SECTION TWO

Technologies of Mapping

2.1

Introductory Essay: Technologies of Mapping

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Introduction

Technological foundations of cartography are crucial to understanding the contemporary nature of maps. Over hundreds of years there have been many new technical developments concerning the capture of data about the world, the processing of geographic information, and the production and design of representational media. Earlier shifts in the mode of production of mapping focused upon the emergence of printing technologies in Western Europe in the Renaissance period, which facilitated the mass production and dissemination of maps printed on paper. A progressive shift took place from manuscript production, to printing based on woodblocks, copper engraved plates, lithography and, by the twentieth century, to photomechanical technologies (Mukerji 2006; Cook 2002). Meanwhile changes in data collection were reflected in changing modes of surveying, such as the systematic development of triangulation associated with the rise of national and military mapping agencies (Biggs 1999; Seymour 1980), and the application of photogrammetry in the early twentieth century (Collier 2002). New technologies were also deployed in the projection of data (Snyder 1993, excerpted as Chapter 2.9).

These developments, and how they were exploited by individuals and institutions to their advantage (e.g. different sea charts aiding more successful navigation and the expansion of trading empires), have profoundly affected the mapping process at different times resulting in many distinct modes of mapping (Edney 1993, excerpted as Chapter 1.10). This introductory chapter focuses in detail upon just one of many technological transitions (Monmonier 1985, excerpted as Chapter 2.2), the latest in a series of shifts through which mapping has passed and explores how different technologies are enrolled into a working series of practices and mapped artefacts.

The dominant technology of contemporary mapping is computing, which has emerged over the last fifty years to underpin digital cartography. Various specialised hardware, sophisticated software applications, databases and video displays operate as powerful socio-technological agents because they provide means to automate and augment existing cartographic process as well as opening new channels for mapping to be undertaken. As Tobler noted in his prescient article in the 1959 at the beginnings of the process: ‘It seems that some basic tasks, common to all cartography, may in the future be largely automated and that the volume of maps produced in a given time will be increased while the cost is reduced’ (p. 534; excerpted as Chapter 2.5).

Digital cartography then exploits processes of automation and augmentation through technologies for data capture (e.g. satellite imagery, GPS, laser ranging tools), the handling and processing of data (e.g. CAD, GIS and desktop publishing applications), the efficient storage and rapid distribution of vast quantities of data (e.g. database software, hard drives, servers, data networks, the Internet) and the delivery, presentation and interactive uses of maps (e.g. widespread availability of high resolution display screens, affordable laser printing, embedded multimedia

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documents, streaming 'live' to location-aware mobile devices).

Computers, as so-called 'universal machines', appear to offer unprecedented advantages in the quest for more accuracy and efficacy in map production. In terms of technologies of data capture, for example, it can be argued that computers, and the assemblage of measurement/imaging/sensing technologies, have brought improved and more mimetic ways of knowing the world and appear to be the next step on the 'path to perfection' in mapping. For example, locational precision has become widely and easily available through GPS and the ever-increasing spatial resolution of satellite imaging. Data can be logged automatically and continuously without human intervention. Indeed, cartography's ability to accurately capture the world has been transformed by digital photogrammetry, remote sensing, GPS-based surveying and mobile mapping (Jensen and Cowen 1999, excerpted as Chapter 2.8; Li 1997, excerpted as Chapter 2.10). Advances in digital data capture, processing and geovisualisation not only enable us to 'see' the world in greater depth (Pickles 2004), but also to 'see' new things (including virtual spaces), in new temporal registers.

Technologies of cartographic production have often been explained through narratives of scientific progress. As a consequence, the history of cartography tends to be written as a history of technique (Crone 1953), with an underlying assumption that rational decision making leads to the adoption of improved technologies and updating institutional practices when they become available. For example, in much of the writing – both applied and scholarly – the computerisation of cartography is bound-up in progressive discourses of scientific advancement and increasing accuracy and depth of knowledge (Goodchild 1999, excerpted as Chapter 2.6; Monmonier 1985, excerpted as Chapter 2.2). This fits within with a long running storyline of progress in cartography: art becomes science, florid designs become formal display, the named cartographer becomes an anonymous technician; see also discussion in Chapter 1.1.

However, whilst it is clear that digital cartography has some distinctive qualities with respect to previous modes of mapping, we argue it would be naive to assert that computers give rise to ostensibly *superior* mapping to other modes. The ideas and techniques underpinning cartographic practice has always been a contested across time and space. As such, we should be careful not be read the present prevalence of digital cartography as a simple and progressive path of innovation and adoption, that inevitably leads to better mapping of the world, any more than earlier applications of technologies *inherently* led to progress. Rather we would argue that change is messy, contingent and partial. Developments unfold in fits and starts, proceeding with leaps and failures. Whilst undoubtedly digital data capture and new computerised mapping systems can supply more detail and more cartographic data to be displayed on-demand, it is questionable as to whether they deliver better or more objective representations of the world than previous methods and technologies of mapping. Maps tend to be judged on how well they communicate, not according to their level of detail. Further, many spaces of human culture remain unmapped and are perhaps unmappable, despite sensors and sophisticated GIS software (Muehrcke 1990, excerpted as Chapter 2.7). Moreover, as a new technology is adopted, the role and power of individuals and institutions is reconfigured: there are always winners and losers due to innovations and new practices and relations (see discussion in McHaffie 1995, excerpted as Chapter 2.3). For example, with the rise of internet-based mapping, the role of national mapping agencies is weakened with respect to commercial data providers, and software engineers and interface designers start to displace professionally-trained cartographers (Wood 2003).

Characteristics of digital cartographies

The development and rapid diffusion of digital technologies in the last three decades has affected all aspects of mapping, changing methods of data collection, cartographic production and the dissemination and use of maps. This has been termed the 'digital transition' in cartography (Goodchild 1999, excerpted as Chapter 2.6; Pickles 1999; Rhind 1999) and it is continuing apace (for example, developments in mass market satnav systems or innovative mobile mapping services; see later). As such the computer is a vital component in understanding the milieu in which new forms of mapping practice are emerging.

While the detailed social and technical histories of the digitisation of the cartographic industry are complex and largely unwritten, it would be fair to say tha, in the last couple of decades, mapping practice has been almost wholly subsumed in a rapid convergence of spatial technologies, such that today professional cartography operates as a rather marginal 'end service' component of the multibillion dollar GI industry. Nowadays, the majority of maps are digital and created only 'on demand' from geospatial databases for temporary display on screens. The heyday of published unwieldy folded map sheets and heavy paper atlases is past: they are being replaced by the rapid technological development of GIS, spatial databases and real time mapping systems; the potency of these developments is most evident perhaps in terms of web mapping.

Developments in networking technologies and computer-mediated communications, and the rise of the World-Wide Web from the early 1990s, have meant that digital maps are now very easy to distribute at marginal cost and can be accessed 'on demand' by many (Peterson 2003, 2008). One of the first examples was the Xerox PARC Map Viewer, launched online in June 1993 by Steve Putz. (The map is no longer online, however background details are available at <www2.parc.com/istl/projects/www94/iisuwwwh.html>). Commercial online mapping and driving instructions were pioneered by the internet portal MapQuest.com in the mid 1990s, which by the turn of the century had already generated more digital maps than any other publisher in the history of cartography (Peterson 2001). Since launching in 2005 the popularity of Google Maps with its open API (Application Programming Interface), has inspired an explosion of new online mapping tools and hacks (Geller 2007, excepted as Chapter 2.12; Gibson and Erle 2006). These web mapping services are seemingly 'free' at the point of use and are encouraging the casual use of cartography (the substantial capital costs of granting no-cost public access to detailed topographic maps and high resolution satellite imagery is being met, in part, by revenues from geographically-targeted advertising, but it is also being heavily subsidised at the moment by large corporations, like Google and Microsoft as they seek to entice users to their sites and to dominate the marketplace for online mapping). There is even the prospect that expensive, complex, standalone GIS will begin to adapt and evolve around a web services mapping model (Sui 2008).

Digital cartography has exploited the affordances offered by computer software and the flexibility of screen display to deliver maps in new media forms and other new modes of user interactivity. As the map itself became a fully digital text, many of its basic properties changed. It became almost infinitely malleable and responsive to the user, such that pre-digital, paper mapping seems stilted and somewhat lifeless. A multitude of maps can be generated from a single database in GIS, many design options can be explored at marginal additional cost. The map itself is an interface to the world that can be directly manipulated by users – zooming, panning, selecting layers, querying (Cartwright 1999, excerpted as Chapter 2.11). Rather than reading off the surface of a map, we become increasingly immersed within the mapping experience. Just as the word processor has reconfigured the practices of composing text, so the GIS has profoundly changed the making of maps. Of course this does not mean necessary better maps (Muehrcke 1990, excerpted as Chapter 2.7) just as using Microsoft Word does not guarantee readable prose. Cheap, powerful computer graphics on PCs and increasingly mobile devices, however, do enable a much more expressive and interactive cartography, potentially available to a growing number of people.

The pervasive paradigm of hypertext as a way to structure and navigate digital information has also influenced digital cartography. Increasingly, maps are used as core components in larger multimedia information resources where locations and features on the map are hot-linked to pictures, text and sounds, to create distinctively new modes of map use (Cartwright 1999, excerpted as Chapter 2.11). In design terms, the conventional planar map form itself is, of course, only one possible representation of spatial data and new digital technologies have contributed to much greater diversity of cartographic-related forms including, pseudo three-dimensional landscape views, interactive panoramic image-maps, fully three-dimensional flythrough models (Dodge *et al.* 2008; Fisher and Unwin 2001; Geller 2007, excerpted as Chapter 2.12). It has also reinvigorated long standing but marginal forms of mapping, including cartograms and globes, and facilitated the construction of many new kinds of cartographic projection that could not have been calculated without computers (Snyder 1993, excerpted as Chapter 2.9).

Developments in computer graphics, computation and user interfaces have also begun to fundamentally transmute the role of the map from the finished product to a visual tool to be used interactively for exploratory data analysis (typically with the interlinking of multiple representations such as statistical charts, three-dimensional plots, tables and so on). This changing conceptualisation of the map is at the heart of the emerging field of geovisualisation, which in the last five years or so has been one of the leading areas of applied cartographic research (Dykes and Wood 2009, excerpted as Chapter 3.12; MacEachren and Kraak 2001, excerpted as Chapter 1.11).

Although not universally the case, it is evident that the emergence of digital cartography has also made mapping much more available, fostered a good deal of creativity and widen participatory options (Goodchild 2007, excerpted as Chapter 4.10; see also discussion in Chapters 4.1 and 5.1). More people have the option to become mapmakers themselves, without needing to master a wide range of technical and technological skills, be it via simple 'map charting' options in spreadsheets to produce basic thematic maps of their own data, through desktop GISs such as MapInfo and, of course, with a plethora of online tools (Geller 2007, excerpted as Chapter 2.12). As more and more people 'bypass' professional cartographers to make their own maps as and when required, it is possible that the diversity of map forms and usage will expand; although access to 'point-and-click' mapping software itself is no guarantee that the maps produced will be as effective as those hand-crafted by professionally-trained cartographers (Chapter 3.1). More recent developments in so-called 'volunteered geographic information' are also dependent on raft of digital technologies for collaboration (Goodchild 2007, excerpted as Chapter 4.10; Elwood 2008). The emergence of open-source cartography, exemplified by the OpenStreetMap project, also has the potential to challenge the commercial commodification of geospatial data by developing a 'bottom-up' capture infrastructure that is premised on a volunteerist philosophy (see also Colour Plate Five, page xx).

The widespread provision of GIS tools and online mapping services is significantly shifting access to mapping and spatial data, as well as altering user perception of what a map should be. There are clear signs that cartography will be seen as simply one of many available 'on demand' web services. As the digital map display becomes more flexible and accessible, it is also, in some respects, granted a less reified status than the analogue paper map of the past. Maps are increasingly treated as transitory information resources, created in the moment, and discarded immediately after use. In some senses, this devalues the map, as it becomes just another ephemeral medium, one of the multitude of screen images that people encounter everyday. Cartographic knowledge itself is just another informational commodity to be bought and sold, repackaged and endlessly circulated (McHaffie 1995, excerpted as Chapter 2.3; Pickles 1999).

However, technological innovation also seems to be pushing digital cartography towards personal mapping. Here, web mapping tools generate maps tailored to answer specific queries with the point of interest lying at the centre of the display, whilst directional controls mean one can move about the map seemingly at will and without arbitrary constraints of sheet boundaries as with paper products. The mundane power of the so-called 'slippy' map is now so common as to be noticed only when it is not available on a digital mapping system. Mobile devices, locational awareness and ubiquitous mapping delivered to the palm of one's hand seem to put the user at the very heart of the map, and crucially this kind of 'me-map' can dynamically update in time with the moving user. The synchronisation of map and body makes for a new and highly compelling form of cartography (Meng 2005, excerpted as Chapter 3.11). The perceptual power of the digital 'me-map' to intimately connect people to place is further enhanced by use of the first person perspective display: one is looking *into* the world, rather than down *onto* it. This can be seen, for example, in the scrolling isometric view pioneered by TomTom satnavs and the ground-level Google Street View mapping. Such views present the world in new ways and the sense of interactivity seems to change who controls the viewing. They are also, importantly, fun to use with game-like qualities of exploration and play (Churchill 2008). It is somewhat ironic that making maps more personally focused also serves the interests of corporations and states, as they can operate as surveillant technologies – typing a postcode into a search boxes generates a unique map for the individual but also reveals to the mapping site what that individual is interested in at that moment in time. In contrast, looking up an address in a paper street atlas leaves behind no trace of mapping intent.

Interestingly, in the future, much of the growth in personal mapping will come from people gathering geospatial data as they go about their daily activity, automatically captured by location-aware devices that they will carry and use (Ratti *et al.* 2006; for overview discussion see Thielmann 2010). From this kind of emergent mobile spatial data capture it will be possible to 'hack' together new types of maps, rather than be dependent on the map products formally published by governments or commercial firms. Such individually made, 'amateur' mapping may be imperfect in many respects (not meeting the positional accuracy standards or adhering to TOPO-96 surveying specifications for example), but could well be more fit-for-purpose than professionally produced, general cartographic products. There is also exciting scope for using locative media to annotate personal maps with ephemeral, micro-local details, personal memories, messages for friends and so on, that are beyond the remit of governmental cartography or the profitability criteria for commercial cartographic industry. An example would be the work of artist Christian Nold's on-going emotion mapping project (www.emotionmap.net), as well innovative work in affective mapping (Aitken and Craine 2006, excerpted as Chapter 3.10).

Cautions and caveats in digital cartographic developments

In some respects, then, the outcome of the digital transition can be read as a democratisation of cartography (Rød *et al.* 2001), widening access to mapping and breaking the rigid control of authorship by an anonymised professional elite. However, if one looks more closely (and sceptically), the freedom for people to make their own maps with these types of software tools is strongly inscribed in the design and functionality of the software itself. The maps one can make online are only the maps the services allows one to make. Many people make their own maps with Google's service but these all ultimately still have the look and feel of a Google Map and are constrained by the tools that the corporation provides. Indeed, the majority of people still do not have the time or skills to break free from the functional constraints that the software imposes (also see Fuller's (2003) analysis of the framing power of Microsoft Word on writing and Tufte's (2003) critique of Microsoft PowerPoint on how people give presentations). Google may currently make a vast amount of spatial data freely available online (supported by advertising) but it is subject to their terms and conditions of use and raises the risk of monopolistic provision (Farman 2010, excerpted as Chapter 5.11; Zook and Graham 2007).

Further, interpreting the digital transition should not merely be about plotting technical 'impacts', but should also involve assessing the political implications of changing social practices in data capture and map authorship. Being wary of linear narratives of progress, one should not read the digitisation of the map as seamless, unproblematic or inevitable (Pickles 1999). Technological change is always contested, driven by competing interests and received in different ways and at different speeds in particular institutional settings (McHaffie 1995, excerpted as Chapter 2.3; Harvey 2001). Technology is never a neutral actor. It is shaped by social forces and bound up in networks of power, capital and control of new institutional practices in the processes of cartographic digitisation. The benefits and costs of change are always uneven. Government agencies and large commercial mapping firms have invested heavily in digitisation not from enlightened ideals to improve cartography, but because it serves their interests by maximising efficiency, reducing costs by deskilling production and by boosting revenues. The popular discourses of digitisation in cartography and elsewhere are often uncritical, driven in large part by the hype of the vendors of hardware and software, and IT consultants offering 'solutions'. The reality of the 'messy' social aspects of digitisation are glossed over in techno-utopian fantasies. There are risks, uncertainties and resistance to technological change that rarely get reported or recorded (e.g. the loss of craft skills; the risks of investing in technology instead of labour; the industrial disputes that often follow from technological innovation etc.).

The digital transition in cartography has made it more urgent to understand the wider social milieu in which maps are produced and disseminated. One needs to realise that the path of digitisation in cartography has been driven in large part by militaristic interests in various guises (Clarke 1992, excerpted as Chapter 2.4; McHaffie 1995, excerpted as Chapter 2.3; Cloud 2002). The underlying geospatial technologies and capture infrastructures (such as satellite imaging and GPS) are still dependent on state funding and imperatives of territorial security. Rather than becoming more democratic, one could argue that the surveillant power of the cartographic gaze is deepening, particularly after 9/11 (Monmonier 2002), accompanied by a fetishisation of the capability of geospatial technologies to 'target terrorism'. The mundane disciplining role of digital maps in systems of computerised governmentality continues to grow, for example in consumer marketing and crime mapping (Crampton 2003, excerpted as Chapter 5.8; Farnham 2010, excerpted as Chapter 5.11). Such surveillance requirements are also a hidden driver in the development of new mapping techniques for internet and mobile services. In conclusion, Pickles (2004: 146) notes cautiously: 'As the new digital mappings wash across our world, perhaps we should ask about the worlds that are being produced in the digital transition of the third industrial revolution, the conceptions of history with which they work, and the forms of socio-political life to which they contribute.'

References

Aitken, S. and Craine, J. (2006) Guest editorial: Affective geovisualizations. *Directions Magazine*, 7 February, www.directionsmag.com. (Excerpted as Chapter 3.10.)

Biggs, M. (1999) Putting the state on the map: cartography, territory, and European state formation. *Comparative Studies in Society and History*, **41**, 374–405.

Cartwright, W. (1999) Extending the map metaphor using web delivered multimedia. *International Journal of Geographical Information Science*, **13** (4), 335–353. (Excerpted as Chapter 2.11.)

Churchill, E.F. (2008) Maps and moralities, blanks and beasties. *ACM Interactions*, July/August, 40–43.

Clarke, K.C. (1992) Maps and mapping technologies of the Persian Gulf war. *Cartography and Geographic Information Systems*, **19** (2), 80–87. (Excerpted as Chapter 2.4.)

Cloud, J. (2002) American cartographic transformations during the Cold War. *Cartography and Geographic Information Science*, **29** (3), 261–282.

Collier, P. (2002) The impact on topographic mapping of developments in land and air survey: 1900–1939. *Cartography and Geographic Information Science*, **29** (3), 155–174.

Cook, K.S. (2002) The historical role of photo-mechanical techniques in map production. *Cartography and Geographic Information Science*, **29** (3), 137–154.

Crampton, J. (2003) Cartographic rationality and surveillance. *Cartography and Geographic Information Science*, **30** (2), 135–148. (Excerpted as Chapter 5.8.)

Crone, G.R. (1953) *Maps and Their Makers: An Introduction to the History of Cartography*, Hutchinson's University Library, London.

Dodge, M., McDerby, M. and Turner, M. (2008) *Geographic Visualization: Concepts, Tools and Applications*, John Wiley & Sons, Ltd, Chichester, England.

Dykes, J. and Wood, J. (2009) The geographic beauty of a photographic archive, in *Beautiful Data* (eds T. Segaran and J. Hammerbacher), O'Reilly, Sebastapol, CA, pp. 85–102. (Excerpted as Chapter 3.12.)

Edney, M.H. (1993) Cartography without 'progress': reinterpreting the nature and historical development of mapmaking. *Cartographica*, **30** (2/3), 54–68. (Excerpted as Chapter 1.10.)

Elwood, S. (2008) Volunteered geographic information: Future research directions motivated by critical, participatory, and feminist GIS. *GeoJournal*, **72** (3/4), 173–183.

Farman, J. (2010) Mapping the digital empire: Google Earth and the process of postmodern cartography. *New Media & Society*, **12**, doi: 10.1177/1461444809350900. (Excerpted as Chapter 5.11.)

Fisher, P. and Unwin, D. (2001) *Virtual Reality in Geography*, Taylor & Francis, London.

Fuller, M. (2003) It looks like you're writing a letter: Microsoft Word, in *Behind the Blip: Essays on the Culture of Software* (ed. M. Fuller), Autonomedia, Brooklyn, NY, pp. 137–165.

Geller, T. (2007) Imaging the world: The state of online mapping. *IEEE Computer Graphics and Applications*, March/April, 8–13. (Excerpted as Chapter 2.12.)

Gibson, R. and Erle, S. (2006) *Google Mapping Hacks*, O'Reilly, Sebastopol, CA.

Goodchild, M.F. (1999) Cartographic futures on a digital Earth. *Proceedings of the 19th International Cartographic Association*, 14–21 August 1999, Ottawa, Canada. (Excerpted as Chapter 2.6.)

Goodchild, M.F. (2007) Citizens as sensors: The world of volunteered geography. *GeoJournal*, **69** (4), 211–221. (Excerpted as Chapter 4.10.)

Harvey, F. (2001) Constructing GIS: actor networks of collaboration. *URISA Journal*, **13** (1), 29–37.

Jensen, J.R. and Cowen, D.C. (1999), Remote sensing of urban/suburban infrastructure and socio-economic attributes. *Photogrammetric Engineering & Remote Sensing*, **65** (5), 611–622. (Excerpted as Chapter 2.8.)

Li, R. (1997) Mobile mapping: An emerging technology for spatial data acquisition. *Photogrammetric Engineering & Remote Sensing*, **63** (9), 1085–1092. (Excerpted as Chapter 2.10.)

MacEachren, M.A. and Kraak, M.-J. (1997) Exploratory cartographic visualization: advancing the agenda, *Computers & Geosciences*, **23** (4), 335–343. (Excerpted as Chapter 1.11.)

McHaffie, P.H. (1995) Manufacturing metaphors: Public cartography, the market, and democracy, in *Ground Truth: The Social Implications of Geographical Information Systems* (ed. J. Pickles), Guilford Press, New York, pp. 113–129. (Excerpted as Chapter 2.3.)

Meng, L. (2005) Egocentric design of map-based mobile services. *The Cartographic Journal*, **42** (1), 5–13. (Excerpted as Chapter 3.11.)

Monmonier, M.S. (1985) *Technological Transition in Cartography*, University of Wisconsin Press, Madison, WI. (Excerpted as Chapter 2.2.)

Monmonier, M.S. (2002) *Spying with Maps: Surveillance Technologies and the Future of Privacy*, University of Chicago Press, Chicago, IL.

Muehrcke, P.C. (1990) Cartography and geographic information systems. *Cartography and Geographic Information Systems*, **17** (1), 7–15. (Excerpted as Chapter 2.7.)

Mukerji, C. (2006) Printing, cartography and conceptions of place in Renaissance Europe. *Media, Culture & Society*, **28** (5), 651–669.

Peterson, M.P. (2001), The development of map distribution through the Internet. *Proceedings of the 20th International Cartographic Conference*, vol. 4, pp. 2306–2312.

Peterson, M.P. (2003) *Maps and the Internet*, Elsevier, Amsterdam, The Netherlands.

Peterson, M.P. (2008) *International Perspectives on Maps and the Internet*, Springer, New York.

Pickles, J. (1999) Cartography, digital transitions, and questions of history. *Proceedings of the 19th International Cartographic Association Conference*, 14–21 August 1999, Ottawa, Canada.

Pickles, J. (2004) Computing geographical futures, in *Envisioning Human Geographies* (eds P. Cloke, P. Crang and M. Goodwin), Hodder Arnold, London, pp. 172–194.

Ratti, C., Williams, S., Frenchman, D. and Pulselli, R.M. (2006) Mobile landscapes: using location data from cell phones for urban analysis. *Environment and Planning B: Planning And Design*, **33** (5), 727–748.

Rhind, D. (1999) Business, governments and technology: inter-linked causal factors of change in cartography. *Proceedings of the 19th International Cartographic Association Conference*, 14–21 August 1999, Ottawa, Canada.

Rød, J.K., Ormeling, F. and van Elzakker, C. (2001) An agenda for democratising cartographic visualisation. *Norsk Geografisk Tidsskrift (Norwegian Journal of Geography)*, **55** (1), 38–41.

Seymour, W.A. (1980) *A History of the Ordnance Survey*, Dawson, Folkestone, UK.

Snyder, J.P. (1993) *Flattening the Earth: Two Thousand Years of Map Projections*, University of Chicago Press, Chicago, IL. (Excerpted as Chapter 2.9).

Sui, D.Z. (2008) The Wikification of GIS and its consequences: Or Angelina Jolie's new tattoo and the future of GIS. *Computers, Environment and Urban Systems*, **32** (1), 1–5.

Thielmann, T. (2010) Locative media and mediated localities. *Aether: The Journal of Media Geography*, **5a**, 1–18.
Tobler, W.R. (1959) Automation and cartography. *Geographical Review*, **49** (4), 526–534. (Excerpted as Chapter 2.5.)
Tufte, E.R. (2003) *The Cognitive Style of Powerpoint*, Graphics Press, Cheshire, CT.
Wood, D. (2003) Cartography is dead (thank god!). *Cartographic Perspectives*, **45**, 4–7.
Zook, M.A. and Graham, M. (2007) The creative reconstruction of the Internet: Google and the privatization of cyberspace and DigiPlace. *Geoforum*, **38** (6), 1322–1343.

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