cartographic techniques

"UO Campus Mapping Program: Integrating CAD, GIS, and Map Publishing"

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Introduction

The University of Oregon Department of Geography's InfoGraphics Lab coordinates the UO's Campus Mapping Program for several offices on campus (Figure 1). The Campus Mapping Program consists of three main components, 1) Computer Aided Design (CAD) drawings of building floorplans, 2) campus Geographic Information Systems (GIS) mapping layers, and 3) graphic illustration map publishing files (Figure 2). Maintaining and integrating these various program components creates many challenges and opportunities. This paper will cover the design and implementation of a comprehensive campus mapping model that addresses multidisciplinary needs, administration issues, cross-campus coordination, and CAD / GIS / Graphic software and database integration.

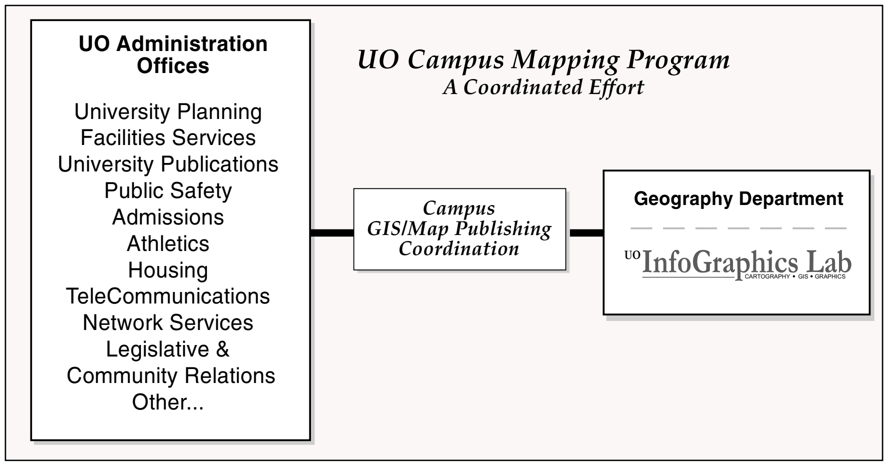

Figure 1. Campus mapping program participants.

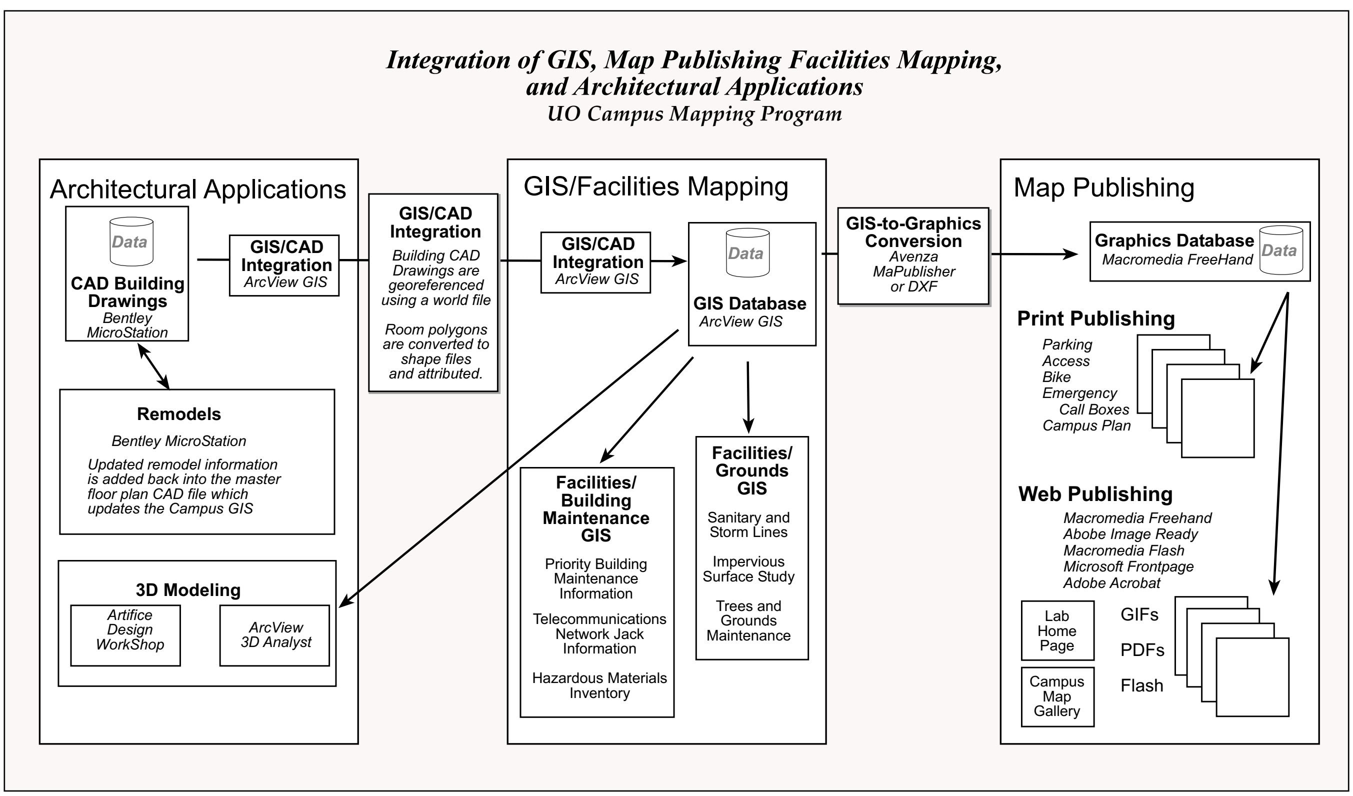

Figure 2. Integration of GIS, CAD, and graphics databases and applications.

Background

The current campus mapping effort was started in 1986. At that time, the University Planner contracted to have aerial photographs taken and a set of planimetric map panels created by a local photogrammetry firm. The resulting products were a set of Mylar 1:600 scale map panels with the original Intergraph IGDS design files. In 1988 the Geography Department acquired a new Intergraph Unix workstation with MicroStation CAD software. This gave the University of Oregon the ability to read and modify the campus CAD files. The panels were mosaicked together to create a new campus base map. Up until that time an ink-on-Mylar map had served the facility mapping needs.

The mapping program has grown in number of users, maps, applications and the size of the mapping databases. There has been an evolution from primarily CAD mapping to include graphic illustration cartography using Macromedia FreeHand and the implementation of Environmental Systems Research Institute (ESRI) ArcView GIS. These changes have been driven by a bottom-up approach of striving to understand and address changing map user needs and then applying new mapping methods and technologies to solve those needs. The program has grown from the single Unix Workstation in the Geography Department to include dozens of PC's and Mac's running CAD, GIS and graphic illustration programs spread across campus. In addition there are great numbers of users accessing the campus maps published on the web. The challenge is to smoothly integrate these systems and maintain the currency of the mapping files.

Multidisciplinary Approach

Creating an accurate and up-to-date spatial framework for campus information that can serve many university community needs is one of the main objectives of the mapping program. The multi-disciplinary needs vary greatly from architects using CAD to design remodels, to facility managers using GIS to inventory utilities and building maintenance information, to the University Publications Office needing high quality cartographic products in graphic illustration software for brochures and web pages. (Figure 1).

Administrative Issues

The UO InfoGraphics Lab housed in the Geography Department serves as the coordinator for this program. This program has created a mutually beneficial bridge between an academic research facility and the administrative offices charged with the management of the campus. The InfoGraphics Lab is a great position to assist campus offices with the implementation of new mapping technologies, helping them fulfill their missions more efficiently. Being able to serve the UO Campus also has many rewards for InfoGraphics Lab's research staff and student assistants in they are able to apply new GIS methodologies and mapping technologies right here on campus.

The funding of this program has been primarily through a "Campus Mapping Consortium." The University Planning Office is the founding member and provides guidance in establishing the concept of a mapping consortium. Each member provides an annual funding amount that reflects their use of and commitment to the campus mapping database and its development and derived map products. Part of the consortium concept is the development of an accurate common mapping database that serves as a vehicle to help bring the diverse working arms of the campus together. This works partly because the members become users and contributors to the system. A common mapping database facilitates more efficient data sharing among the member offices and other campus users. The semi-regular funding helps establish stability for the continued progression and maintenance of the program.

Software and Database **Integration**

Integration of CAD, GIS and graphic illustration software is central to the mapping program, because one software application does not fulfill the diverse mapping needs on campus. The use of CAD software for the architectural design, GIS for facilities management and graphic illustration software for publishing creates a need to for a mapping program that can efficiently move and integrate mapping databases between software applications.

Architectural Applications

The *Architectural Applications* consist of the development of a CAD database of buildings with floor plans and interior features. The CAD building floorplan drawings are created by the Facilities Services using Bentley MicroStation software. The building drawings rely on the source information of architectural construction and existing condition drawings. These drawing files are generated in a local coordinate system in the CAD file with the design unit of inches. The building floor plan drawings are used for remodels and various architectural and space planning needs.

The CAD files are integrated with the ArcView GIS database by georeferencing the building drawings with the campus map coordinate system (Figure 3). The first step in registering the building drawings is to shift the buildings within the CAD file so they are in their correct relative position to other cam-

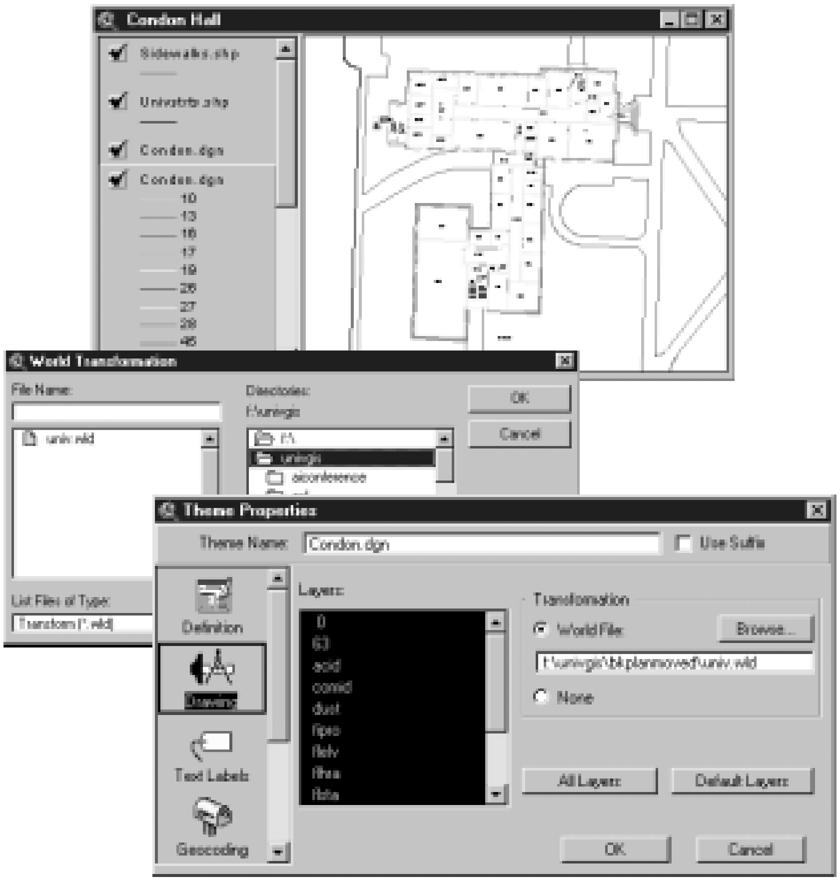

Figure 3. CAD/GIS Integration. Condon Hall first floor plan georeferenced with world file and added into campus GIS ArcView project.

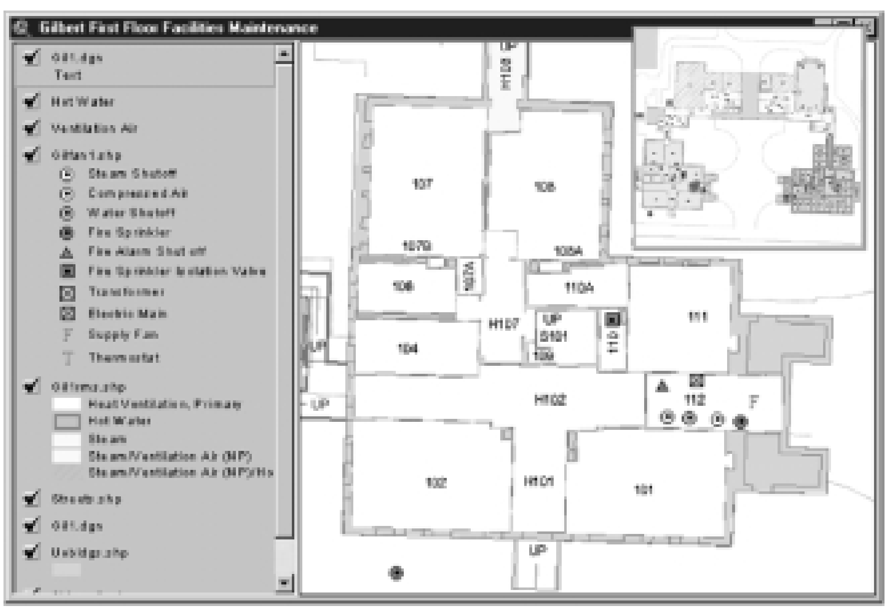

Figure 4. Building maintenance facilities mapping/GIS application: tracking of priority building information.

pus buildings. Having the buildings in their relative location to each other allows for use of a single common university "world file". In ArcView when the CAD drawing is added to a "view" the user can select the university world file from the "theme properties-drawing menu." The world file contains information for the coordinate offset, scale, and rotation to transform the CAD drawing into the campus GIS projection. The world file format is: <X,Y location in CAD drawing> <space> <X,Y location in geographic space>. The ArcView GIS online help has a good explanation of how to create a world file.

A layer within the CAD file is defined for room outline polygons. In ArcView the CAD file is added and the level with the room polygons is selected and converted to a shape file and attributes are added. The other layers in the CAD file are not converted as they are used only as a visual reference with the GIS themes.

GIS/Facilities Mapping

The *GIS/Facilities Mapping* area can be divided into two main categories: building maintenance and grounds maintenance. The building maintenance applications track a variety of maintenance and infrastructure information down to the room level (Figure 4). The grounds maintenance applications track campus-wide information on several themes including trees (Figure 5), storm lines, and sanitary lines. The GIS database contains base layers of building footprints, sidewalks, roads, hydrography, topography, and other base features. The GIS database is stored in an ArcView GIS shapefile format. The map projection is the same as local city and county government GIS mapping systems (Oregon State Plane South Lambert projection). Having a common projection is beneficial in exchanging facility, and planning GIS data layers with the city and county. This has been especially useful in making county zoning and city utility ESRI Arc/Info coverages available to university facility managers and planners.

A web-based GIS application is being planned and investigated potentially using either ESRI ArcIMS, Intergraph GeoMedia Web Map or another similar type application to serve the GIS campus layers on the internet.

Map Publishing

The *Map Publishing* part of the program relies primarily on FreeHand 8 for the development of many products for print and for the web. A series of FreeHand map files have been created for a variety of regular publications. The series includes maps for the university catalog, class schedule, parking (Figure 6), bicycling, campus at night, and campus accessibility, among others.

The FreeHand database of graphics information relies on updates from the ArcView GIS shape files and other sources. The ArcView Shape files are converted into FreeHand using Avenza MaPublisher. MaPublisher is also useful for converting CAD data in a DXF format into FreeHand.

Using FreeHand as the main application for map publications has allowed the InfoGraphics Lab to work successfully with the graphic-oriented University Publications and Printing Services in creating high quality products. The FreeHand files allow for more graphic control when producing a variety of web graphics. The main campus web map is in a GIF format (Figure 7) and the FreeHand maps that are created for print are converted directly into an Adobe PDF (Portable Document Format) and published on the web. Converting the FreeHand map to PDF directly out of FreeHand is an export option. The building drawings are also being converted from the CAD

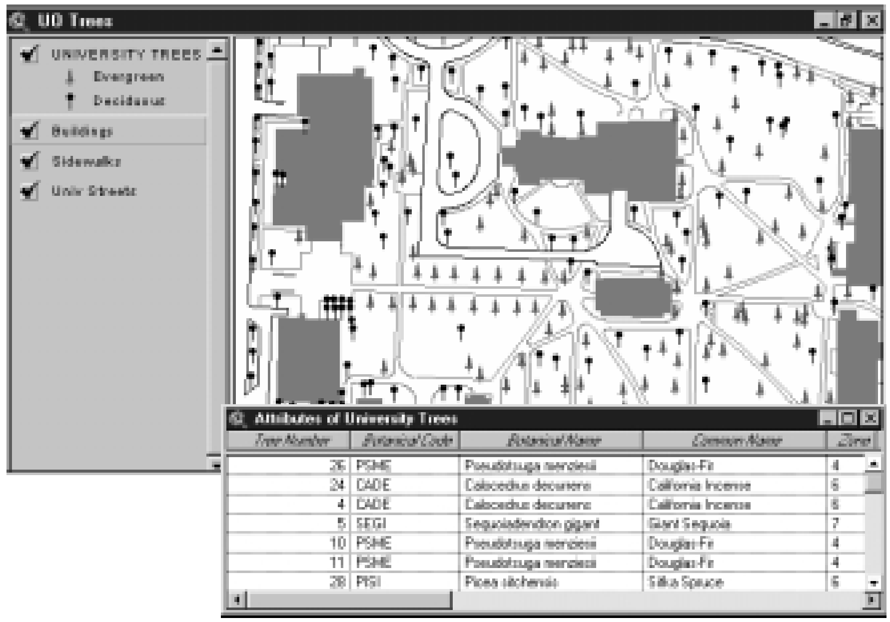

Figure 5. Grounds maintenance facilities mapping/GIS application: inventory of campus trees.

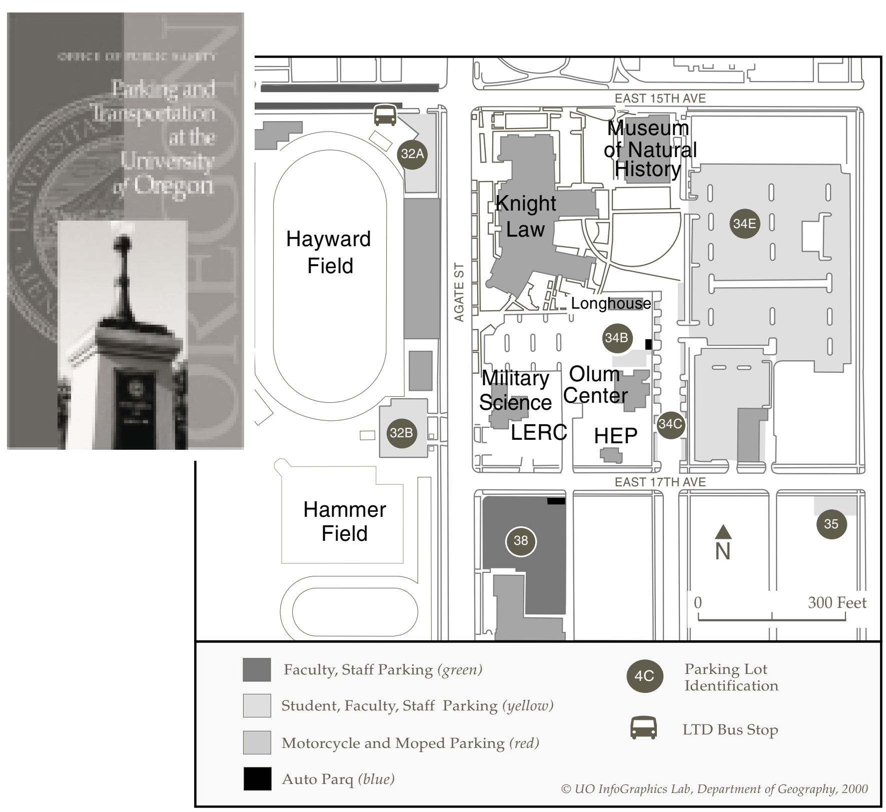

Figure 6. Portion of parking and transportation map with legend and reduced cover.

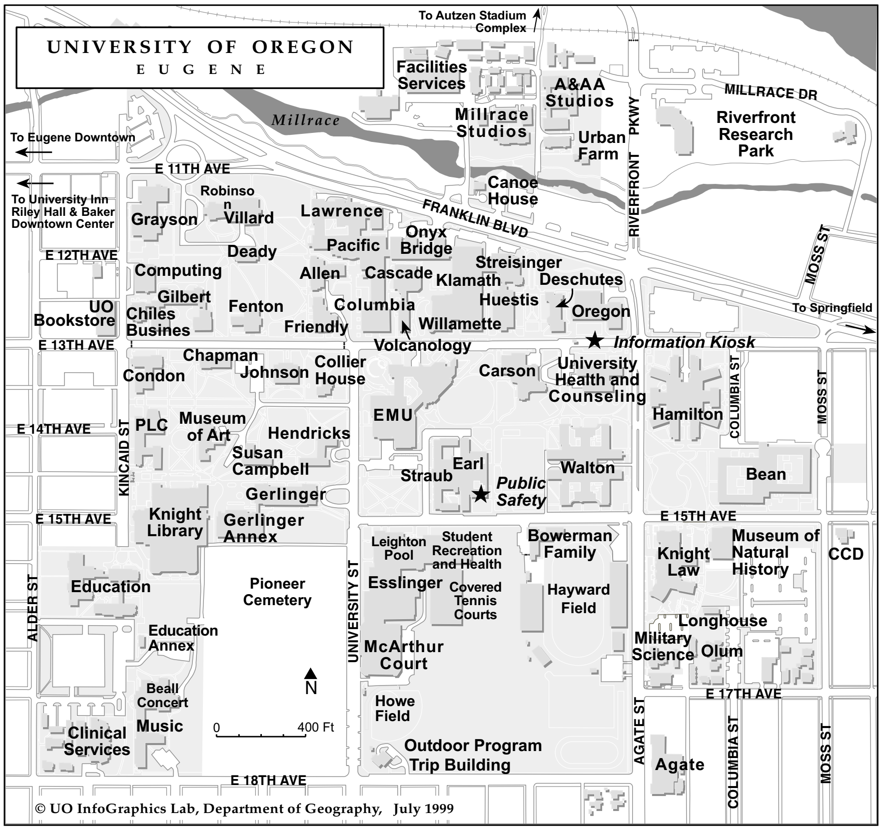

Figure 7. Main campus web map (published in GIF format).

format into a PDF for web publication.

By using a diverse number of tools and data formats we are able to solve a wide range of multi-disciplinary problems and provide better and more extensive service to the university community. We anticipate that the use of the campus map information will continue to increase and become more widespread as the web applications develop.

online mapping

Critical Success Factors when Publishing Internet Mapping Services

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The internet has changed the way cartographer's package and distribute maps. Rather than dwell upon previously well documented technical considerations of internet mapping, this paper concentrates upon the commercial and logistical factors which determine the success of an internet mapping service.

Internet Growth

The current annual rate of internet growth is estimated to be 46%[1]. This rate is driven primarily by an increasing range of access points, improved bandwidth and the growing availability of diverse content[2]. If the internet continues to expand exponentially, and is soon accessed by significant portions of the population, then the challenge for cartographers will be to deliver effective internet mapping services across this new publishing medium.

Internet Mapping Services

In the rapid transition from a paper to online medium the key needs of any map user have not altered greatly. The desire to conveniently navigate and locate places and people still exists today as it did during the previous centuries of paper based mapping.

What has altered is the technology with which we use to publish and distribute maps. Printing technology enabled cartographers to reach critical mass by making multiple copies of any one map edition[3]. Today, internet technology is enabling the re-packaging of maps and spatial information into more service based applications which have interactivity and customisation as their core function.

There are indeed many ways to segment the current range of mapping services available on the internet. The following attempts to do so across 5 broad application areas:

1. Mapping & Routing Services: Often with localisation (geocoding) functionality, used to position addresses, towns, POIs (Points of Interest) or other relevant locations (www.mapquest.com).
2. Dealer Locator Services: Published by organisations wishing to display the location of their dealer networks and thus assist customers in accessing and purchasing their goods and services (www.visa.com).
3. Directory Services: Location based mapping of directory databases such as White Pages, Yellow Pages or even classified advertising (www.whitepages.com.au).
4. City Guide Services: Online information regarding the leisure, entertainment and touristic activities of a particular town or city (www.newyork.sidewalk.com).
5. Telematic Integrated Services: Real time local information (such as traffic congestion) provided using internet protocols and increasingly delivered over wireless networks (www.etaktraffic.com).

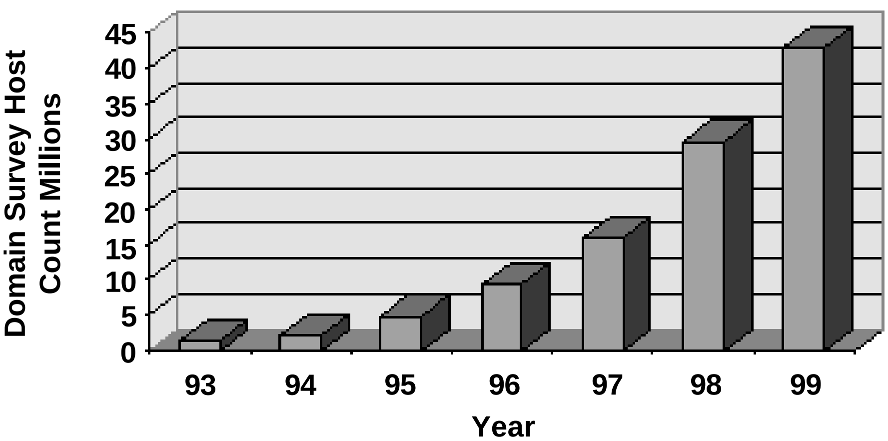

Figure 1. Annual Internet Growth Rate '93 - '99[1].

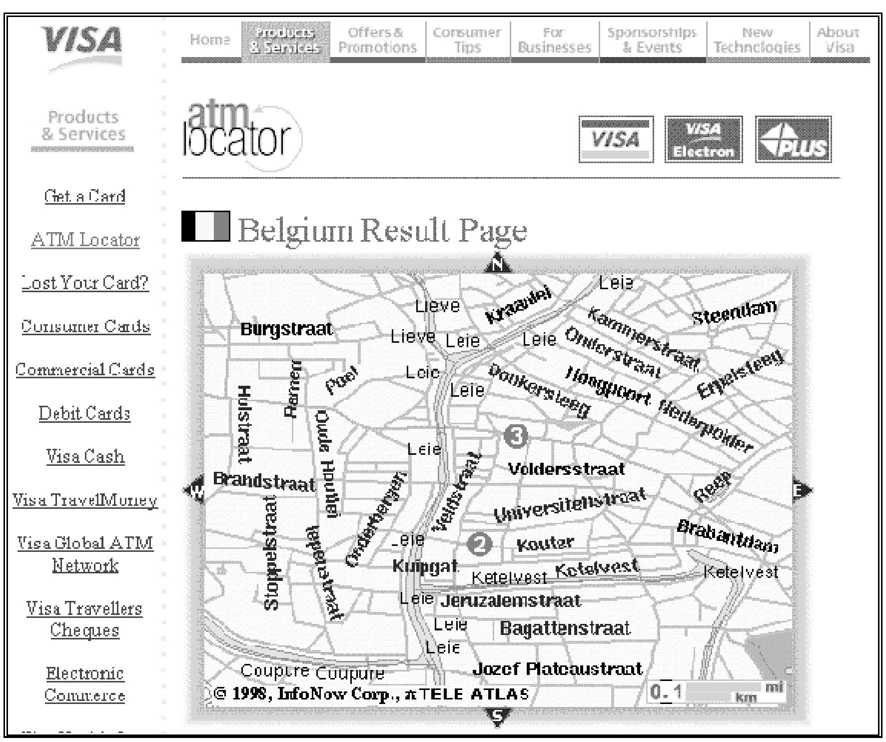

Figure 2. The VISA ATM locator service developed by InfoNow Corp. (www.visa.com).

Critical Success Factors

As with any mapping product, it is in the best interests of the internet map publisher to ensure that the user receives a more than satisfactory service. This will encourage repeat usage and hopefully enable the publisher to reach and maintain profitability. Factors which determine this are typically related to the cost and quality of the actual service.

Valued Eye Balls

The internet community represents a small, but rapidly growing, percentage of the population and as such has considerable power. This power has been used to quickly establish a marginal, if not free, expectation of the cost of any internet offering.

However, many users fail to realise that although they believe they are receiving a genuinely free service that they are in fact paying dearly with their time and attention rather than cash[4]. Online advertising has quickly established itself as the predominant model used to finance most web services with global advertising revenues estimated at $2.7 Billion US in 1999[5]. As such, it is in the map publishers interests to not only increase the number of users accessing their web site, often referred to in the internet world as 'eye balls', but also to lengthen the amount of time users spend accessing the site. This motive conflicts with most users desire to spend less time on the web accessing difficult to find and slow to use sites. If end users collectively desire more control over the quality of any internet based service then they must realise that this can only occur once the services receive greater funding, perhaps through more traditional payment methods. This will in turn provide sound justification for publishers to steer away from advertising as their sole source of internet revenue.

Payment after Delivery

Another unique aspect regarding the cost of any internet mapping service is that maps have to be virtually given away before they can be purchased. This has largely to do with the fact that electronic information cannot be shown without first giving it away (or portions of it). Either way, when a user pays for information (either with funds or through time) they are always paying for the last piece of information they received, not the next piece of information they are going to receive[6]. This is in complete contrast to what occurs when purchasing traditional maps and both the end users and publishers must also quickly adapt, and respect, this new online payment paradigm.

Value of Content

The cost of any internet mapping service is partly determined by the cost associated in securing content (ie digital map data, directory information, traffic information etc.). Unlike traditional cartographic publishers, who over many years were able to build and develop their own proprietary content, it is highly unlikely that publishers of electronic media will also be able to support the cost of sourcing, digitising and monitoring their own digital content. More often than not, publishers of internet mapping services will need to license the actual maps from dedicated content providers whose sole task is to develop and maintain digital mapping databases and other related information.

Regardless of whether it is the actual publisher who owns the intellectual rights, or whether the rights are held by a 3rd party, digital content providers themselves have several important issues to consider when licensing or publishing data over the internet which in turn directly effect the cost of any given service.

Unlike traditional forms of content, electronic content is not a scarce resource. For example, 10,000 un-sold maps are considered an asset because they are the last remaining titles of an expensive print edition. As such, these remaining maps are a scarce finite resource and, as basic economic principals state, will hold their value given no change in demand[7]. This is not the case for electronic information which, as a potentially infinite resource, can run the risk of not remaining scarce and therefore experience a dramatic decrease in value when distributed widely. This is a major dilemma electronic map providers face today when confronted with the massive distribution power of the internet.

Content or Context

If map content providers continue to focus upon the actual information they supply in licensing data online then they risk of running into a limited revenue stream as information approaches marginal commodity rates. Rather, content providers must study the context under which their data is distributed and used online. For example, an anxious tourist arriving in Paris without any idea of how to find a hotel will most probably pay more for this information then than prior to their arrival. It is in understanding this context, not the actual content, that providers of information will find successful models under which to license their data. More often than not, this means locking into the actual transaction which occurs when users access internet based services. Only through the establishment of transaction based licensing, or other related price models, will map content providers ensure that they also benefit from future internet growth.

Creating Friction

The main goal of any internet map publisher is to create friction[8]. The internet is a frictionless medium, owing to the fact that it takes no effort for a user to switch between sites. In fact, movement and navigating amongst different page views and hyperlinks is something that is encouraged and is one of the fundamental aspects of the world wide web.

The quality of any online service varies significantly and end users tend to remain loyal to those services from which they receive consistent results. Many believe that services will not improve until a viable commerce system, together with a range of suitable payment options, is put in place. Until such a time, maps of any real value will tend to stay with other media, such as printed publications, which have well established distribution models that support map publishers and their respective suppliers.

Quality internet mapping services can best be described as those which profit from the interactivity and multimedia opportunities implicit within electronic devices[9]. It is not simply enough to translate the all too familiar paper based product directly online. Utilising the implicit interactivity of the internet is key.

Interactive Functionality

Simple functionality, such as tools from which users can generate and email a customised route, will assist publishers in differentiating the internet service from paper. With end users now rapidly questioning the amount of time spent accessing unsatisfactory sites it will be only those few compelling services, which effectively couple mapping content with customisation and interactivity, that earn the repeat usage of a demanding map user.

Sophisticated internet solutions are now also possible which promote mobility and are expected to completely revolutionaise the way users interact with geographical information. Several European mobile phone operators are now trialing the next generation devices which utilise WAP (Wireless Application Protocols) to distribute map related services (www.webraska.com). Such technology will enable the map user to access internet mapping services while actually in the field and not restrict internet usage to the desktop.

Necessity of Brand

Making users aware of internet based services, and enabling them to easily access such services, is indeed a difficult task. Most first time users tend to locate services via major portal sites (ie www.yahoo.com). The internet is 'intangible' and often the only aspect with which a user can identify is the actual brand associated with particular services. The relationship, established between service providers and end users, must be packaged in a way that users instantly recognise and appreciate.

It is true that existing publishers over traditional mediums are able to benefit from their prior established brands when migrating to the internet. Michelin, who have a strong brand in European paper maps and travel guides, were able to benefit from their dominant consumer awareness when migrating their mapping services to the internet (www.michelin-travel.com). However, the internet also provides tremendous opportunities for new web-specific brands to quickly develop rapport. For example, MapQuest.com was a brand virtually unheard of 3 years ago and is now quickly becoming a 'household name' within the United States.

CONCLUSION

There are indeed many critical success factors that publishers must address when attempting to deliver internet mapping services. Unfortunately, many of the issues highlighted in this paper are currently unresolved, some even creating more questions than they do answers. Publishers of successful internet mapping services will be those who are quick to address

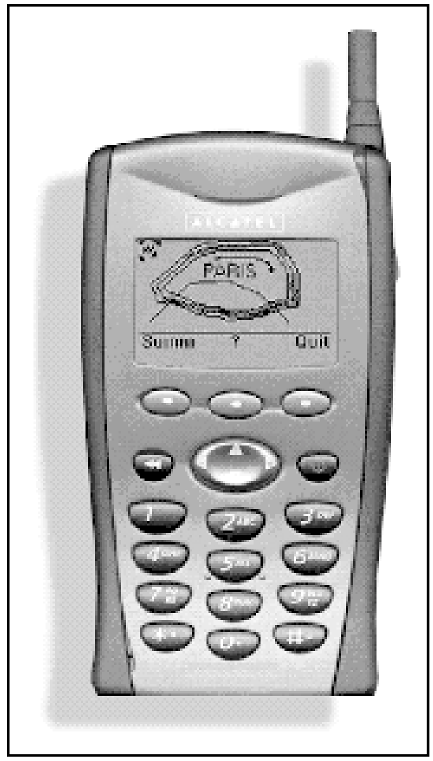

Figure 3. An example of an internet based mapping service, combined with real-time traffic information, and delivered to a WAP enabled mobile phone.

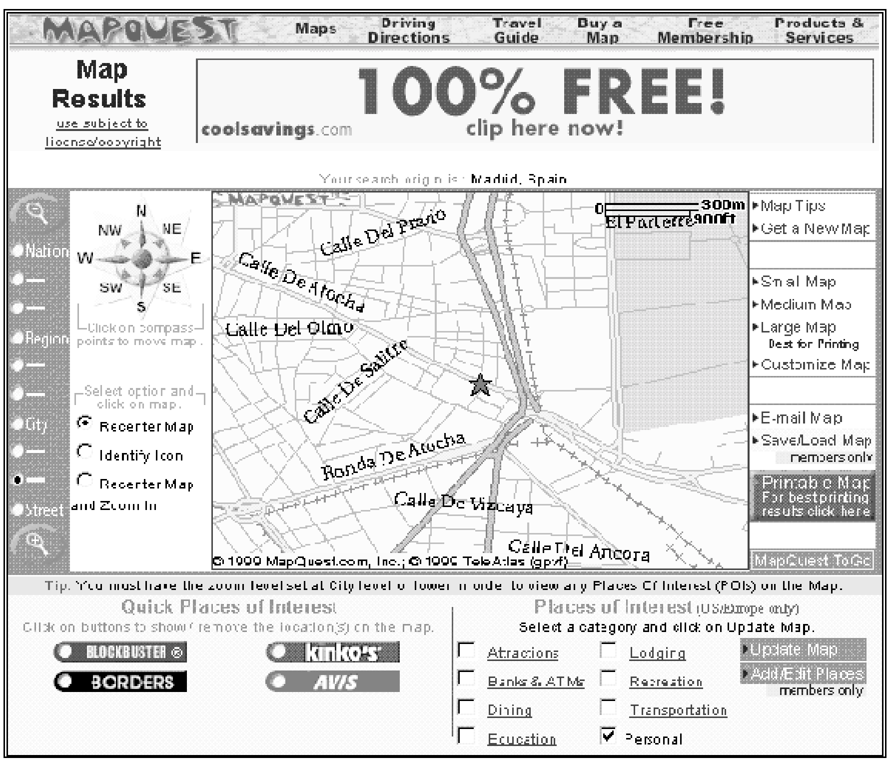

Figure 4. MapQuest.com is now an established global internet mapping brand (www.mapquest.com).

these issues and work towards appropriate solutions. Fortunately, the pace of internet growth will ensure that this occurs sooner than latter.

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Building an Atlas of Cyberspace

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What is Cyberspace and can cartographers map it? Cyberspace is the multifaceted digital space in and of computer networks. At the very heart of Cyberspace, and its golden children, the Internet and the Web, are a rich and deep foundation of spatial metaphors, both literary and visual (Adams 1997, Graham 1998). Given how deeply ingrained spatial metaphors are throughout the emerging Cyberspace, it would seem that cartographers have much to contribute in mapping out this new geography and advancing our understanding of it. Scholars in a number of disciplines have done valuable work critically examining Cyberspace through the lens of geographic space at varying scales; for example, urban planning (Graham & Marvin 1996), architecture (Mitchell 1995, Anders 1998), urban sociology (Castells 1996), and geography (Kitchin 1998, Crang et al. 1999). The field of information visualisation has emerged in the 1990s from computer science and computer graphics, and has contributed significantly to mapping Cyberspace (Card et al. 1999). Also, we should also not overlook the expertise in the graphic design community in charting Cyberspace (Jacobson 1999).

There is no one single map of Cyberspace that can show everything, just as there is no one map of the geography of a country like Britain. Instead, we compile atlases to show the complex and many fold geographies of a country. A comprehensive atlas of Britain covers all aspects - the landscape, the soil, the buildings, the roads, the people, disease, crime, wealth and poverty, rivers and rainfall. In just the same manner, an atlas of Cyberspace will contain many different kinds of maps, mapping the myriad distinct virtual spaces of Cyberspace (e.g. telephone & fax, email, web, chat rooms, multi-user games, intranets, and electronic financial flows). There are also different dimensions of the spaces to be mapped and understood (infrastructure, protocols, content and traffic). As yet, you can not buy an atlas of Cyberspace in the shops, but over the past couple of years I have attempted to construct one by combining the best maps of Cyberspace from many diverse sources. Appropriately enough the current version is available on the Web at <*http://www.cybergeography.org/atlas/*>. In the rest of this article I present five exemplars from the Atlas showing how different aspects of Cyberspace are being mapped and the diversity of cartographic forms being employed.

It is important to realise the Cyberspace is not new, it builds on decades of technological evolution in computing and telecommunications. While maps of Cyberspace have been drawn since its earliest times, for example there are the black and white line drawn maps of topological structure of ARPANET, the cold war forefather of today's Internet (figure 1). The maps were drawn for the engineers who built and managed the network and they are strictly utilitarian and functional, simply showing the nodes of the network - the advanced research labs of universities and corporations doing defence related research - and the links between them on an outline of the Continental USA. Figure 1 shows an example from October 1980, but a whole series were produced through the 1970s and 1980s from which one can trace the growth and eventual decline of the ARPANET. This map is particularly interesting for me, as it shows the satellite linkage from the US to London, installed in 1973, which connected to UCL where I now work. This wavy line on the map is significant as it represents the first wiring of the UK into the Net.

Maps like these, from the early days of wide-area networking and internetworking, are in some senses the ancient maps of Cyberspace. They are becoming important as historical documents recording the growth and spread of networks of which there is now little physical trace. For this reason they are frequently employed in books on the history of Net (e.g. Salus 1995, Hafner & Lyons 1996, Abbate 1999), after all what better means of illustrating a network that has disappeared than a map of it. For further examples, see the historical maps section of the *Atlas of Cyberspace* at <*http://www.cybergeography.org/atlas/historical.html*>.

Mapping the infrastructure - the nodes and wires - is a common representation of Cyberspace. Look around the web sites of telecommunications companies and ISPs and you will almost always find some kind of marketing map propounding the power and capacity of their network to potential customers. (Many examples are shown at <*http://www.cybergeography.org/atlas/isp_maps.html*>.) Computer scientists and network researchers who are trying to understand and better engineer the Internet also employ maps in their work. A notable example, which extends cartographic form beyond a conventional planar view of the world, was the work of Tamara Munzner and colleagues, who mapped the nodes and wires of Cyberspace in three-dimensions onto the globe (Munzner et al. 1996).

They mapped the geographic topology of part of the Internet called the MBone, visualising the links between routers as arcs traversing the Earth high in space. The result is a visually striking and powerful image of Cyberspace, in many ways matching people's popular imagination as arcs of light encircling the globe (figure 2). Their maps were created as 3d models in Virtual Reality Modelling Language (VRML) and they are available online allowing the map reader to download them, with an appropriately configured Web browser, and explore them from any position or angle.

(See <*http://oceana.nlanr.net/PlanetMulticast/*>)

Other researchers mapping Cyberspace have chosen to lose the familiar, and perhaps constraining, framework of real-world geography, latitude and longitude and country boundaries. Instead, they map Cyberspace onto abstract grids of their own choosing. One of the best recent examples of this approach are the massive and richly

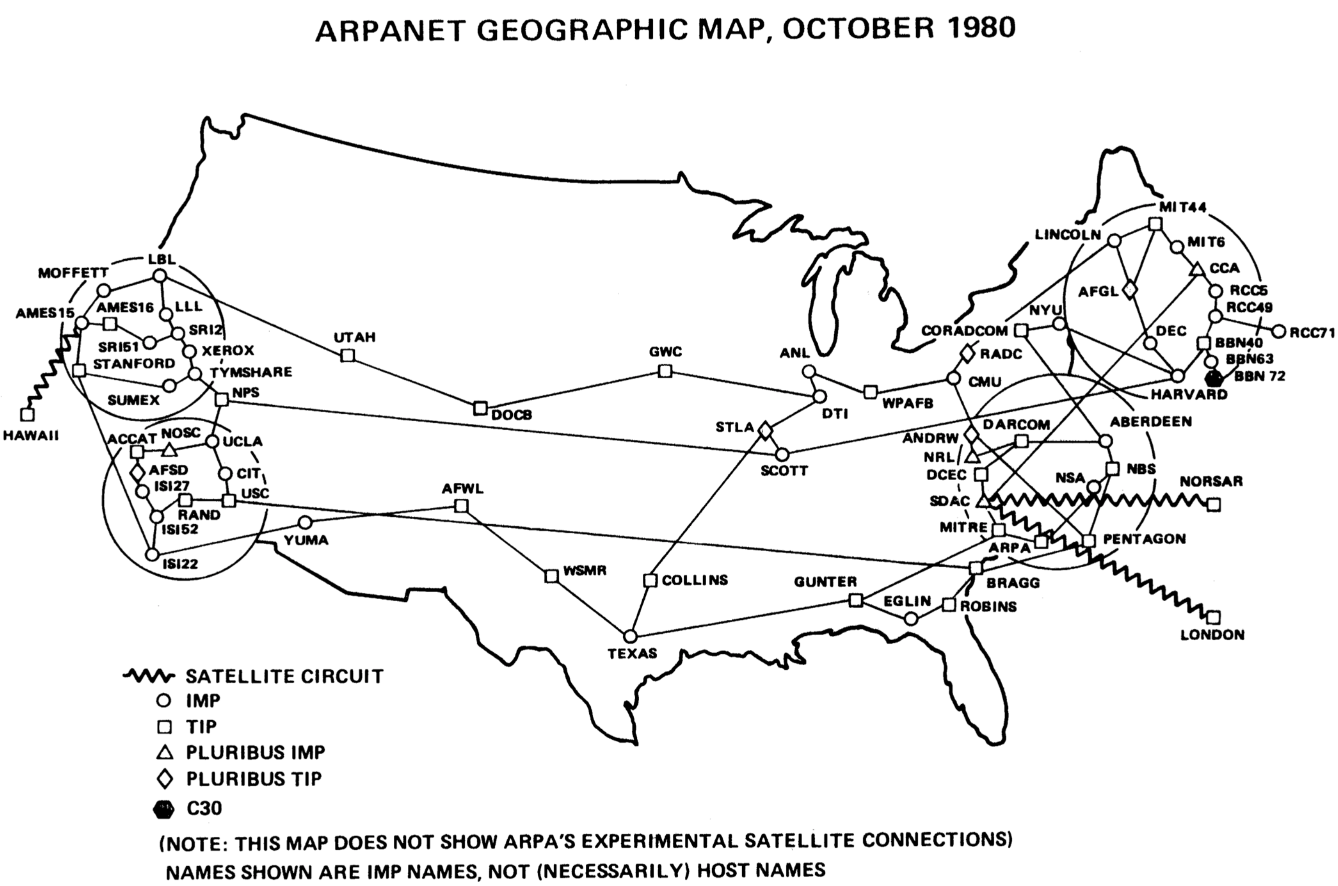

Figure 1: An arc-node style map of ARPANET in October 1980. (Source: CCR 1990, copyright: The Computer Museum, Boston, MA.)

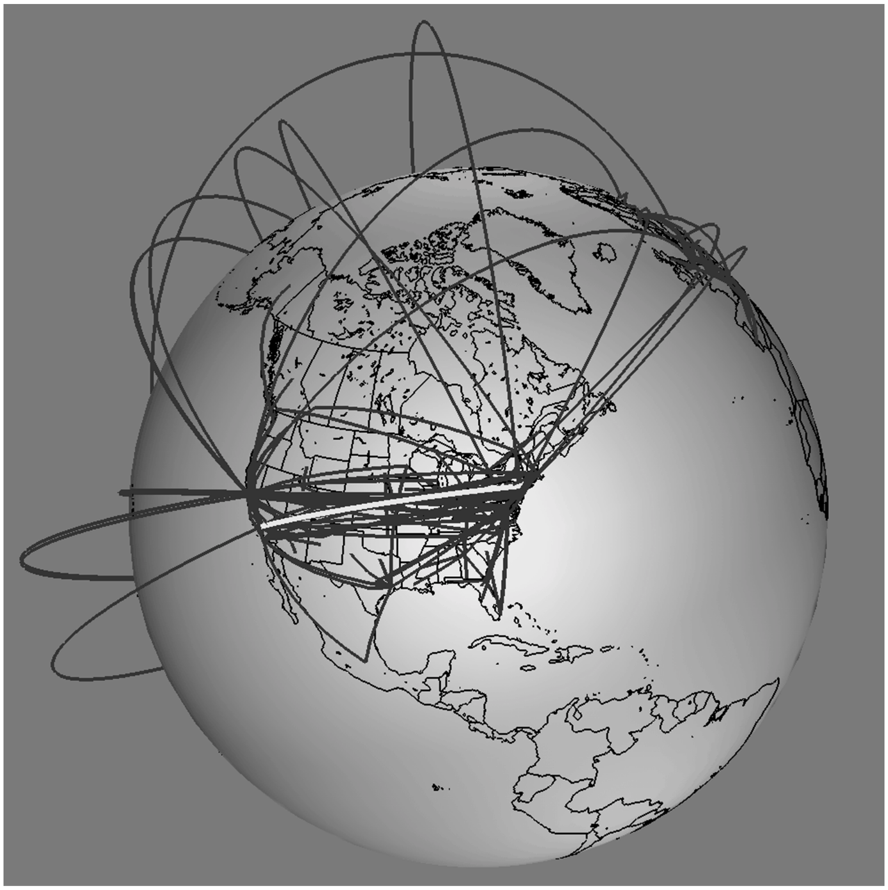

Figure 2: Three-dimensional global MBone map by Tamara Munzner, K Claffy, Eric Hoffman and Bill Fenner. (Source: Munzner et al. 1996)

detailed visualisations of the Internet produced by Bill Cheswick, a researcher at Lucent Technologies-Bell Labs and Hal Burch, a graduate student at Carnegie Mellon University (Burch & Cheswick 1999).

Cheswick and Burch use the Internet to measure itself, tracing the routes data packets take to reach several thousand sample nodes which reveals how the many intermediate computers and networks connect together to form the Internet. They map the results as a huge graph containing nearly one hundred thousand edges (figure 3). This maps Cyberspace with the appearance of a human lung from an anatomy book, with its incredibly fine lattice of filaments laid bare for all to see. In addition, the map is an image of considerable fractal beauty.

For many people it is more important to map what is "on top" of the infrastructure, rather than focus on the computers and wires. How can we map the actual information content and human interactions of Cyberspace. The largest information space on the Internet at present is the World Wide Web, comprising upwards of 800 million publicly indexable pages, on over three million servers (Lawrence & Giles 1999), that are all interconnected by hyperlinks to form the eponymous web. Users have difficulty navigating through this vast Web space to find the things that interest them in a timely fashion. What they need, perhaps, is a map of the Web from a distance, floating above it somehow, so they can get a broad view of the information landscape.

An obvious approach is to map the structure of Web pages and the hyperlinks between them as a graph. This has been attempted with little success beyond visualising individual Web sites, because the graphs quickly grow so large and dense as to be impossible to use as navigational maps. In addition, mapping the Web's structure does not really tell us much about the actual content of the pages. An interesting alternative strategy is to map this information content as a landscape using the terrain metaphor from conventional topographic mapping. There are several academic projects and commercial applications which produce information terrains, with the best current example being NewsMaps (http://www.newsmaps.com/). Figure 4 shows an example of a NewsMap map from mid June 1999. It maps the information content of 951 online news reports on the Kosovan war.

NewsMaps uses sophisticated analytical software, developed by Cartia (http://www.cartia.com/), to process and in some senses understand the content of an information space, in this case a large collection of online news reports on the Kosovan war, determining what are the key topics and how they relate to each other. This statistical abstraction of the information is mapped as a continuous terrain, with virtual mountain peaks representing the most popular topics in the news reports. The higher the peak the more significant the topic. Spatial proximity is used to layout topics, so the more related two topics are, the closer together they will be drawn on the map. The maps are interactive and can be explored on the Web, helping people gain an overall sense of the topography of the information space and track down particular news articles or Web pages of interest. The fundamental research into the processing techniques behind NewsMaps was funded by US intelligence agencies to aid them in understanding,

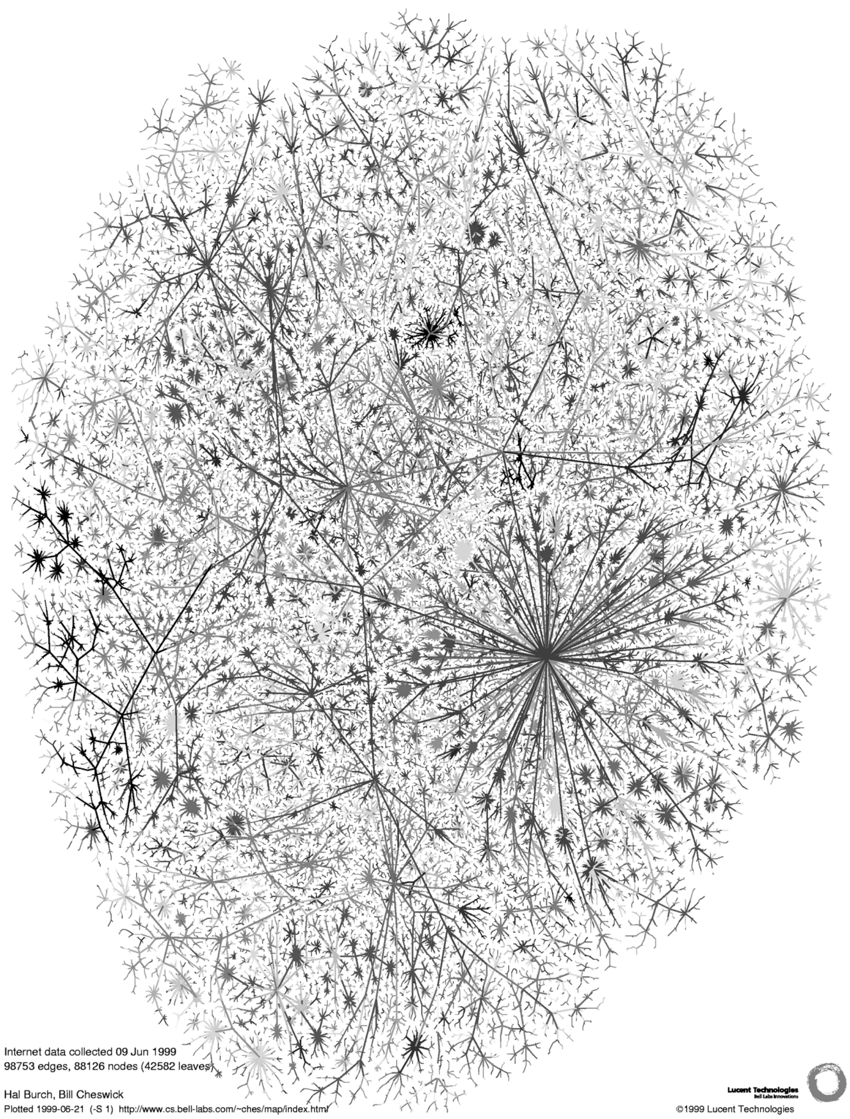

Figure 3: The Internet Mapped as a Graph, by Hal Burch and Bill Cheswick, 9th June 1999. (Copyright: Lucent Technologies)

through visual mapping, their vast information resources.

People talk to each other in Cyberspace. Some of the most popular activities, beside the rather solitary act of Web browsing, involve real-time conversations (via short typed text messages) between real people. Millions of people meet and talk in all manner of chat channels and rooms. All this raucous chatter is the vibrant social heart of Cyberspace, but how can it be mapped? Researchers, Fernanda Viégas and Judith Donath at MIT's Media Lab, are developing what they term "social visualization" to map these Cyberspace conversations. Figure 5 shows one of their innovative mapping techniques called Chat Circles (Viégas & Donath 1999).

This maps the participants of chat rooms as different coloured circles. The size and brightness of the circles is dependent on how much and how open the people talk. Circles also cluster together to conduct particular conversations, just like the groups that form at a party. Overtime the dynamic of the conversation can be seen as the circles grow and shrink, and drift to different groups. A major aim of their research is to provide a more visually appealing and useable interface to real-time conversations than the austere windows of scrolling text of conventional chat software. This highlights the fact that much of the effort in mapping Cyberspace is really about providing better interfaces to existing online information or activities, which is becoming possible through interactive computer graphics and greater network bandwidths (Holtzman 1997, Johnson 1997).

There are many more example maps we could look at, visualising different aspects of Cyberspace, and using many different graphic styles. Many are experimental, work in progress, only providing a fragmentary, imperfect view of Cyberspace, just like the Mappae Mundi's gave of the ancient world. However, they are still worth examining because they having a powerful impact on how people are conceiving the shape and form of Cyberspace. Like the Mappae Mundi, today's maps of Cyberspace provide a visual structure for thinking about the world, a world that is now virtual.

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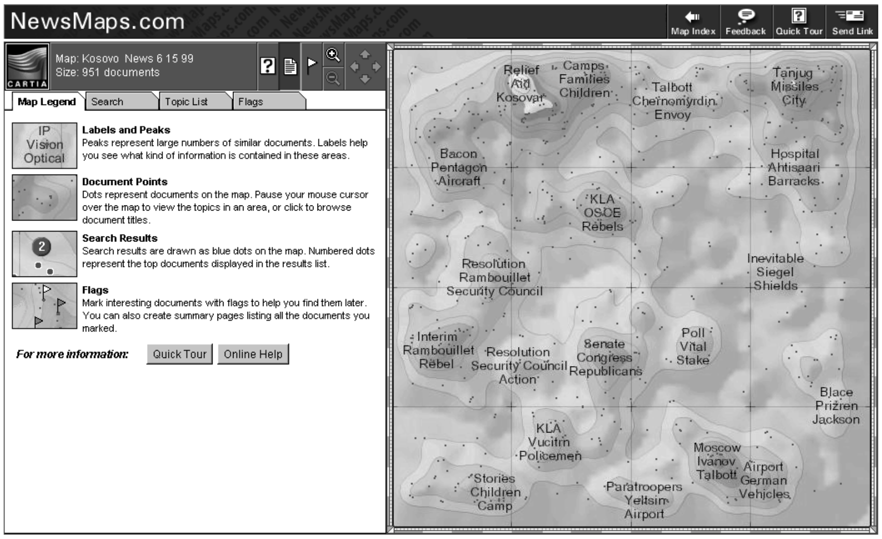

Figure 4: NewsMap information landscape map of Kosovan war news report from June 1999. (Source: http://www.newsmaps.com/)

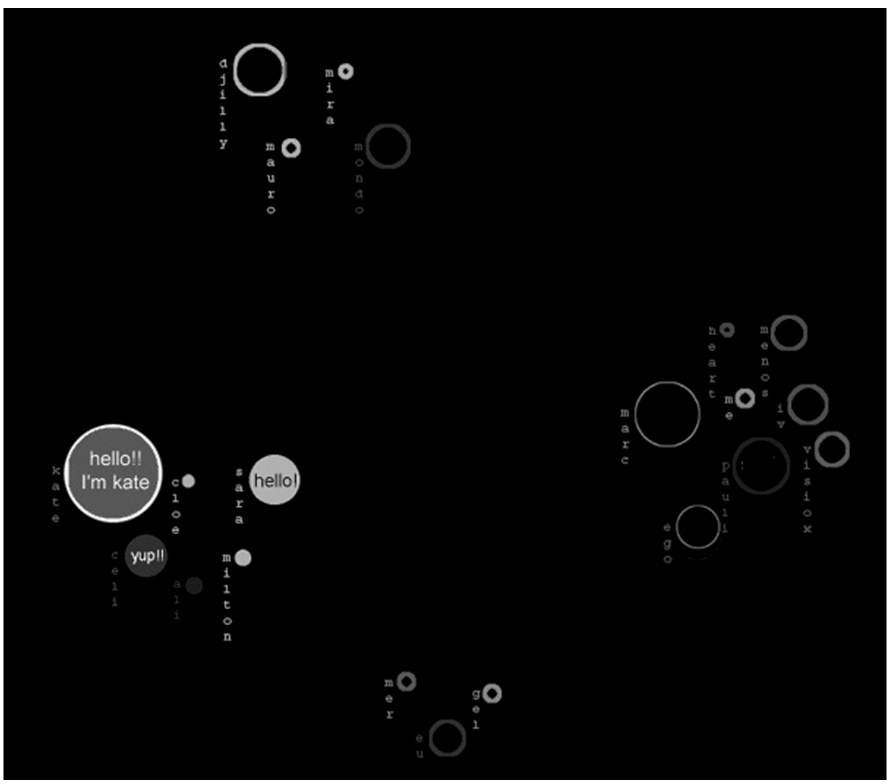

Figure 5: Chat Circles by Fernanda Viégas and Judith Donath. (Source: http://www.media.mit.edu/~fviegas/circles/)

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