

Web-Mapping Innovations in Teaching and Research

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One of the most spectacular areas of growth in recent years in the general field of geospatial technologies is the discovery by the most prominent companies in the Internet search and portal services sector, such as Yahoo, Google and Microsoft, of live and interactive mapping. The current generation of 'live' Internet maps is substantially more useful than the earlier generation of static graphic mapping such as MapBlast and MapQuest (<http://www.mapquest.com>), which relied on static image mapping in contrast to the substantially more interactive approach pioneered by Google. The Google approach is technically known as Asynchronous Java Script And XML (AJAX) (Garrett, 2005) and it heralds the dawning of a new era in Internet mapping and Internet map and location-based services. Google Maps (<http://maps.google.com>) which was released in February of this year and Google Earth (<http://earth.google.com>) which was released as recently as June were substantially facilitated by Google's acquisition of Keyhole technologies which opened the possibility for using geography as a fundamental organizational principle of information for the entire World Wide Web. The rapidity with which new web mapping applications built upon AJAX foundations have been taken up is quite astonishing.

Microsoft followed Google's lead by acquiring MapBlast and introducing their MSN Virtual Earth (<http://virtualearth.msn.com>) application in July this year. Yahoo Maps (<http://maps.yahoo.com>) was somewhat earlier on the scene in 2004 with their SmartView application that enables users to extract useful information from static maps. In addition to the release of these new map tools, Google and Microsoft have released application programming interfaces (APIs) to their products (Google on June 30th this year) to allow the world-wide community of developers to build applications that add value to the initial products by creating useful third party tools.

However, none of these 'new' technologies are in fact revolutionary since they represent more of a transitional evolution in development and deployment from the earlier web mapping technologies. It is evident that the new generation AJAX-based web mapping approaches have rapidly jumped past the 'mainstream' geographic information system (GIS)-based map servers, such as ESRI's Arc Internet Map Server (IMS), MapInfo's MapXtreme and Intergraph's GeoMedia WebMap. While these products have relatively large constituencies world-wide and are deployed in a large number of contexts, they are evolutions

of older approaches to web mapping where a user's interactions with maps require a complete refresh of the corresponding web page, both for web map services and web features services delivery. In contrast, an AJAX-based approach to web mapping offers key performance advantages that will likely see it supplant the client-server communication and full page refresh approaches used by the mainstream commercial products.

At the University of Waterloo we have recognized the importance of introducing students in the GIS course stream to the role of the web and web mapping to better prepare them for the increasing deployment of these technologies in the workplace. This recognition first saw the introduction of lab work in the 4th year course 'Management Issues in GIS' to allow students to build a web map server application, launch a series of data layers and code and attach metadata for on-line browsing. This initial foray into web mapping has since been extended by the introduction of a new course at the fourth year level that focuses exclusively on web mapping. This course has focused to date on the use of ArcIMS software, however it is clear that the web mapping industry is much bigger, more advanced and substantially more diverse than ArcIMS alone. In order to expand the possibilities for extending student knowledge and applying web mapping services, especially in the area of public participation GIS, initial advances were made to a Canadian owned company, Kheops Technologies (<http://www.kheops-tech.com>), located in Montreal and developers of a pure Java web mapping tool named JMap. In February of this year, a site license agreement was made with Kheops to deploy JMap in teaching and research within the Faculty of Environmental Studies. This agreement was intended to cement a relationship with a relatively small Canadian company to explore the use of their software and extensions to it, developed through access to and use of its software development kernel (SDK), for use in distributed web-based decision processes.

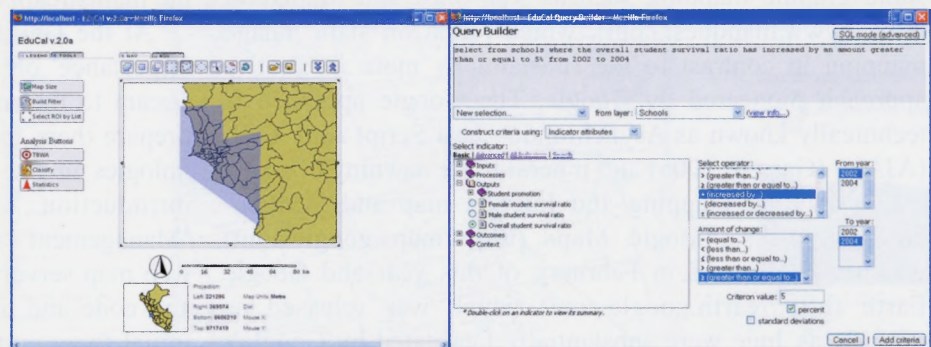
To date experimentation in a research project funded by the GEOIDE (GEOmatics for Informed DEcisions) National Centres of Excellence program at Waterloo has developed a prototype tool with JMap that allows participants in a decision process to participate in synchronous on-line chat while working through the JMap interface on a decision problem. JMap is a proprietary tool and, as such, development of software extensions within the software has various constraints as far as intellectual property is

concerned. In the interests of open development and distribution of source code between developers, we have also formed a strategic relationship with other Canadian companies involved in the burgeoning web mapping sector. In this context, the DM Solutions Group Inc. (<http://dmsolutions.ca>), based in Ottawa, is a strategic partner in the GEOIDE National Centres of Excellence.

Work underway at Waterloo over the past two years has focused on extensive use of MapServer, an open source web map server developed originally at the University of Minnesota. The DM Solutions Group has fulfilled primary coordination and development of MapServer over the past several years and has worked closely with other Canadian companies such as Refractions Research from Victoria, British Columbia (<http://www.refractions.net>). Refractions Research has made significant contributions to the open source web-mapping and GIS communities through the development of their PostGIS package which enables the open source PostgreSQL database to store and manipulate spatial objects (<http://www.postgresql.org>). Research-based applications using MapServer, PostGIS and PostgreSQL at Waterloo have been centred on a multi-year project based in Peru and funded by the Ford Foundation. This project has developed

EduCal, a software tool for assessing, using on-line mapping and spatial analysis via the Internet, the performance of state funded primary schools in Peru in terms of the quality of education that is delivered to students. The EduCal tool is currently undergoing substantial revision for release of a second version in April of 2006.

EduCal 2 uses the Chameleon interface for MapServer with substantial reprogramming of aspects of the interface (see Figure). A description of Chameleon (<http://chameleon.maptools.org/index.shtml>) can be found at the Maptools web site (<http://www.maptools.org>). EduCal 2 uses AJAX programming and allows users to perform basic data mining of a multi-dimensional education database that includes spatial, attribute and time series education data that are assembled at the individual school level.



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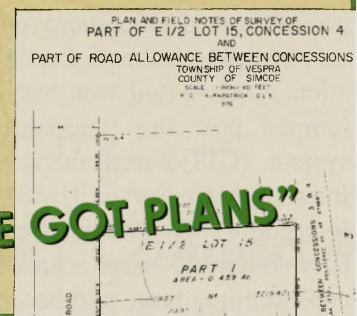
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In addition to the EduCal project, research is underway to re-implement the synchronous on-line chat tool (MapChat) prototyped in JMap within a MapServer Chameleon environment. This tool is currently in the early alpha stages of development. Its intention is to allow decision participants (either individuals and/or groups) to communicate with each other on-line when working on a common decision problem using spatial data. In addition to facilitating chat between users, spatial objects can be attached to messages and researchers can explore the content of a decision conversation stream between participants in order to identify points of agreement and disagreement in crafting a 'position' on a decision problem. This will allow commonalities to be established and used as a basis for seeking consensus between users.

Perhaps the most significant aspect of web mapping in general and its inclusion in research and teaching at Waterloo is the commitment to following the open source initiative for the newer generation tools that are appearing. While Google Maps and Virtual Earth are not strictly open source in the conventional sense of the word, they do provide developers with APIs. This access to programming extensions for applications combined with the willingness of companies such as Kheops to provide their SDK has allowed graduate researchers to experiment with the latest technologies to facilitate application development within a Canadian university environment. Canadian companies such as the DM Solutions Group Inc. and Refrations Research work exclusively within the open source geospatial community. Here code is not limited to API level interaction with a tool, but rather the entire source code is posted to the Internet and made available for other developers and is typically subject to the one of the forms of licensing approved by the Open Source Initiative (OSI) (<http://www.opensource.org/licenses/index.php>). The most common of these is the GNU General Public License or the GNU Lesser General Public License that is available from the OSI licensing URL noted above. The condition with most forms of open source licensing are designed to guarantee the freedom of software sharing and change for all users, although some licenses are somewhat more restrictive in what is permitted than others.

In accordance with the speed of change that characterizes web mapping technologies, on November 28th this year (i.e. only several days prior to writing this article) the formation of a new foundation, namely the MapServer Foundation (<http://www.mapserverfoundation.org>), was announced on the Internet. This announcement has a number of implications for the open source mapping communities within all sectors (universities, government at all levels and the private sector). Specifically, it heralds the insertion of Autodesk Inc. (developers of AutoCAD and the associate family of computer assisted design and 3D modeling products) into the open source geospatial community in conjunction with MapServer and several of the key

members of the MapServer community (including the DM Solutions Group). Previously, Autodesk had been a relatively minor player in the web-based geospatial community with their MapGuide product, but have clearly harboured long-standing aspirations to become more heavily involved.

The formation of this new foundation has several implications. First, it will split development of MapServer into two complementary platforms named MapServer Cheetah and MapServer Enterprise. The former will retain its connection with the original University of Minnesota MapServer platform, which continues to be reputedly the world's leading open source mapping platform with approximately 10,000 downloads (note that downloads do not necessarily translate closely into deployments) per month (Autodesk, 2005). In contrast, the latter platform will be based on source code donated to the foundation by Autodesk. Based on information provided from GISUser.com, the enterprise edition will work with PHP, .NET and Java code. Moreover, Autodesk will make available its feature data objects code, which provides application developers with an interface to connect to a number of environments including ESRI's ArcSDE, ODBC connections and MySQL. It is noted also that Autodesk plans to market a commercial version of this platform to be named Autodesk MapServer Enterprise Edition in 2006 and the connections between this and the open source counterpart are, as yet, somewhat unclear.

The impact of this announcement remains to be seen within the context of web mapping in general and within the open source web mapping community in general. Its impact on developments that relate to use of web mapping in the teaching and research activities at the University of Waterloo are likely to be minor in the short term, with a wait-and-see attitude prevailing. One thing is clear and this is that web mapping is likely to continue its accelerated growth path. The incursion of Autodesk into the open source world may force the hand of some of the other major companies within the geospatial community to make their APIs more open and easier to work with than they are. However, it is too soon to be able to state with any certainty what impact this will have.

It is clear, however, that the Internet, the World Wide Web and Internet mapping are here to stay for the foreseeable future. Users of geospatial data who need to make use of rapid conveyance mechanisms between field collection of data and end users are likely to turn increasingly to the web and the Internet as the medium to facilitate the carriage of data and packaged with end user applications. This need is particularly important within the land surveying world and also within municipalities that have the mandate to make geospatial data available to local residents for querying and reporting purposes. Moreover, many businesses and governments are deploying web-based mapping to attract business investment and to direct consumers to points of interest within urban and rural space. To

contribute to this growing deployment it is no longer optional for Canadian Universities to teach only conventional GIS software use and techniques. Rather, a spirit of innovation both in teaching programs and especially in research projects such as those noted above is mandatory within today's rapidly changing landscape.



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Sites to See

<http://local.live.com>

Microsoft has renamed and upgraded its online mapping service, MSN Virtual Earth beta: it is now called Windows Live Local powered by Virtual Earth beta and includes bird's-eye view imagery from Pictometry International Corp. Covering about 25 percent of the U.S. by population, these bird's-eye images are captured by Pictometry via low-flying airplanes and then integrated with road and satellite maps to simulate 360-degree panoramas that can be viewed from four compass directions. On-screen navigational tools and preview tiles enable navigation between directional views or zooming in closer to a destination. The new Windows Live Local service also gives users new ways to identify where they want to go and map the best route to get there. Users will be able to point to any place on the map that interests them and immediately calculate directions to it. Over the next couple of years, Microsoft plans to continuously update bird's-eye, aerial, and road map data and imagery as well as local listings and information.

Microsoft Launches Windows Live Local