Chapter Three

Cyberspace Cartographies

> [N]ow we have the emergence of cyberspace … It is largely invisible to conventional methods of observation and measurement … We need to begin to map this space, to visualize its architecture, and to show how it connects to and transforms our traditional geographies. The task before us is urgent, baffling, and exciting…
>
> -- Michael Batty, *The Geography of Cyberspace,* 1993.

> The mapping of that vast territory known as cyberspace has begun in earnest ... They range from glorious depictions of globe-spanning communications networks to maps of Web information. Many have no geographic references, instead turning to nature, the cosmos or neuroscience for spatial models.
>
> -- Pamela Licalzi O'Connell, *Beyond Geography: Mapping Unknowns of Cyberspace*, 1999.

3.1 Introduction

A major part of my interest researching cyberspace cartographies has been to learn about the authorship of the new map representations produced outside of the mainstream mapping industry. Who are the new map-makers and what motivates them to tackle the challenge of mapping aspects of cyberspace? Over the past thirty years many different map-makers, from a diverse range of academic, technical and institutional backgrounds, have mapped different aspects of cyberspace. It is apparent that cyberspace cartographies are one of the significant areas of creativity in map-making, with a considerable amount of experimentation with new visual metaphors, new survey methods and data sources, and above all new forms of users interaction with map artefacts. Indeed, as cyberspace is lacking established conventions of representations, it is a domain ripe for real cartographic innovation, along with opportunities for counter-hegemonic and 'bottom-up' mapping activity outside of established institutional boundaries. As such cyberspace cartographies need to be studied in greater depth.

This chapter, therefore, begins by offering a substantive review of cyberspace cartographies using a three-fold classification of mapping modes identified in the introduction. This is followed by a review of relevant theoretical literature focusing on how other scholars have defined the domain of cyberspace cartographies and the issues implications they highlight. The review also considers the more significant media reporting of the field revealing how these new mapping modes have been presented to the general public.

3.2 Cyberspace and new modes of cartography

The cartographic imagination in Europe was profoundly changed during the 'age of discovery' in the fifteenth century as the bounds of geographic knowledge expanded. Now, at the digital 'fin de siècle', a new and diverse range of mapping activities has emerged in concert with the so-called 'age of information', giving rise to new cartographic imaginings encompassing cyberspace. As discussed in chapter two there are a range of ways to theorise such cartographic change and innovation and here I follow Edney's (1993, 54) non-progressive genealogical approach in which map-making is composed of a number of *modes*, that are historically contingent sets of "cultural, social, and technological relations which define cartographic practices and which determine the character of cartographic information". Modes of cartographic practice are coupled to the continual emergence of new knowledges, problems, methods, and institutions, driving developments in both the design of map representations and roles that cartographic artefacts serve in society.

Contemporary mapping practices for the information age - what I term cyberspace cartographies - can be categorised into three distinct modes:

- maps <u>in</u> cyberspace,
- maps <u>of</u> cyberspace,
- maps <u>for</u> cyberspace.

The first mode, ‘maps in cyberspace’ involves putting existing forms of terrestrial cartography online to widen access and add user interactivity. Whilst somewhat more prosaic than the other two modes, work in this area to distribute existing map information in new ways, and to new audiences, has undoubtedly had the widest impact on the discipline of cartography (e.g., many millions of people use Web mapping services daily to create custom maps). Maps in this mode are characterised by their spatial conception based exclusively on conventional geographic frameworks. In institutional terms, the established cartographic industry is at the centre of these developments (although being challenged by new players, e.g., Google Maps).

The second mode of ‘maps of cyberspace’ is focused on mapping that describes the structures of networks and documents the operations of cyberspace itself, as viewed from external positions. In some senses they can be thought of as the engineering and thematic maps of cyberspace infrastructures and customer statistics. (As already noted, this thesis is focused on this mode through the analysis of two different genres of Internet network infrastructure mapping, of network routes and national connectivity statistics) The scope of this mode is, therefore, primarily defined by the subject of the maps rather than the spatial conception of the map representations or the tasks undertaken with them. The resulting maps encompass a multitude of graphic forms, some of which appear quite un-cartographic in a normative sense, such as topological network graphs and abstract flow diagrams (see discussion in chapter four on spatial metaphors to envision Internet infrastructure).

The last mode produces maps for navigating through cyberspace, their purpose is to guide users within the virtual spaces themselves. They are mostly created through the spatialization of non-geographic information structures to produce a visual map-like interfaces to virtual space that can support interactive browsing and searching. As such this mode is primarily defined by the task to which the maps are put rather than their subject or spatial conception. Many of the maps from this mode are experimental interfaces and produced in different institutional contexts to the other modes, particularly academic computer science and commercial software research laboratories, as well as more expressive and experimental work from new media artists.

The formal nature, and wider cultural meanings and social implications, of these three modes of cyberspace cartography is a novel area for scholarly research. It has received relatively little consideration within academic cartography and geography (although, the ‘maps in cyberspace’ has been subject to a sizeable amount of analysis, but this tends to be technical rather than conceptual or political). While this framing of cyberspace cartographies into three modes is an imposed classification and somewhat artificial, I think it does provide a useful conceptual aid to analysis. It is useful to try to group social-technical innovations into a new modes to see the overlaps between them, to identify the distinctive themes (in terms of ‘what’ to map and ‘how’ to map it) that divide them, and to mark out their particular relationships to wider ‘information age’ discourses (e.g., the pluralism of authorship and open content versus enforced marketisation and the greater corporate control; enhanced activism and transparency versus increased securitisation and the rise of the ‘fear economy’; strengthening of localism and regional diversity versus deepening cultural globalisation and homogenising consumption patterns).

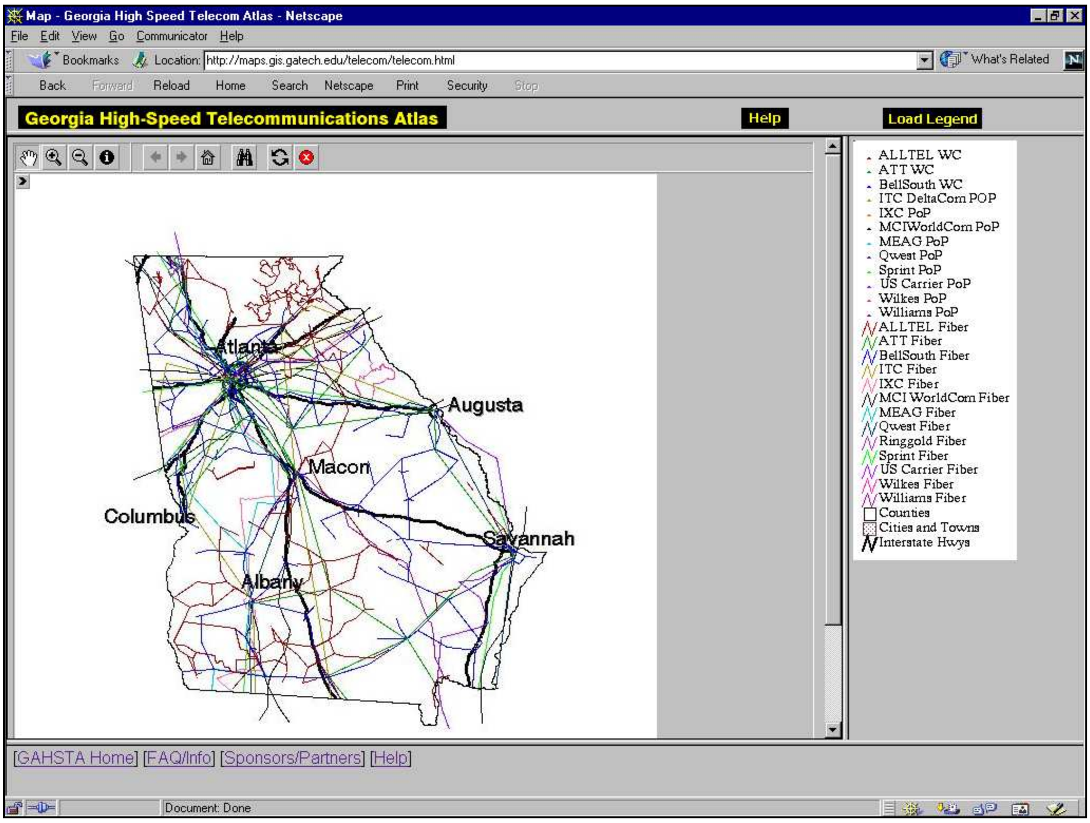

Figure 3.1: Telecommunications atlas of network infrastructure in Georgia, USA is an example of 'maps of cyberspace' mode based on it thematic interest and was disseminated using Web mapping technology that is more characteristic of the 'maps in cyberspace' mode. (Source: Center for Geographic Information Systems, <http://maps.gis.gatech.edu/>, no longer available online.)

3.2.1 The 'maps in cyberspace' mode

The work in this mode has already produced demonstrable utility and commercial viability in putting 'real-world' cartography online through developments in Web mapping portals and Internet-based GIS services. Much of the innovation in this mode has links into the visualisation research in the representation paradigm, however, the large-scale deployment is very much commercially driven, often through joint ventures between established mapping organisations and newer Internet-focused companies with e-commerce experience (e.g. Google launching its impressive online mapping service in the summer of 2005 with topographic data primarily from Tele Atlas and imagery sourced from its purchase of Keyhole). GIS software vendors are also active in this mode, developing platforms for customers to distribute maps via the Web (e.g., built using ESRI's ArcIMS software, such as in Figure 3.1; see also French and Jia 2001). Many in the mapping industry see the future as one in which they provide cartographic information as a bespoke Web service rather than publishing general-purpose map products.

This mode has received much greater attention from cartography practitioners and academic researchers because it represents an obvious continuation of many of their ongoing activities. Nearly all the work examining this mode is technical in scope, concerned with adapting existing mapping practices for the new media and adopting new technological solutions for user interactivity (e.g., Kraak and Brown 2001; Peterson 2003 and 2008; Plewe 1997). The edited volume by Kraak and Brown (2001, 1) for example delineates Web cartography straightforwardly and instrumentally as maps "presented in a Web browser" and is primarily concerned with design and presentation issues in relation to the constraints and opportunities of the new medium of publishing. Two notable exceptions to the focus on the 'engineering' side are Crampton's (2003) useful genealogical analysis of distributed mapping and Monmonier's (2002) consideration of some of privacy implications of making cartographic information widely available online.

One of the more sophisticated research efforts to understand this mode of cartography is led by Taylor and colleagues at Carleton University in Canada, under the project they call 'cybercartography' (Taylor and Caquard 2006). He argues that the Internet, as a new publishing media, is "revolutionising cartography" and that the map reconceived as an interface tool will be "key to navigation in the information era, as both a framework to integrate information and a process by which that information can be organized, understood and used" (Taylor 2003, 405). Their research agenda in many respects sets the techno-cultural imperatives underlying this mode of cartography, focuses on new multiple representation for maps and the media to deliver them. It comprises seven core elements aimed at creating new maps which:

- are multisensory (vision, sound, touch and leading to smell and taste),
- are multimedia format, exploiting new media,
- are highly interactive and engage users in new ways,
- are applied to a wide range of topics of interest to society,
- are integrated with analytical capability rather than a 'stand-alone' products
- are compiled by teams of individuals from different disciplines,
- involve new research partnerships among academia, government, civil society and the private sector.

(following Taylor 2003, 407).

The agenda is clearly building upon a communicational view of cartography with the focus on designing better map artefacts for representing data about geographic spaces rather than as an immersive navigation tool for information space (hence it should be seen as distinctive from the third mode of cyberspace mapping, 'maps for cyberspace'). If this research agenda is achieved - and much is being actively pursued by geovisualisation researchers (cf. Dodge *et al.* 2008; Dykes *et al.* 2005) - the nature of mapping as experienced by a general audience will likely be profoundly changed in the next decade. One might argue that Google Earth is already delivering much of this.

3.2.2 The 'maps of cyberspace' mode

A functional definition of the 'map of cyberspace' mode is any visual image that facilitates the spatial understanding of the physical makeup and operation of cyberspace itself. Their distinctive subject matter is to show what cyberspace 'looks like' by mapping how it is produced, revealing unseen details of its technical geography: infrastructure, operations and the patterns of customer activity. (See also chapter four on the role of spatial metaphors in this context.) There are overlaps between this mode of cyberspace cartography and the 'maps in cyberspace' mode outlined in the preceding section; for example, the commonality of practice and visual form in online mapping techniques used to display network routes (e.g., in interactive telecommunications atlases; Figure

3.1 above). One of the key denominators of the 'maps of cyberspace' mode from the other modes is, therefore, its thematic focus. Its 'external' descriptive approach distinguishes it from the 'maps for cyberspace' mode that are designed to be used 'internally' for searching and navigating online spaces.

The 'maps of cyberspace' mode encompasses a broad range of representational genres: cartography, abstract diagrams and charts and graph visualisations (chapter four details examples relating specifically to Internet network infrastructures; see also Dodge and Kitchin 2001). It is, therefore, difficult to taxonomise this mode based on graphic form or spatial conception of representations.

Many of the maps produced in this mode do look familiar in that they use semiotic conventions of mainstream cartography – for, example mapping the routes of cables as colour-coded line symbols on a generic geographic base map in the Georgia Telecommunications Atlas (Figure 3.1 above). A large proportion draw directly on the practices of thematic mapping to spatially represent statistical data on cyberspace's production, such as mapping telephone calling pattern (see Figures 3.2 and 3.3); chapter five analyses a series of conventional choropleth maps, produced at the world scale, to track the national diffusion of Internet connectivity and technological progress towards the 'information society'.

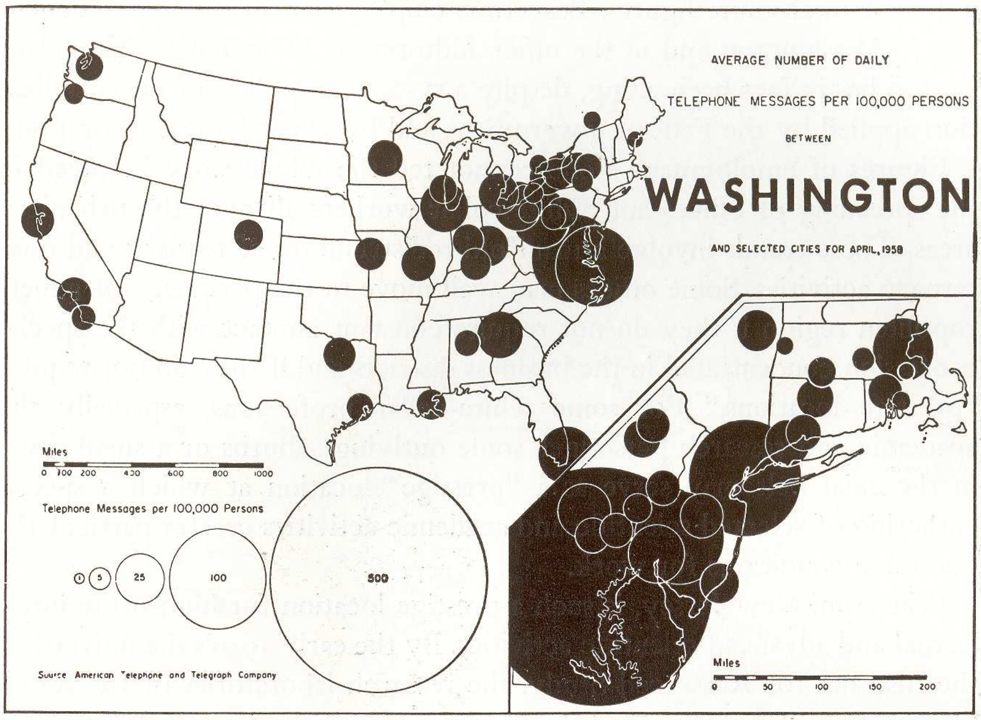

Figure 3.2: Statistical map of telephone calling patterns from Washington DC. This is a typical example of ‘maps of cyberspace’ mode presenting results of cyberspace census-taking in the context of academic analysis. (Source: author scan from Gottmann 1961, 593.)

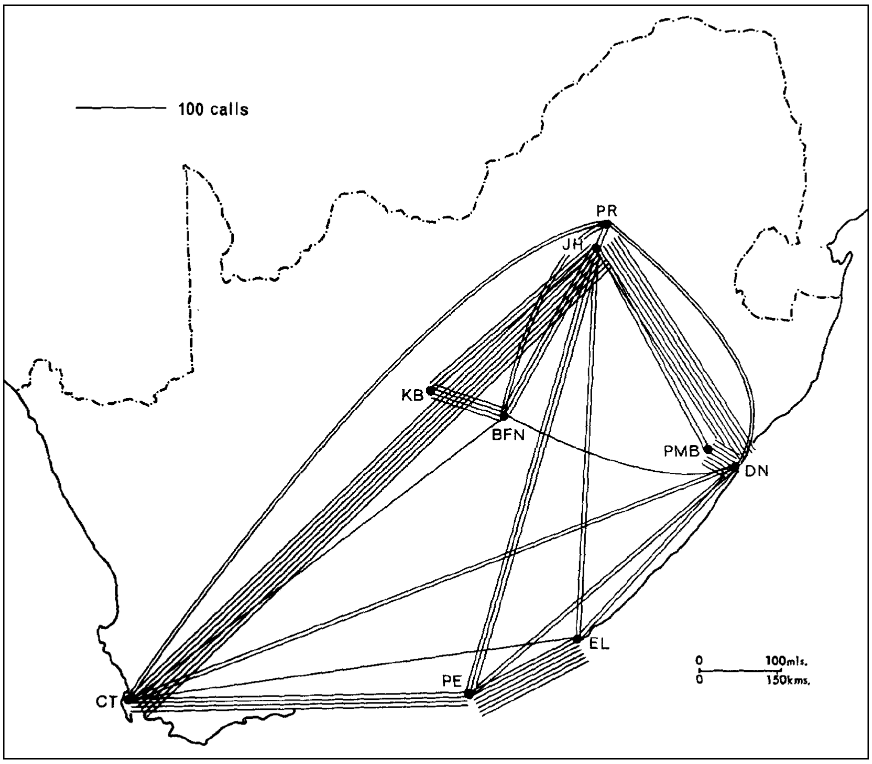

Figure 3.3: Statistical flow map of the volume of trunk telephone traffic between metropolitan centres in South Africa, 1963. (Source: author scan from Board *et al.* 1970, 381.)

A significant amount of geographical research on various types of networks has been undertaken by geographers and regional scientists in the last fifty years. A good deal predates the emergence of cyberspace per se and the tremendous growth in the Internet, but does offer insights in terms of analytical methods and patterns of interpretation that could inform contemporary work on the spatial impacts of ICTs on the economy and society. Much of this work focuses on understanding the spatial structures of the economy as measured by geographically differentiated patterns in flows, including 'invisible' flows of information via telecommunications and visible, yet ephemeral, transportation and communications flows such as road traffic or postal mail (C. Board, PhD examiners report, 24th October 2006). Noteworthy early work on geographical analysis of information flows includes the work of Gottmann (1961) who examined inter-city telephone call patterns as part of his assessment of the emerging 'informatisation' of the U.S. economy (example of the mapping produced is shown in Figure 3.2 above). Board *et al.* (1970) analysed telephone call statistics as one of a number of empirical variables in their integrative spatial analysis of the economy in South Africa (example of the mapping produced is shown in Figure 3.3 above) and they found that "the network closely integrates the northern metropolitan nodes and joins the system to Cape Town, through Johannesburg, the national focus; [while] Port Elizabeth and East London are isolated in a secondary and peripheral nodal system." (p. 380). Lastly, Pred's (1973) historically-focused analysis of intra-urban information flows and industrial growth and innovation in U.S. antebellum cities in the nineteenth century derived, in part, from empirical analysis of newspaper circulation.

In terms of physical movement of goods, vehicles and people in transitory patterns and cyclical patterns across space, there is a lot of literature at various scales. For example, ranging from Goddard's (1970) factor analysis of the movement economy of central London based on taxi flows, to Mitchelson and Wheeler's (1994) analysis of the aggregate patterns of inter-urban FedEx parcel deliveries to infer the hierarchy of U.S. cities; and up to global scale investigation such as Taylor (1999) and colleagues quantitative analysis of airline networks and passenger flows, as an element in their much larger empirical understanding of the systems of world cities, showing through network links how the major cities for chains and clusters of specialisation that underpins the global economy.

Tracing out more generalisable theories on spatial impacts of networks on society and the meanings embed in different kinds of flows and movements has tended to be dominated by other fields of social sciences than geography. The sociologists in the form of Manuel Castells, Anthony Giddens and John Urry seem to have been particularly successful in galvanising support for their ideas. An exception is the work of Ron Abler who has attempted to develop a general geographical theory relating distance to communication flows (cf. Falk and Abler 1980).

3.2.2.1 Representational forms

Other products of the 'maps <u>of</u> cyberspace' mode go beyond what many people would think of as 'maps' in their use of non-geographic forms of representations. For example, non-Euclidean visualisations of the topological structure of network infrastructures (e.g., Figure 4.10 in the next chapter). These abstract graphs focus on showing the connectivity between nodes rather than their position in geographic space. (In some cases such non-geographic visualisation is undertaken because of the difficulty in meaningfully and reliably geo-coding data objects, e.g. problems of locating Internet network addresses; see discussion in Grubesic and Murray 2005; Shiode and Dodge 1999).

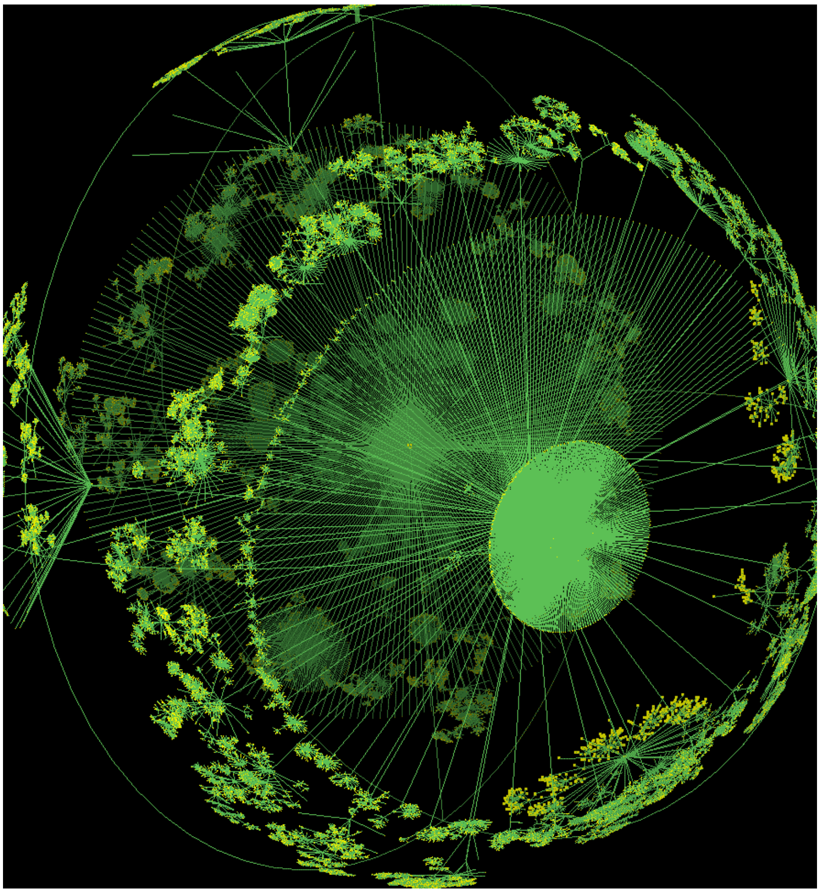

Figure 3.4: A screenshot of a three-dimensional hyperbolic visualisation of Internet topologies created by Young Hyun in 2000. It was produced using custom-written hyperbolic graph viewer called Walrus designed to allow researchers to interactively browse huge graphs (greater than 100,000 nodes). (Source: Courtesy of Young Hyun, Cooperative Association for Internet Data Analysis (CAIDA), <www.caida.org/~youngh/walrus/walrus.html >.)

In terms of map use, a good many ‘maps <u>of</u> cyberspace’ move beyond the static two-dimensional representational norms of mainstream cartography to provide interactive multi-dimensional visualisations. There are overlaps in this case with visualisation research being undertaken in the representation paradigm in cartography (discussed in chapter two). The lure of sophisticated three-dimensional graphics and virtual reality interfaces to produce mapping with the requisite ‘cyber’-look has been a recurrent feature of this mode. The Earth globe aesthetic has proved to be a particularly popular backdrop onto which infrastructural data can be mapped (see the discussion in chapter four of the power visual metaphor for imagining the Internet). For example, Lamm *et al.*

(1996) visualising Web server traffic as 'skyscrapers' on VR Earth. (The striking images from this research proved to be suitably iconic that one was used as the major illustration of the 1999 *New York Times* story on cyberspace cartographies (see Figure 3.8 below). Eschewing the globe and restrictions of terrestrial referencing, others have produced immersive three-dimension visualisations of cyberspace operations in abstract space, such the Walrus system used to interactively display huge graphs of data routing in a hyperbolic space (Figure 3.4). In some respects these types of interactive three-dimensional visualisations of topological structures are the most innovative for cartographic practice by pushing outwards the boundaries of the map users experience. However, most also suffer with poor semiotic performance in actually conveying information for general audiences (Dodge and Kitchin 2000a). In terms of DiBiase's schema of the role of maps in the research process discussed in chapter two (see Figure 2.5), these kinds of interactive graph visualisations are designed primarily for use in private realm for 'visual thinking' rather than for public communication.

Many of the map-makers creating 'maps of cyberspace' would not class themselves as 'cartographers'. They are a diverse collection of individual explorers/programmers, academic research groups (typically from the computer science domain), market research companies, the marketing departments of networking / telecommunications corporations, and government statistical and regulatory agencies. Unsurprisingly, they tend to come from fields that are most involved in the daily production of cyberspace, having the need for maps to accomplish immediate pragmatic goals (e.g., engineers analysing network traffic and planning new infrastructure deployment, market researchers tracking and predicting the growth of the network, industry regulators monitoring competitiveness of provision for multiple services areas). Those directly responsible for building and operating the data networks underlying cyberspace are the most prolific single group of map-makers in this mode; however much of their work is for internal use and is never made public, except for specifically designed marketing maps (examined in chapter six).

In some senses then, many of these people are compelled to become cyberspace map-makers because the basic maps they needed to do their jobs do not exist within the normal cartographic supply-chain. There is no coverage of cyberspace in major world atlases, for example and the national mapping agencies, like USGS and Ordnance Survey, do not record telecommunications infrastructure in small scale topographic mapping; it is very much the poor cousin to other infrastructures, like railways, that are mapped in much greater depth[1]. A key reason for this is the 'invisibility' of much of the Internet's infrastructures, relative to other networks like rail or roads (see discussion in chapter four).

In terms of authorship, the 'maps of cyberspace' mode has offered a renewed scope for dedicated individual endeavour to make an impact. In much of conventional commercial and state-sponsored mapping, cartographic authorship has been firmly professionalised and largely anonymised. This is not the case with mapping the Internet, for example, because the network infrastructures open up new technical opportunities to be used to map themselves in really quite innovative ways and at very low costs (see Dodge and Kitchin 2006). This allows novel opportunities for what might called 'super-empowered individuals' to chart vast swathes of cyberspace with minimal resources, utilising recursive software algorithms to automate the surveying process and reduce the burden of charting huge volumes of data. The work of undergraduate physics student Stephen Coast[2] is a telling example. Individually he mapped the core topology of the Internet as a summer internship project in the Centre for Advanced Spatial Analysis in 2001 using software 'bots' to scan the network and report results to a database (in much the same way that search engines monitor the Web). Coast's work also highlights how whole territories of cyberspace can be remotely sensed from a single survey location.

Given the diversity of institutions and individuals producing 'maps of cyberspace' it is not surprising that they serve multiple normative purposes. At a basic level, most of the maps in the mode provide a visual census of where cyberspace nodes are located, and in very few cases the traffic that flows

[1] The Ordnance Survey's 'Digital National Framework' (marketed as their MasterMap product), for example, does not contain a coherent representation of telecommunications networks suitable for spatial analysis.

[2] Results of the project are available at <www.fractalus.com/steve/stuff/ipmap/>.

between them. (The 'where' in this case can be plotted in geographic space or according to some other topologic framework). 'Maps of cyberspace' at the level of infrastructure can detail how computers are physically wired together to create complex networks that operate over several spatial scales, from individual buildings up to global scale systems. Depending on scale, these maps can be used by engineers to install and maintain the physical hardware of the networks, by system operators to manage networks more effectively, and by marketing and business development departments to demonstrate the size and penetration of networked services (see chapter six for analysis of examples of the last instance).

Many of the 'maps of cyberspace' serve as significant components in the market-driven development of cyberspace fostered by global capital. They are produced as cartographic propaganda by companies and consultants who have vested financial interests in the expansion of cyberspace. Maps are deployed as persuasive devices (Tyner 1982) because they provide authoritative support to the rhetoric of universal expansion, helping to visually assert the global ambitions of corporations and as a means to exert sovereignty of private capital over public electronic spaces (Dodge and Kitchin 2000b). A examination of most ISP Web sites, undertaken in chapter six, reveals the presence of 'high-gloss' marketing maps showing a generalised and simplified view of the company's network. They usually represent the network on a familiar template of real-world geography. As such they have many design commonalties with airline route maps displayed in the back of in-flight magazines and are part of an established cartographic lineage of marketing maps used to highlight the advantages of the latest communications technology to prospective investors and potential customers (see chapter six for full discussion).

Beside selling cyberspace, another motive is census-mapping cyberspace in support of academic and policy analysis (see the analysis in chapter five for detailed empirical discussion). The results, with varying degrees of reliability and impartiality, are fed back into business strategies and government policy formulation, thereby directly effecting the future production of cyberspace. More recently, much of policy analysis work using census type mapping focused on explaining the exponential growth in Internet infrastructures, connectivity and usage. Visual summary presentation using statistical charts, diagrams and maps is common (Figure 3.5).

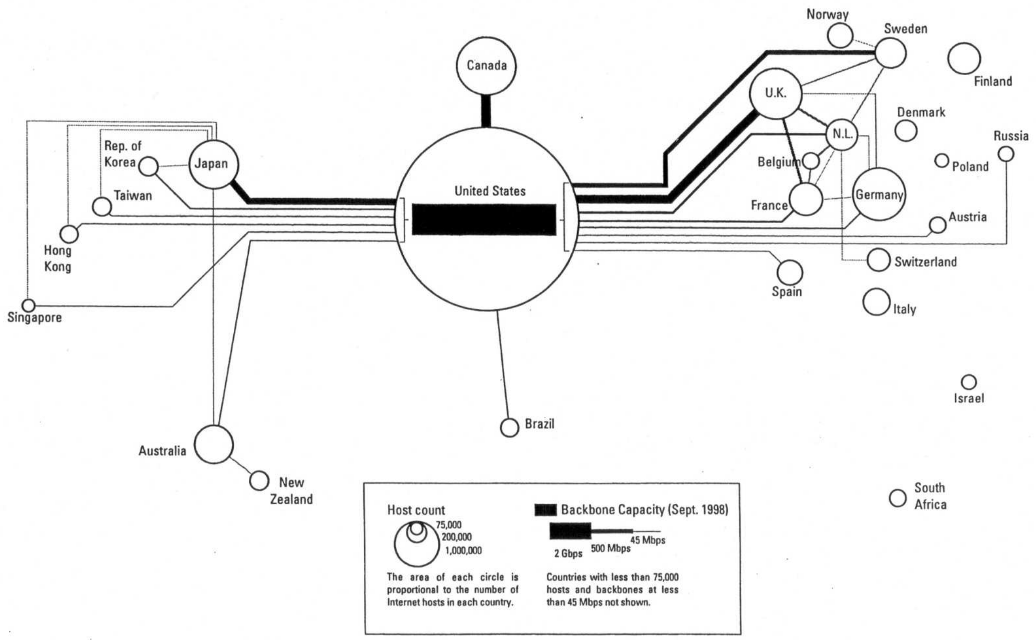

Figure 3.5: Diagrammatic summary of Internet bandwidth capacity between core countries in 1999. (Source: TeleGeography 1999, 34.)

TeleGeography, a market analysis firm based in Washington DC has produced some of the more innovative examples of cyberspace mapping for policy. They measure and map telecommunications traffic flows and Internet bandwidth between countries (Figure 3.5), and provide one of the most important and credible data sources for the growth of cyberspace. The company grew out of the pioneering work by telecommunications lawyer Gregory Staple in the late 1980s, who gathered telecom traffic flow data between countries for the first time (see Staple and Dixon 1992). Staple's goal was to map out the structures of telegeography; his motivation in doing this was simple: "At the time, I was a few streets away from one of London's best stocked book stores and I had the same frustrating experience; the information society was everywhere, but you couldn't find a map of who was connected to whom to save your job." (quoted in Dodge 2000e). While some of Staple's output used conventional statistical cartography templates (for example, see TeleGeography's wall posters[3]), he is also interested in more innovative visual vocabularies for 'maps of cyberspace' as evidenced by his publication of the 'The Whole Internet' maps[4] (based on the graph projection by Hal Burch and Bill Cheswick, see chapter four, Figure 4.10).

There are several reasons why 'maps of cyberspace' are important beyond their normative roles in planning network construction, in selling network access or network census-taking for policy-making. Firstly, taken as a whole the output from this mode has significant pedagogic utility in challenging the misconception of cyberspace as a paraspace[5] and the naïve notions that the potential for virtual interaction spells the 'death of distance' and somehow renders geographic location almost insignificant (Cairncross 1997). As noted in the introduction these notions have been prevalent in cyberspace discourses, particularly in much of the business-orientated coverage in the 1990s, and stemmed in part from infrastructure invisibility (discussed in chapter four), combined with techno-utopianist fantasies of transcendence of the physical constraints of embodied human lives and corporate dreams of borderless worlds.

The seemingly magical ability to surf effortlessly through online information, moving from website to website in a single click, belies the scale and sophistication of the socio-technical assemblage of protocols, hardware, capital and labour that makes this possible. Despite the virtualised rhetoric, this infrastructure assemblage remains embedded in real places and 'maps of cyberspace' have utility in revealing the intersections between virtual space and geographic space. Mapping is, therefore, significant as it can provide insights into who owns and controls the supporting infrastructure from where cyberspace is being produced. In addition, maps are especially useful for communicating this

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[3] See <www.telegeography.com/products/maps/cable/index.html>. The basis of the undersea cable map published in a Guardian news story was TeleGeography, see chapter four, Figure 4.1.

[4] Four iterations of this striking poster were sold by Staple's company Peacock Maps, <www.peacockmaps.com>. Note, I worked for Peacock Maps in 2001 and participated in the publication of the last version.

[5] Paraspace means 'other space' - a sublime space that has forms and practices alien to that in geographic space (see Bingham 1999).

kind of detail to public audiences because they use a familiar template of countries and continents.

Understanding the ‘where’ and ‘how’ of the physical embeddedness of data networks and information flows through mapping is also important because of the uneven geographical distribution of cyberspace and the consequent socio-spatial implications in terms of access and inequalities. The location and structure of infrastructure is a key determinant in access to cyberspace, affecting cost, speed, reliability, and ability to connect (Holderness 1998; Warf 2001). Maps in this cartographic mode can illustrate how, on a global scale, infrastructure is concentrated in certain countries (such as the USA, UK, Scandinavia), at the national scale how it is concentrated in certain regions (e.g., Silicon Valley, the west London-M4 corridor, the Helsinki metropolitan area), and even at very localised neighbourhood clusters within ‘high-tech’ cities like San Francisco or New York (see for example Zook’s (2000; 2005) cogent economic analysis and mapping of Internet domain name ownership). Accessing cyberspace is fragmented along traditional spatial and social divisions with infrastructure density and variety being closely related to areas of wealth (see Warf 2001). These issues are discussed in depth in chapter five in relation to maps of Internet globalisation.

Despite much innovation and effort from the range of map-makers, in terms of coverage, the available ‘maps <u>of</u> cyberspace’ give only a partial view of the production of cyberspace. Mappable information is still limited in many areas; for example, the inability to measure information flows between and within cities. The early work by Gottmann and Board *et al.* analysing telephone call traffic discussed above has not been repeated for the Internet because of limited availability of representative datasets. And in some important respects, mappable information of cyberspace is actually diminishing. The growing diversity, size and privatisation of cyberspace are making it harder to survey and map legibly compared to say ten years ago. This has been acerbated with recent post-9/11 ‘chilling’ (Zellmer 2004) in which details on cyberspace infrastructures and operating procedures are kept from public purview for ‘security’ reasons; for example, the Georgia Telecommunications Atlas (Figure 3.1 above) is no longer online. Visitors to the site looking to produce maps of network infrastructure are now informed: "Due to security concerns from telecommunications providers, the Georgia High-Speed Telecommunications Atlas is no longer available."[6]

Yet the 'maps of cyberspace' that have been created and published remain politically important, not because they accurately and reliably denote the shape of cyberspace itself, but because they reveal how certain people, groups and organisation perceive and (re)present cyberspace to themselves and to the outside world. All the 'maps of cyberspace' necessary have connotative meanings that expose the interests and agendas of the people who make them: for example, is cyberspace being presented as a dangerous, threatening place needing to be controlled? or as a new digital 'public square' for invigorating community and democracy? or a new market ripe for economic exploitation? The agendas in two particularly important classes of 'maps of cyberspace' are made apparent in chapters five and six through a semiotic reading of their connotative meanings.

3.2.3 The 'maps for cyberspace' mode

The extent and usage of cyberspace has grown very rapidly in the last decade. With so many distinct virtual spaces and users online, cyberspace has become an enormous and often confusing entity that can be difficult to cognise and navigate. The 'maps for cyberspace' mode focuses on helping people understand the structures of online spaces of information and social interaction, rendering them in visual form and enabling people to navigate through them. These are cyberspace cartographies designed purposefully as a means to explore 'inside the wires', rather than to see how the 'wires' themselves are produced.

It may seem surprising, in the first instance, that a worthwhile case can be made to use cartographic maps to navigate cyberspace. This surprise is based on two false assumptions: firstly, that cyberspace has no meaningful spatial structure and is somehow 'unmappable'; and secondly, that maps can only represent geographic phenomena in relation to the surface of the earth. Both these

[6] See <http://maps.gis.gatech.edu/telecomweb/index.html>.

assumptions are untenable for maps are not just geographic and cyberspace has meaningful structures to be surveyed (and calculated) and mapped, such as semantic similarity between content, affinity ties of differing strengths in online social networks, turn-taking in mediated conversations. The self-evident answer is that it *is* possible to make 'maps for cyberspace' - as many researchers have indeed done (cf. Dodge and Kitchin 2001, chapters three and four for myriad examples) - although as yet map-makers in this mode have largely failed to produce effective maps suitable for widespread public usage. In cognitive and semiotic terms there is no equivalent to the Tube map for the navigating the Web.

In terms of authorship, the range of work in this mode is undertaken by a surprisingly diverse group of map-makers, including graphic designers, sociologists, new media artists, information scientists, librarians and software interface engineers. Contributions by cartographers and geographers have been minimal (with the exception of the notable work by Skupin (2000) and Fabrikant, (2000)). The bulk of the work is being done within academic contexts, particularly in U.S research labs and universities. Also, quite a number of start-up companies have spun-out from academic research to develop novel interface concepts into commercial products[7], particularly so in the late 1990s dotcom boom when venture-capital was readily available. (Few survived the subsequent technology market crash and none has achieved large scale success in the commercial market.)

A number of computer science specialisms interested in the 'engineering' aspects of new interactive visualisation have also been heavily involved in the 'maps for cyberspace' mode, including researchers in computer graphics, human-computer interaction, visual analysis of massive datasets, and virtual reality areas. Many of these fields share common goals of being able to better understand information navigation and, thereby, create more efficient means of human-computer interactions. In some respects online spaces, such as the Web, provide a

[7] For example, Visual Insights, Perspecta, Inxight Software and Cartia were spins-off from cutting-edge research at Bell Labs-Lucent Technologies, MIT Media Lab, Xerox PARC, and Pacific Northwest National Laboratories respectively.

conveniently accessible, large-scale testbed for this work. In addition to these fields within computer science, an allied research community has grown up in the 1990s under the banner of information visualisation[8] which provides many of the most innovative ‘maps for cyberspace’ exemplars because of their specific emphasis on developing dynamic interfaces to navigate large volumes of textual data (see Card *et al.* 1999; Spence 2001).

Outside of computer science and technically-focused visualisation research, the information design community, with direct responsibly for the architecture of online content has been most active within the ‘maps for cyberspace’ mode; for example in terms of site maps on websites (e.g., Kahn 2000). Valuable but eclectic contributions have also come from new media artists, who are developing interactive maps as works of art (see reviews in Anders 1998; Holtzman 1997; Paul 2003) and as virtualised architectural spaces (e.g., Benedikt 1991; Spiller 1998). One especially interesting group here, working at the intersection between online art installations and software computation, are the new breed of so-called ‘data-viz’ artist/programmers including Ben Fry at the MIT Media Lab and Martin Wattenberg at IBM Research (see Dodge 2001c, 2001d).

3.2.3.1 The potential of information mapping

Cartographic concepts have utility for the maps for cyberspace mode since they can help render the intangible virtual media, composed of immaterial code (in essence just software algorithms manipulating database records) into visually tangible spaces[9]. Even though one cannot ‘touch’ hypertext, for example, it is possible to visually plot its structures on screen to aid navigation. Depending on their scale and design, maps of virtual media can give people a unique sense of spaces difficult to understand from navigation alone (Dodge 2000a). As such

[8] It has been defined by three of leading academic computer science researchers as follows: “The use of computer-supported, interactive, visual representations of abstract data to amplify cognition” (Card *et al.* 1999, 2).

[9] Of course, there are many other visual interface approaches beside cartographic mapping - the most common is the temporally ordered list of items, which underlies the experience of email for example.

notions from cartographic mapping applied to virtual media offers three distinct and interlinked advantages over other interfaces to cyberspace:

- Creating a sense of the whole information space,
- Supporting ad-hoc, interactive user exploration,
- Revealing hidden connections between data objects.

In a metaphorical sense information maps enable users to get 'above' the virtual space. In terms of the Web this kind of 'birds-eye view' function has been described by David D. Clark, Senior Research Scientist at MIT's Laboratory for Computer Science, as the missing 'up button' on the browser (Dodge 2000a). Such overview visualisation, displayed on a single screen for cognition at a glance, is particularly important when combined with support for interactive exploration given the nature of much of online information seeking is via unstructured and poorly formulated browsing and foraging techniques. "[A] user may be unable to say exactly what they are looking for in a collection of documents because they may not *know* exactly what they are looking for. They may want to discover *roughly* what is available in the collection and then, by exploration, gradually refine their inquiry" (Spence 2001, 179, original emphasis). Maps <u>for</u> cyberspace need to be able to show, in an intuitive and meaningful fashion, the structures of the information space in terms of direct relationships between documents (via citations or hyperlinks, for example), but also similarity in terms of shared themes, semantic connections and common patterns of usage. These structures and relationships are usually completely hidden in the presentation of conventional media interfaces, like the Web browser. Yet, this is often where users need insights to assist their visual-cognitive assimilation of the mosaic of available information. As cartographic theorist Bertin (1981, 64) reminds us: "Items of data do not supply the information necessary for decision-making. What must be seen are the relationships which emerge from consideration of the entire set of data. In decision-making, the useful information is drawn from the overall relationships of the entire set." The effective power of 'maps <u>for</u> cyberspace' comes from showing these relationships to users to enable them to make better decisions.

3.2.3.2 Spatialization for information mapping

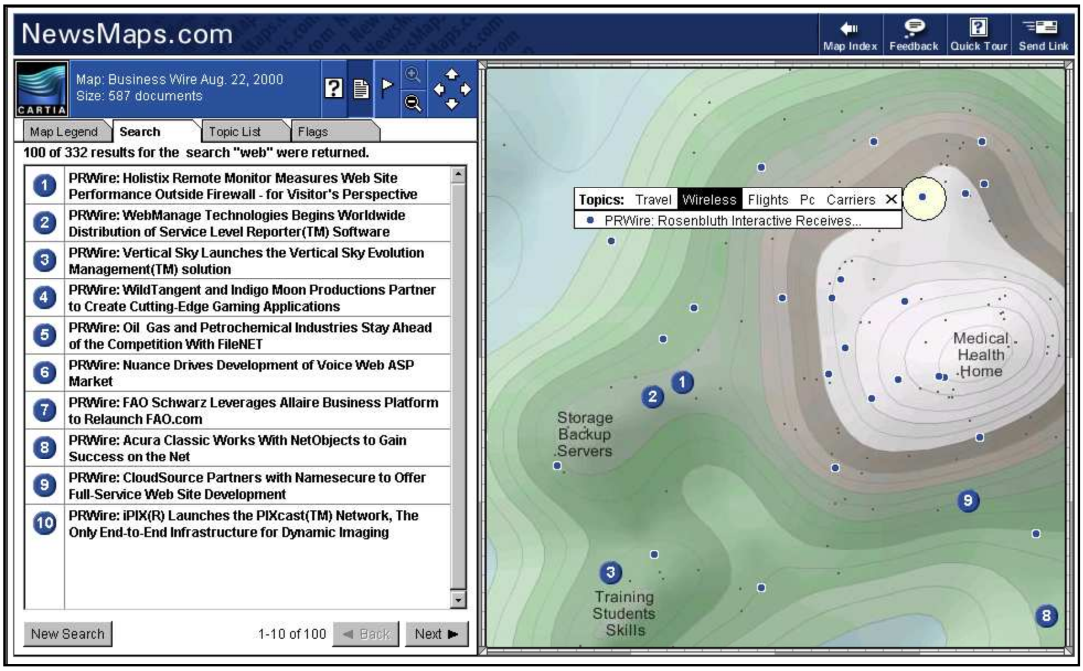

Figure 3.6: The NewsMaps interface was a navigable information terrain where the hills and valleys represented variable volumes of textual information. The white peak represents a large number of news stories discussing the same topic (labelled with keywords). The axes are a decorative device to frame the display and do not provide useful measurement. The interface was based on Cartia's Themescape spatialization system and was one of the more effective 'maps <u>for</u> cyberspace' produced in the late 1990s. (Source: author screenshot.)

Developments in the field of information visualisation in last decade have proved particularly fertile in creating novel visual metaphors for navigating high-dimensional information spaces through processes of spatialization (see Couclelis 1998; Fabrikant 2000; Fabrikant and Buttenfield 2001; Fabrikant and Montello 2008; Fabrikant *et al.* 2004). These are map-like interfaces that "rely on the use of spatial metaphors to represent data that are not necessarily spatial" (Fabrikant 2000, 67-68). According to Couclelis (1998, 209), "true spatialization goes beyond the conversion of information into general visual patterns to reproduce aspects of the kinds of spaces that are familiar to people from everyday experience ... Spatializations work by allowing the establishment of metaphors linking a particular task domain with a familiar domain of experience in such a way that the modes of thought and action appropriate in the familiar domain area also appropriate in the task domain."

Spatialization renders large amounts of abstract data (usually textual corpus) into a more comprehensible, compact visual form by generating meaningful synthetic spatial structure (such as distance on the map display scaled according a measurement of lexical similarity between data items; see Fabrikant *et al.* 2004) and applying cartographic design concepts from topographic mapping and thematic cartography (Skupin 2000). Some of the most map-like examples have used the conventions of hill shading and contouring from terrain mapping to create browseable virtual 'information landscapes' (Wise 1999; Dodge 2000f) (Figure 3.6 above). Skupin and Fabrikant (2003, 113) have called for much greater involvement of cartographers in information visualisation to develop improved spatializations for non-geographic data, arguing that "it may lead to a renewed interest among non-cartographers in how our community has managed to not only represent the infinitely complex geographic reality within a limited display space, but also do it in a manner that enables people to recognize their world within it."

3.2.3.3 Challenges in information mapping

Given these potential advantages, actually creating practicable spatializations, however, faces real challenges. This is particularly the case, firstly, because cyberspace is new and diverse. It is not a single, homogenous and continuous phenomenon, but a myriad of rapidly evolving digital databases, channels, and media, each providing a distinct form of virtual interaction and communication (as shown in Figure 1.1 in the introductory chapter). Secondly, many virtual spaces are overlapping and interconnected, but often in ad-hoc and unplanned ways, giving rise to complex rhizomatic[10] structures that can not easily be surveyed and mapped. Cyberspace, composed of infinitely malleable software code that can produce numerous media forms - including Web pages and their hyperlinks, social interactions as text in synchronous chat rooms and

[10] A rhizome is a tangled root system that develops horizontally, and in a non-hierarchical fashion. Hypertexts are said to be rhizomatic in form because any node may connect with any other.

asynchronous mailing lists, three-dimensional VR environments, huge distributed file corpuses on peer-2-peer networks - all with “their own sense of place and space, their own geography” (Batty 1997, 339).

Some virtual spaces can be highly mutable and in continual informational flux as content is refined, expanded and deleted in unpredictable ways - the average life span of a Web page in 2000 was reported to be only 44 days (Lyman 2002). These are inherently transient landscapes, but where changes are ‘hidden’ until they are encountered. Change can happen instantaneously, for example deleting a Web page leaves behind no trace (unless archived elsewhere previously). The lack of reciprocity in relations means an information node can vanish without notice or notification to any other party (hence the problem of ‘dead-end’ hyperlinks on the Web). The programmed logic of cyberspace – presence or absence, zero or one – makes for a hard landscape to map.

Furthermore, these issues of information mutability and transience are likely to grow, and become obfuscated by increasing use of encryption and ad-hoc distributed architectures (e.g., P2P and WI-FI mesh networks) making mapping even harder[11]. The task of generating even a basic index of parts of cyberspace for example, continues to tax the largest corporations and government agencies. The Web search engines, for example, have failed to keep pace with the growth and mutability of just this one part of cyberspace. Of course, issues of data currency and change management are well known in cartography (e.g., the uneven revisions cycles of paper topographic maps by some organisations). However, the surveyed environment represented on conventional topographic maps is really quite a stable place (change tends to be gradual in relation to human perceptions; most things stay the same, and when they do change, they typically leave evidence behind in the material landscape.) The physical fixity, friction and inertia of geographic space means the ‘shelf-life’ of most maps is

[11] Tim Berners-Lee and others counter that the growth and complexity of online information resources can be more effectively managed with application of XML to encode semantic meanings and the use of collaborative user tagging and rating. Additionally, the wholesale automatic geocoding of information objects, as they are created and transmitted, opens up interesting possibilities for spatial indexing, filtering by distance and searching by geographic location.

quite long (most of the information printed on a Ordnance Survey Landranger map remains valid for decades). There is no such friction or inertia in cyberspace and the 'shelf-life' for many cyberspace maps is terribly short. What is really needed are 'maps for cyberspace' that are capable of dynamically mapping out virtual space in real-time, much like a radar map for tracking weather patterns.

A third set of challenges in mapping relate to the nature of the space. Cyberspace offers media that at first, often seem contiguous with geographic space, yet on further inspection it becomes clear that the space-time laws of physics have little meaning online. This is because virtual spaces are purely relational. They are not 'natural', but are solely the productions of their designers and, in many cases, users. They adopt the formal qualities of geographic (Euclidean) space only if explicitly programmed to do so, and indeed many media such as email have severely limited spatial qualities. Significantly, many virtual spaces violate two principal assumptions of modern (Western) cartography making them difficult to map legibly using conventional techniques[12]. The first of these are the Cartesian properties of space as continuous, ordered and reciprocal; there are no sudden gaps or holes in the landscape, everything is somewhere, and the Euclidean notion of distance holds true, i.e. the distance from *A* to *B* will be the same as from *B* to *A* (Staple 1995). Yet parts of cyberspace are discontinuous, lacking linear organisation and in some cases elements can have multiple locations.

The second assumption is that the map is not the territory but a representation of it, (i.e. the territory has a separate, ongoing existence and meaning beyond the map.) Yet there are examples of virtual space where in a literal and functional sense the map *is* the territory. Cartesian logic collapses and there is no reality independent of the representation (Dodge and Kitchin 2000a). This conflation of the map and the territory is most obviously seen in hypertext spaces when the structuring of the data is both the space and its map. This can be experienced in the experimental three-dimensional 'fly-through' spatializations of hypertext, such MIT Media Lab's Perspecta system (Holtzman 1997) or Apple's HotSauce

[12] Of course, a number of geographers have undertaken work on non-Euclidean geographies using relational measurements of distance (e.g., Gould 1991).

navigation map-interface (Figure 3.7) (cf. Dodge 2001a). Staple (1995, 71) comments further that in "a very real sense the session is the map. Or paraphrase Marshall McLuhan, the medium is the map." Interestingly, none of the experiments in 'fly-thru' map-spaces that emerged in the 1990s gained widespread usage despite great hope by some pundits that they would overturn the page-by-page view of the Web (a visual paradigm based largely on book metaphors) ingrained in browsing software.

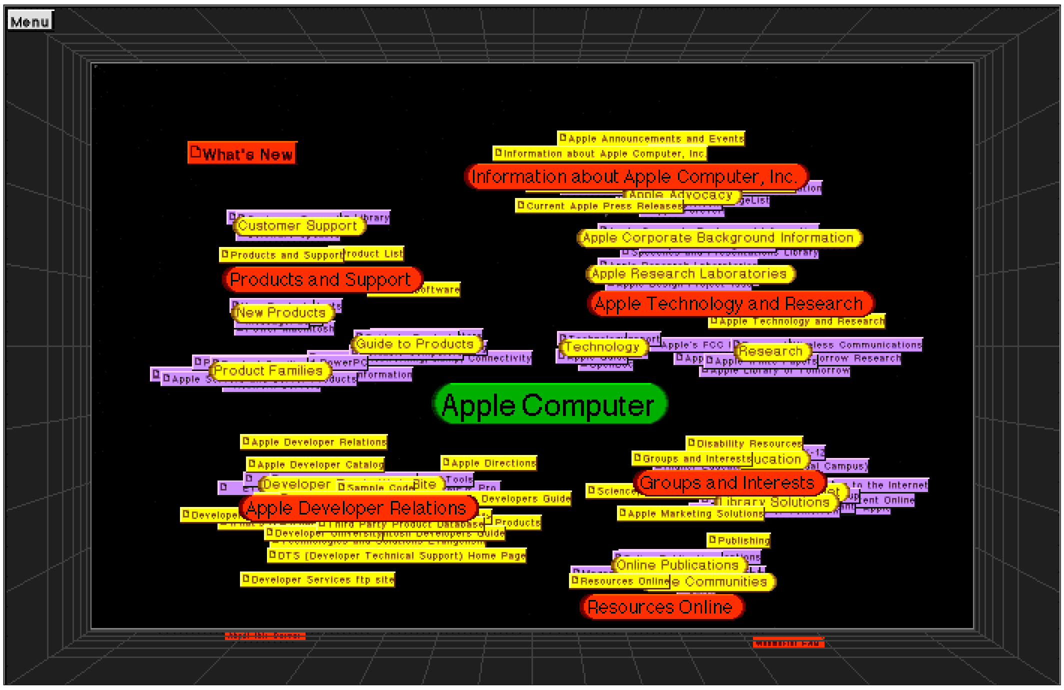

Figure 3.7: A screenshot of the HotSauce fly-through interface to Web space produced in the mid 1990s by Ramanathan V. Guha while working at Apple Research. It was an experimental three-dimensional abstract representations and illustrates the degree to which 'maps <u>for</u> cyberspace' mode stretches beyond cartographic conventions. As an effective navigation map it was a failure. (Source: author screenshot.)

At present, it is probably fair to say that in relation to the challenges of producing effective 'maps <u>for</u> cyberspace', the current map-makers are at a comparable stage of development to the cartographers at start of Renaissance period in creating comprehensive and useful maps. Although armed with a knowledge of traditional mapping and sophisticated computing, mapmakers are lacking the vital 'blueprints' that Ptolemy provided for European cartographers in terms of a projective grid for plotting the knowledge of vastly expanded territories that the New World explorations brought back. At present there is no equivalent world-making grid of latitude and longitude for cyberspace. As a consequence, many cyberspace cartographers have generally resorted to extending existing methods.

One productive route forward for this mode is to draw upon the mapping epistemologies of non-western, aboriginal cartographies, which are markedly different from the dominant conventions and norms of Western cartography, and might well provide insights for future cyberspace mapping projects. Much of the focus in indigenous cartography is on the non-textual visualisation of conceptual links, pathways and relationships between space rather than the geometric grids and locational accuracy emphasised in modern (Western) cartography.

3.3 Literature on the cartographies of cyberspace

There is a substantial body of critical analysis on the history of cartography, and on contemporary digital mapping and the practices of GIS, yet there has been little scholarly work examining cyberspace cartographies *per se*. While examples of cyberspace maps crop up frequently in different literatures, such as network maps used as illustrations in technical guide books (e.g., Quarterman 1990) and histories of the Internet (e.g., Abbate 1999; Hafner and Lyon 1996; Salus 1995), most are without systematic comment on their semiotic properties or their wider social significance.

To begin the summary of relevant literature on cyberspace cartographies, I want to consider Gregory Staple's paper, *Notes on Mapping the Net: From Tribal Space to Corporate Space* (1995). (Staple is a telecoms lawyer and the founder of TeleGeography, as noted above.) Although it is a non-academic treatise in some respects, and was published in grey literature, the paper provides a valuable perspective on the emergence of cyberspace cartographies from one of the pioneers in the field. Staple argues firstly that cyberspace is significant in extending the centuries old debate about 'what are maps' and starts by drawing direct parallels to the explorative drive from the 'age of discovery' to define contemporary cartographic motivations. He notes that effective maps of cyberspace are rare because "[f]ew among this frontier fraternity" of hackers and webmasters, "have both the navigational and drafting skills of a Ferdinand

Magellan or a James Cook" (Staple 1995, 66). He then provides a role call of 'issues' that make cyberspace mapping challenging, including the lack of an established mental conception of what cyberspace *should* look like: "Ask a communications engineer to draw a picture of cyberspace and you are likely to get a sea of clouds each representing a different network" (Staple 1995, 67) (see also chapter four). The confusion in how to represent cyberspace calls for a clear separation of the "hardware and software side of the on-line world." (Staple 1995, 67), matching partially the mode conceptualisation used here in this thesis (i.e., 'maps of cyberspace' and 'maps for cyberspace').

Staple's principal interest is in 'cybermaps' to represent information spaces for user navigation (what I define as the 'maps for cyberspace' mode). To achieve this, he notes, new maps will likely be cartographically unconventional (i.e. breaking the Euclidean conventions of most Western maps) and he draws on ideas from tribal mapping as a source for such alternative conceptions. Importantly, connectivity rather than continuity of virtual spaces of cyberspace need to be represented to users and he cites American Indian and Australian Aboriginal mapping as a useful model for this: "Cybermaps like tribal maps may ... dispense with conventional perspective to conserve connectivity. They are true to the land, not to the theodolite" (Staple 1995, 68). Staple means the focus of measurement and mapping should be on overall topology rather than topographic detail. He concludes the paper by discussing the social implications of cybermaps in relation to the changing forms of cyberspace evident in the mid 1990s with the start of rampant commercialisation, arguing that initial exploration mapping will open up cyberspace to the controlling cartography of "a more mercantile genre" with universalising grids capable of locating all virtual territory. "Tomorrow's cybersmaps" he concludes "will record the boundaries of corporate space on the Net even as earlier ones illustrated its tribal origins" (Staple 1995, 72).

In terms of writing by academic cartographers, there are two descriptive papers by Jiang and Ormeling (1997 and 2000) which do engage with cyberspace cartography directly, although they do not attempt any theoretically-informed critique of their social implications. The lead author is heavily involved in visualisation research and the papers were both published in the *Cartographic*

Journal, the house journal of the British Cartographic Society which speaks to 'mainstream' practitioners and researchers. Both papers review a range examples of 'cybermaps' with an explicit 'call to arms' to cartographers to lend their skills and experience to make improved maps, asserting that: "cartographers with a long standing tradition of mapping geographical space, can make an important contribution to mapping cyberspace" (Jiang and Ormeling 1997, 111).

Jiang and Ormeling's first paper, *Cybermap: The Map for Cyberspace* (1997), defines the nature of the 'cybermap' elliptically as a "special map for cyberspace" (p.112) that encompasses representations of both the physical network and the information spaces. Drawing on theories of maps as communication tools, they set out a three-fold 'functional classification of cybermaps': navigation maps, maps for cyberspatial analysis, maps for persuasion. The short paper includes five colour cybermaps as illustrations, but these are not politically critiqued. The authors use them in the affirmation of the need for professional cartography, somewhat snobbishly noting that "[a]s many cybermaps are produced by non-cartographic professionals, it is unavoidable that some low quality maps are created."

Jiang and Ormeling's second paper, *Mapping Cyberspace: Visualizing, Analysing and Exploring Virtual Worlds* (2000), covers similar ground to the first, with the map again normatively defined as "a visualisation tool for understanding and perception of space" (p. 118). They set out a somewhat modified conceptualisation of cyberspace mapping as being concerned, firstly, with analysing the geography of the "physical anchorages" of Internet following the "principle of traditional thematic mapping" (Jiang and Ormeling 2000, 118), secondly, a typology of network forms in which the Internet is visualised as non-geographic trees and graphs (they cite the Cheswick-Burch visualisation as an exemplar; see Figure 4.10). Lastly, they argue cybermaps are the means to produce "general purpose maps for virtual worlds" (Jiang and Ormeling, 2000, 118) as an aid to user navigation through three-dimensional space.

Batty and Miller (2000) bring the concept from quantitative modelling of accessibility into their analysis of representations of different types information space. They are concerned with developing a research agenda for understanding the nexus between material and virtual spaces, the hybrid space that they argue will be the "focus for a new geography of the information age" (Batty and Miller 2000, 134). Attempts to directly map out virtual spaces using traditional techniques developed for Euclidean landscapes, they argue, may well not be applicable because of the ease with which 'rules' of geographic space are broken and the unsuitability of the existing tools: "current GIS software does not treat non-Euclidean space in an appropriate way" (Batty and Miller 2000, 136) they point out. An alternative, to map the real-world locations of the physical and logical components of virtual space, is again viewed with caution by Batty and Miller because "[t]he spatial/geographical metaphor may not be appropriate, particularly since information flow in most networks apparently does not correlate with geographical space" (Batty and Miller 2000, 136). This is an issue because fluid and uncertain phenomena are hard to represent in cartographic meaningful ways.

One route forward, they suggest, might be to look beyond mapping the 'surface' morphology of cyberspaces towards an analysis of the structural process underlying cyberspatial production by modelling interactions using measures of latency instead of Euclidean distance to "see whether or not the frictionless world that has emerged has any parallel in traditional geographic spaces" (Batty and Miller 2000, 139) or by applying the notion of power laws and small world networks to understand the emergent properties of information objects (such as Web sites and their hyperlink structures). By way of conclusion they set out a fourfold research program for representing hybrid space (p. 144) focused on (1) visualisation of connections between material and virtual geographies by augmenting existing measures of accessibility and developing new ones; (2) researching information flows and costs in relation to existing market, social and institutional processes; (3) mapping activity spaces by extending time geography theories to take account of network flows; (4) developing tools for cyber-navigation. This agenda has clear overlaps to my conception of cyberspace cartography, with the first two items aimed at advancing the 'maps <u>of</u> cyberspace' mode and the other two items come within the remit of the 'maps <u>for</u> cyberspace' mode.

Castells' (1996) sophisticated sociological theorisation of the network society was founded on the power of informational flows to reconfigure time-spaces of material places. In his book, *The Internet Galaxy*[13] (2001) he analyses in more depth the material production of the Internet with a review of the geography of the infrastructure with descriptive statistics and census-type mapping. He sets out a three-fold schema for analysis that in many respects correlates to major types of 'maps of cyberspace' mode outline above. The first element in the schema is the "technical geography" by which Castells' (2001, 208) refers to "the telecommunications infrastructure of the Internet, the connections between computers that organize Internet traffic and the distribution of ... bandwidth". The second element is the customer statistics, especially concerning the uneven geographic distribution of access and usage. The final element in Castells' schema is the economic geography of Internet production, which has a much more spatially concentrated pattern that usage. Drawing heavily on the work of economic geographer Zook, the chapter includes seven illustrative thematic maps of Internet statistics that show very much the conventional face (and normative utility) of cyberspace cartographies to make intangible spaces seem tangible to a non-technical audience.

Outside of academic geography, the most theoretically sophisticated work on cyberspace cartographies is the paper by Harpold, titled *Dark Continents: Critique of Internet Metageographies* (1999). Coming from the cultural studies domain, Harpold provides a cogent postmodernist critique of maps of global-scale Internet infrastructure, richly illustrated with relevant empirical evidence. He views much of the output of the 'maps of cyberspace' modes as a pernicious new 'metageography'[14] sustaining the information society. "[T]he inherent selectivity and social subjectivity makes a map", Harpold (1999, 18) argues, "a

[13] As an interesting side point, the book's cover features a version of the Burch-Cheswick Internet graph as its central motif. Clearly this image conjured up, both, the space of networks as well outer (galactic) space in the mind of the designer (see discussion in chapter four).

[14] Harpold's concept of metageography, following Lewis and Wigen (1997), is defined as "sign systems that organize geographical knowledge into visual schemes that seem straightforward, but which depend on historically- and politically-inflected misrepresentation of underlying material conditions." (p. 5).

problematic construct for describing the heterogeneous conditions and practices of the emerging global telecommunications networks." He is particularly concerned with the politics of silence and the iniquitous *under* representation of the peripheries of cyberspace as evidenced in the blank spaces of the African continent on most infrastructure maps. He draws direct ideological parallels here to the colonial mappings of the nineteenth century, arguing "[t]he blank region is 'empty' only in relation to the comparable fullness of the rest of the map" (Harpold 1999, 3). He proceeds to trace out the implications of using nation-state boundaries as the 'natural' background to represent Internet diffusion, bandwidth and access, when the motive forces behind the processes are operating in a multi-scalar networked political economy. The result, he agues, is that these kinds of 'maps <u>of</u> cyberspace' are deeply deceptive, overstating the extent of Internet diffusion because fundamentally they are unable to "account for the extreme local obstacles which must be overcome before anything like a viable African Internet is possible, at least as netizens of digitally-saturated, liberal-democratic nations understand the Internet." (Harpold 1999, 12)

In Harpold's opinion (1999, 17), too many 'maps <u>of</u> cyberspace', by opting for conventional geographic projections, nation state boundaries and signs systems of thematic cartography, produce mythologies that reduce the Internet into categories of "on/off, traffic/no traffic, wired/unwired". Thus the maps work, Harpold asserts, as a display of "counterfeit ubiquity and technological reasonableness" that masks the unevenness of the process of Internet diffusion and the extent to which the network will further acerbate social difference between places. He ends his analysis with a call to map the Internet using a different cartographic imagination, with "new schemes for representing the archipelagic landscapes of the emerging political and technological world order." (Harpold 1999, 18). It is not clear whether these have been drawn yet or, indeed, whether they can be drawn at all by map-makers cultured with conventional Western metageography.

Circuits

G1

THURSDAY, SEPTEMBER 30, 1999

The New York Times

Beyond Geography: Mapping Unknowns Of Cyberspace

Mapmakers Stretch The Definition of Cartography To Help Visualize the Web

Cyberspace maps can take many forms, including a multilayered map of the space represented by 100,000 entertainment-related Web addresses, above; a real-time representation of Web traffic, far left, and the featherlike tracings of data routes, left.

By PAMELA LiCALZI O'CONNELL

THE mapping of that vast territory known as cyberspace has begun in earnest.

Cyberspace maps are being produced by geographers, cartographers, artists and computer scientists. They range from glorious depictions of globe-spanning communications networks to maps of Web information.

Many have no geographic references, instead turning to nature, the cosmos or neuroscience for spatial models. They stretch the definition of a map in their effort to capture, sometimes fancifully, what is sometimes referred to as the "common mental geography" that lies beyond computer screens.

The maps hold the potential to change, subtly or perhaps more directly, the relationship of the average person to cyberspace, the world of electronic communication that includes but is not limited to the Internet. How people envision the on-line landscape influences their behavior there, experts say.

"We need maps not just to navigate but to define and control new territory," said Martin Dodge, a researcher in the Center for Advanced Spatial Analysis at University College London. "Simply having a map allows a new perspective, a new way to orient yourself. Relationships otherwise obscure may be revealed."

The largest collection of maps can be found at Mr. Dodge's Web site, An Atlas of Cyberspaces **(cybergeography.com)**. The dozens of examples there include many that arise from science and instrumentation, while others are more products of imagination.

"We are in the very early stage of map making — these maps are far from perfect at the moment," Mr. Dodge said. "Most have been produced outside traditional cartography by people such as data visualization researchers who may not even call their results a map."

Maps of cyberspace fall into two categories: those depicting the physical structure and information traffic patterns of global networks, and those addressing the content and social spaces of the electronic world.

Structural maps, although seemingly straightforward, have proved quite thorny to create. Since the National Science Foundation relinquished its stewardship of the Internet in 1995, there has been no central source of information about the Net's backbone networks and traffic. Instead, there is a jumble of networks owned by phone companies and Internet service providers, some of which do not share information, for competitive reasons.

The Cooperative Association for Internet Data Analysis, or Caida, at the University of California at San Diego develops tools to collect and analyze data about the Net, like the specific paths a test packet of information may follow.

"We are not at a point yet where we are drawing maps with any compelling utility for any particular community,"

Continued on Page 7

Figure 3.8: The highly illustrated first page of a major story in the *New York Times* that publicized the notion of cyberspace cartographies at the end of the 1990s. (Source: O'Connell 1999, G1.)

3.3.1 Popular interest in cyberspace cartographies

The field of cyberspace mapping has also received coverage from the mainstream media in many parts of the world. Notable articles where the journalists provided useful analysis includes: Bodzin (1999), Forde (2000), Johnson (1999) and O'Connell (1999). The last of these was a substantive review article in the *New York Times* entitled *Beyond Geography: Mapping Unknowns of Cyberspace,* which provided a coherent frame to the field, noting that cyberspace cartographies encompass a diverse range of representations and are being "produced by geographers, cartographers, artists and computer scientists" (p. G1). The story was illustrated prominently with five colour examples from both modes with the front page dominated by an Earth globe from the visualisation research of Lamm *et al.* (1995) (Figure 3.8). Two other well known Internet visualisations were used, firstly a fragment of the Burch-Cheswick topology graph (see also Figure 4.10) and the 'arc across the world' map by Stephen Eick and colleagues (see also Figure 4.4). O'Connell (1999, G1) argued that cyberspace cartographies stretch the "definition of a map in their effort to capture, sometimes fancifully, what is sometimes referred to as the 'common mental geography' that lies beyond computer screens." Defining the field, she divided cyberspace cartographies into two types, infrastructure and traffic maps on one side, and "those addressing the content and social spaces of the electronic world." (O'Connell 1999, G1) on the other. The quotes she includes from various domain experts create an impression of a nascent field with few practical maps available, but an upbeat prognosis about future developments; as she notes: "The maps hold the potential to change, subtly or perhaps more directly, the relationship of the average person to cyberspace." (O'Connell 1999, G1).