu B A (2010b) , " Issue and Challenges in the Creation of institutional Repositories with Local Content: Critical Reflections" , Information, Society and Justice, Vol. 3, No. 1, p. 66.

27. Tebbetts D R (1999)," Building the Digital Library Infrastructure: A primer", Journal, of Library Administration, Vol. 26, Nos. 3 & 4, p. 6.

28. Well H G (1937), " World Brain : The Idea of a permanent Word Encyclopaedia", available at https://sherlock.ischool.berkeley.edu/wells/world_brain.html